SUSTAINABLE PRODUCTION OF COCONUT IN SARAWAK:
NUTRIENT DEMAND, PEST MANAGEMENT AND RELATED
IMPLICATIONS

by

LAi KUI FONG

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>8MP</td>
<td>Eight Malaysia Plan</td>
</tr>
<tr>
<td>a. i.</td>
<td>Active Ingredient</td>
</tr>
<tr>
<td>AFTA</td>
<td>Asean Free Trade Area</td>
</tr>
<tr>
<td>B</td>
<td>Boron</td>
</tr>
<tr>
<td>C</td>
<td>Carbon</td>
</tr>
<tr>
<td>Ca</td>
<td>Calcium</td>
</tr>
<tr>
<td>CEC</td>
<td>Cation Exchange Capacity</td>
</tr>
<tr>
<td>CGIAR</td>
<td>Consultative Group for International Agriculture Research</td>
</tr>
<tr>
<td>CIRP</td>
<td>Christmas Island Rock Phosphate</td>
</tr>
<tr>
<td>Cl</td>
<td>Chlorine</td>
</tr>
<tr>
<td>CPB</td>
<td>Cocoa Pod Borer</td>
</tr>
<tr>
<td>CSDS</td>
<td>Coconut Smallholders Development Scheme</td>
</tr>
<tr>
<td>Cu</td>
<td>Copper</td>
</tr>
<tr>
<td>CV</td>
<td>Coefficient of Variability</td>
</tr>
<tr>
<td>DAT</td>
<td>Days After Treatment</td>
</tr>
<tr>
<td>DID</td>
<td>Drainage and Irrigation Department</td>
</tr>
<tr>
<td>DMRT</td>
<td>Duncan's Multiple Range Test</td>
</tr>
<tr>
<td>DOA</td>
<td>Department of Agriculture</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
</tr>
<tr>
<td>Fe</td>
<td>Iron</td>
</tr>
<tr>
<td>GAP</td>
<td>Good Agricultural Practice</td>
</tr>
<tr>
<td>ICM</td>
<td>Integrated Crop Management</td>
</tr>
<tr>
<td>IPGRC</td>
<td>International Plant Genetic Resource Council</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated Pest Management</td>
</tr>
<tr>
<td>K</td>
<td>Potassium</td>
</tr>
<tr>
<td>MATAG</td>
<td>Malayan Dwarf x Tagnanam Tall</td>
</tr>
<tr>
<td>MAWA</td>
<td>Malayan Dwarf x West African Tall</td>
</tr>
<tr>
<td>Mg</td>
<td>Magnesium</td>
</tr>
<tr>
<td>Mn</td>
<td>Manganese</td>
</tr>
<tr>
<td>MOP</td>
<td>Muriate of Potash</td>
</tr>
<tr>
<td>MRL</td>
<td>Maximum Residue Level</td>
</tr>
<tr>
<td>N</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Na</td>
<td>Sodium</td>
</tr>
<tr>
<td>NAP3</td>
<td>Third National Agriculture Policy</td>
</tr>
<tr>
<td>P</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>PHI</td>
<td>Post Harvest Interval</td>
</tr>
<tr>
<td>R &amp; D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>S</td>
<td>Sulphur</td>
</tr>
<tr>
<td>SALM</td>
<td>Skim Akreditasi Ladang Malaysia</td>
</tr>
<tr>
<td>SARD</td>
<td>Sustainable Agriculture and Rural Development</td>
</tr>
<tr>
<td>SD</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>SE</td>
<td>Standard Error</td>
</tr>
<tr>
<td>UNCED</td>
<td>United Nation Conference on Environment &amp; Development</td>
</tr>
<tr>
<td>WTO</td>
<td>World Trade Organisation</td>
</tr>
<tr>
<td>Zn</td>
<td>Zinc</td>
</tr>
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</table>
Abstract

Coconut is a crop that is socially important in Malaysia. However, it has declined in importance due to low competitiveness and if left unchecked, is a threat to the social security as it is an important food in the local diet. Dwarf coconut cultivation to meet the demand of young tender coconut, an emerging health food is a feasible component of the coconut industry. Premium value can be obtained from selling young tender coconut, thereby boosting the income of the coastal rural small holder farmers. However, the critical factors affecting the cultivation of dwarf coconut are soil types, nutrient and pest occurrence. The emerging threats of pest outbreak in the recent years are cause for concern, including the coconut leaf miner, the two-coloured coconut beetle and the rhinoceros beetle. During outbreak, control becomes necessary. Trunk injection of systemic pesticide such as methamidophos is considered the practical and cost effective method and is recommended for mature palms.

This study is an attempt to assess such factors, in particular soil-nutrient-crop relationship, and the implications of using the precision pesticide application technique for pest control during outbreak. The studies attempt to provide some insights and findings, to come up with possible suggestions and recommendations for sustained production of coconut.

From the multilocational trials to assess the performance under different soil types and levels of nutrients, the performance of dwarf coconut is found, with good nutrient input of ground magnesium limestone and NPK, to produce well under Pendam soils, a Marine Gley soils used extensively for coconut cultivation. Under similar treatment, the crop produce fairly on Rampangi soil, a Thionic or an acid sulphate soils. To enhance productivity, more information on the soil-nutrient-crop relationship is needed for Rampangi and Sematan soils, the latter an Arenaceous soil traditionally grown with tall coconut.

Studies on the residues in the plant parts after the trunk injection of methamidophos revealed that the pesticide has an immediate pest control effect as it is taking up within three hours to the shoot and the fronds, and is able to protect the fronds against coconut leaf miner for two months as the chemical persisted at significantly high level in the fronds during this period. The chemical is also found in the shoot within three hours after injection and persisted for a month, thus is toxic to pests including the two-coloured shoot feeding beetle and the rhinoceros shoot borer, as well as to any human who intends to harvest the shoot for salad or for cooking during the period. About 3-7 days after injection, methamidophos is found in the young tender coconut water and soft kernel up to a level of 0.05-0.15 mg/kg and the pesticide residue persisted for about 13 weeks or 91 days. For the old nuts, the residue is only detected in significant amount (above the MRL of 0.01mg/kg) one month after injection, and persisted for a duration of 112 days.

Cash flow analyses indicated the financial return from per hectare of dwarf coconut is lucrative on Pendam soil, Asajaya (IRR of 23.8%) but not on Rampangi soil (IRR of 7.9%).
Abstrak


Dari percubaan multi-lokasi untuk penilaian prestasi tanaman di atas jenis tanah yang berbeza dan aras nutrien, prestasi kelapa kerdil telah dikenalpasti, dengan input nutrien yang baik dari batu kapur magnesium dan NPK, memberi hasil yang baik di tanah Pendam, sejenis tanah 'marine gley' yang digunakan secara meluas untuk penanaman kelapa. Tanaman ini mengeluarkan hasil yang sederhana dengan input nutrien yang baik pada tanah Rampangi yang banyak maklumat diperlukan bagi hubungan tanah-nutrien-tanaman bagi tanah Rampangi dan Sematan, sejenis tanah berpasir yang lazimnya ditanam dengan jenis kelapa tinggi.

Kajian ke atas sisa racun di dalam bahagian pokok selepas suntikan batang dengan methamidophos mendapatkan bahawa racun perosak tersebut memberi kesan kawalan perosak yang cepat kerana ia mengambil masa tiga jam sahaja ke pucuk dan semua pelepah, dan boleh melindungi pelepah selama dua bulan kerana bahan kimia tersebut kekal pada aras tinggi yang signifikan semasa tempoh berkenaan. Bahan kimia tersebut juga boleh dijumpai pada pucuk dalam masa tiga jam selepas suntikan dan kekal untuk tempoh sebulan, keadaan ini memberi kesan toksik kepada perosak termasuk kumbang dua-warna, pemakan pucuk dan kumbang badak yang melombong pucuk kelapa dalam tempoh tersebut, begitu juga kepada manusia yang ingin mengambil pucuk untuk dijadikan salad atau untuk bahan masakan. Lebih kurang 3-7 hari selepas suntikan, methamidophos didapati berada di dalam air kelapa muda dan isi yang masih lembut sehingga pada paras 0.05-0.15 mg/kg. Sisa racun perosak kekal untuk tempoh 13 minggu atau 91 hari, iaitu tempoh minima masa jeda pasca tuai (PHI) yang diawasi untuk buah kelapa muda. Bagi kelapa tua, sisa racun hanya dikesan dalam jumlah yang signifikan (melebihi MRL-0.01 mg/kg) sembulan selepas suntikan, dan kekal dalam tempoh 112 hari.

Analisis aliran tunai menunjukkan pulangan kewangan daripada sektor kelapa kerdil untuk 25 tahun berasaskan input nutrien yang tinggi dan kawalan perosak yang baik, adalah menguntungkan di tanah Pendam, Asajaya (IRR 23.8%), tetapi tidak di tanah Rampangi (IRR 7.9%).
CHAPTER ONE
INTRODUCTION

1.1 Background

Agenda 21 identified agriculture as the major sector activities which can significantly affect resources and the environment. Modern agricultural systems have become dependent on regular usage of fertilizers and pesticides, and are characterised by soil degradation, water contamination and loss of biodiversity (Whitten, 1992; FAO, 1996). The FAO irrigation and drainage Paper 55 entitled ‘Control of water pollution from agriculture’ gives an excellent account on the adverse impacts of fertilizers and pesticides on the environment. FAO (2002) in “Challenges and opportunities for the World summit on sustainable Development : FAO’s perspective” reported that arable land per person has been shrinking from 0.38 hectare in 1970 to 0.23 hectare in 2000. About 3.6 billion hectares are affected by land degradation and an estimated 250 million people have been directly affected by desertification whilst nearly one billion are at risk. The paper concluded that new technologies and economic globalization have had profound - and sometimes negative - effects on sustainable agriculture, land use and fragile ecosystems.

Agenda 21 further cautioned that major adjustments are needed in agricultural, environmental and macroeconomics policy, at both national and international levels, in developed as well as developing countries, to create the conditions for sustainable agriculture and rural development (SARD). The major objective of SARD is to increase food production in a sustainable way and enhance food security. This involves education initiatives, utilization of economic incentives and the development of appropriate and new technologies, thus ensuring stable supplies of nutritionally adequate food, access to those supplies by vulnerable groups, and production for markets; employment and income generation to alleviate poverty; and natural resource
management and environmental protection. To achieve the above, priority must be on maintaining and improving the capacity of higher potential agricultural lands to support an expanding population. However, conserving and rehabilitating the natural resources on lower potential lands in order to maintain sustainable man/land ratios is also necessary. The main tools of SARD are policy and agrarian reform, participation, income diversification, land conservation and improved management of inputs. The success of SARD will depend largely on the support and participation of rural people, national Governments, private sector and international cooperation, including technical and scientific cooperation.

SARD is very relevant for coconut as the crop is by and large cultivated by smallholders, mainly the rural population in Malaysia. The crop is amongst the earliest cultivated, in early years without inorganic fertilizers and pesticides, similar to traditional paddy, in the rural coastal zones in Sarawak. In order to modernise coconut cultivation and to ensure competitiveness of the coconut industry, it is necessary to introduce high yielding varieties which require high input of fertilizers and pest control measures to express the full potential. Thus, without exception, it is necessary to address the environmental implications as well.

Woodroof (1979) states that "Of all the palms, coconut palm is of highest economic value, is grown over the widest geographical area, has probably the largest number of uses and is most suitable for use in the widest variety of food". The coconut's uses are many, representing an important sustainable natural resource. Uses of coconut include a source of food and shelter, raw materials for many small industries, and a commodity for export (Woodroof, 1979). Coconut cultivation covers approximately 11.6 million hectares, spread over at least 86 countries with most cultivation (85%) occurring in Asia and the Pacific, although other major producing areas occur in west and east Africa, Central and South America (Persley, 1992). Optimum growing conditions for coconut are in lowland humid tropics at altitudes below 1,000 m, near coastal areas in sandy
and well drained soils (Persley, 1992).

Three main coconut types exist: tall (*Cocos nucifera typica*), dwarf (*C. nucifera nana*), and hybrids between the two (Lombard, 2001). Tall coconut varieties comprise most of the world’s coconut population and are typically cultivated for commercial use because of their general superiority in copra production (Persley, 1992; Woodroof, 1979). Dwarf varieties are also widely cultivated but generally produce poorer quality copra than tall variety and for this reason are often discouraged from large scale planting, though some dwarfs out-produce tall varieties (Woodroof, 1979). An advantage of hybrid varieties is early bearing of nuts and high yields (Persley, 1992). The demand for young tender coconut for drinking and fresh consumption has renewed the interest in cultivation of dwarf varieties and hectarage is increasing rapidly.

1.1.1 Coconut and its environment

Coconut is a traditional crop steeped in history, cultivated for generations and is of good aesthetic values, symbols of tropical paradise and widely used for landscaping and resort areas, with many ecotypes throughout the world.

The coconut provides food, drink, shelter at community level, and copra, oil, and other products for local cash or export earnings. Seven important uses of coconut in world trade have been described by Woodroof (1979) and include: whole coconuts, copra, coconut oil (extracted from copra or fresh endosperm), coconut oil cake formed from residues during oil extraction, coir fiber from outer husks, desiccated shredded coconut and coconut skim milk and protein. Other uses include cooking oil, margarine, confectionery, salad oil, toddy (alcoholic beverage), animal feed, soaps and detergents, surfactants, emulsifiers, synthetic resins, ester fuels, toothpaste, cosmetics, rope, matting, charcoal, furniture, and housing (Persley, 1992). Today, a product of importance is
the young tender coconut for fresh drinks and meat, with expanding market world wide and of
premium value as it is wholesome, refreshing and healthy. Fresh coconut water is used as
substitute fluid for drip in emergency medical treatment as well as in culture of plant tissues. The
young shoot or palm heart is used as salad and vegetable.

Coconut makes an ideal agroforest crop, that is, multi-cultivation or forage use of a tree/crop
management system. The shallow and non-invasive root systems, combined with greater amounts
of light reaching the ground at canopy maturity, makes coconut palm ideal for intercropping,
allowing the utilization of large areas of land already under coconut cultivation without the need
for new land development (Reynolds, 1988). Intercropping systems that have been practiced with
coconut include banana, citrus, cloves, cocoa, coffee, legumes, papaya, pepper, pineapple, root
crops, and vegetables. Cattle grazing also utilize lands under the canopy of coconut plantations.
Cattle are often used as grazers to keep weeds and other native vegetation under control, and as an
extra source of income.

1.1.1.1 Biophysical environments

Coconut cultivation traditionally is the main occupation of the rural and coastal smallholder
farmers. In general coconut is grown on coastal sandy soils, marine and riverine alluvials, drained
peat and more fertile inland soils as well as volcanic soils (seldom found in Sarawak). As an
intercrop, the biodiversity of coconut system is high and thus can be considered as
environmentally friendly.

Most of the main coconut farms are located in the coastal and riverine Drainage and Irrigation
(D&I) scheme areas where drainage and supply of water can be controlled. Many of the coconut
gardens are established from reclaimed nipah (*Nypa fructicans*) areas. As such some wild stands
of nipah can be seen growing adjacent to the fringes of coconut gardens and found in abundance along flood control dykes, drainage canals and along the river fringes.

Being located in accessible areas, and with large-scale development activities taking place adjacent to and at the vicinity of coconut farms, the previously stable environment has been disturbed. Fluctuation of climatic conditions which has been experienced during the last decade has been attributed to the change in the environment. The harmonious balance of host-pest-natural enemy relationship could have been thrown off balance, with the end result of pest outbreak, even though the pest has been found to be present for a long time.

1.1.1.2 Socioeconomic importance

Coconut is of great social economic importance, as it is cultivated for own consumption as well as a source of income. The significance is exemplified by the crisis during the post 1997 haze and El Nino period where Malaysia faced shortage of coconut, especially during the festive seasons and had to meet with import from East Malaysia and neighbouring countries (The New Straits Time, 1999; The Star, 1999). The experience was instrumental in formulation of a new Government policy on food security and resulted in decision to revitalise the coconut industry in the country in mid-term review of the Eighth Malaysia Plan and later, the Ninth Malaysia Plan. Prior to that, coconut was considered a sunset industry as it was unable to compete with the golden crop, namely the oil palm.
1.2 Coconut in Malaysia

1.2.1 Policy and trend on coconut as a commodity

The Malaysian Government (in 1963), launched the Coconut Replanting and Rehabilitation Scheme with the aim of eradicating poverty and raising smallholders' income. Under this scheme, which was later renamed as the Coconut Smallholders Development Scheme (CSDS), smallholders were given subsidies and seedlings to help finance rehabilitation and replanting of unproductive coconuts and for conversion of rubber to coconuts. Smallholders were encouraged to intercrop coconuts with coffee, fruit trees, cocoa and any other suitable crops. Between 1963 to 1981, about 12,716 hectares were replanted and a further 50,806 hectares were rehabilitated (Anon, 1988). The MAWA (Malayan Dwarf X West African Tall) hybrid only became available towards 1977 by which time most of the rehabilitation and replanting under the scheme was already completed.

Declining copra prices and yields prompted diversification into alternative crops, mainly oil palm and cocoa, in the seventies. Since cocoa performed well under the shade of mature coconuts, cocoa-coconut intercropping became an attractive proposition. With the advent of MAWA in the middle of 1970's, some cocoa-coconut plantations embarked on a programme of progressively replacing the tall variety with hybrid. More recently, the prolonged depressed prices for cocoa, aggravated by declining cocoa yields and high cost of production due to Cocoa Pod Borer (CPB) has resulted in a relook at these crops. Many growers have opted to convert from cocoa-coconuts to oil palm cultivation. Coconut as a commercial crop has declined in importance after the decline of cocoa. Similarly, emphasis of the Government have shifted to other crops which were considered more important. However, the drastic shortage of coconut in 1997 has resulted in the government realising the socioeconomic importance of coconut. This has resulted in
reconsideration and coconut rehabilitation program has been instituted by the government during the mid-term review of the Eighth Malaysia Plan and during the Ninth Malaysia Plan as well.

The Third National Agricultural Policy (NAP 3) (1992-2010) Statement (January 1993), page 12 on coconut is quoted below: “Coconut Item 28. Coconut cultivation will be aimed at fulfilling the domestic requirements for young nuts, santan, desiccated coconut, and for downstream activities such as production of canned santan and handicrafts. Present intensive use of coconut holdings for intercropping with coffee, cocoa, and other crops such as salak and rattan including for livestock rearing will be further pursued.”

The revised Third National Agricultural Policy (1998-2010), categorised coconut under “Other economic crops product group, Item 53. This group consists of coconut, pepper, tobacco and other miscellaneous crops such as sugar cane, cassava, sweet potato, maize, tea and coffee. This group is generally characterised by dwindling or stagnating output and relatively lower productivity. Some of these commodities play an important socio-economic role in the welfare of the rural community. Under the NAP3, where viable, production of these commodities will be encouraged for import substitution and for supplying quality raw materials for further development of downstream activities. Research and Development (R&D) and necessary support will be provided to further enhance the development of more high value-added products.”

Under Eight Malaysia Plan (8MP) review, the Coconut Industry Development is focused on replanting to maintain existing coconut areas. Replanting is through integrated approach using MATAG (Malayan dwarf x Tagnanam tall) hybrid. This policy is to be continued and further intensified in the coming Ninth Malaysia Plan (9MP).
1.2.2 Coconut cultivation in Sarawak

The export value of coconut products from Sarawak during the previous several years has stagnated at about RM2.4 million (Anon, 2002). Most of the coconut and coconut products are exported to Peninsula Malaysia (Table 2).

1.2.2.1 Hectarage

The production area for coconut is as shown in the Table 1 below:

Table 1: Hectarage of coconut in Sarawak

<table>
<thead>
<tr>
<th>Year</th>
<th>Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>25,683</td>
</tr>
<tr>
<td>1999</td>
<td>26,334</td>
</tr>
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<td>2000</td>
<td>25,578</td>
</tr>
<tr>
<td>2001</td>
<td>25,186</td>
</tr>
<tr>
<td>2002</td>
<td>25,495</td>
</tr>
<tr>
<td>2003(tentative)</td>
<td>25,495</td>
</tr>
</tbody>
</table>

Source: (Agricultural Statistics, DOA, Sarawak 2004)

The area under coconut for the last five years remains at about 25,000 hectares. Under the Ninth Malaysia Plan, the proposed development program for coconut in Sarawak is tentatively at 1,000 hectare per year and the focus is on rehabilitation of existing coconut areas (Sulaiman, 2005).

1.2.2.2 Export and import statistics

The export and import values for coconut during the last 10 years do not show a distinct trend. The highest values were observed for the year 1999, with total export value exceeding RM10 million from the various products (Table 2).
Table 2: Export and import of coconut and products*

<table>
<thead>
<tr>
<th>Year</th>
<th>Export (RM)</th>
<th>Import (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>6,568,278</td>
<td>99,611</td>
</tr>
<tr>
<td>1995</td>
<td>1,684,814</td>
<td>342,742</td>
</tr>
<tr>
<td>1996</td>
<td>2,412,225</td>
<td>101,253</td>
</tr>
<tr>
<td>1997</td>
<td>3,228,588</td>
<td>159,115</td>
</tr>
<tr>
<td>1998</td>
<td>3,225,370</td>
<td>373,884</td>
</tr>
<tr>
<td>1999</td>
<td>10,325,514</td>
<td>3,156,328</td>
</tr>
<tr>
<td>2000</td>
<td>5,759,440</td>
<td>2,922,279</td>
</tr>
<tr>
<td>2001</td>
<td>2,488,579</td>
<td>828,427</td>
</tr>
<tr>
<td>2002</td>
<td>2,430,204</td>
<td>656,938</td>
</tr>
<tr>
<td>2003</td>
<td>2,353,252</td>
<td>792,157</td>
</tr>
</tbody>
</table>

*desiccated coconut, copra, copra cake, crude/refined coconut oil, mature nut and young nut.

1.2.2.3 Major coconut locations in Sarawak

The main coconut growing areas are Beliong and Sibu Laut of Kuching Division; Asajaya, Batang Sadong, Sebangan-Bajong of Samarahan Division; Kabong and Nyabor of Betong Division; Belawai, Kuala Matu, Mukah and Dalat of Mukah Division; Sg. Semalau, Sg. Bapa, Tg. Jol of Sarakei Division; Kuala Sibuti of Miri Division; Kuala Tatau of Bintulu Division and Limbang of Limbang Division. Major coconut areas in Sarawak are as shown in the map in Appendix F.

1.2.3 Soil types for coconut in Sarawak

The major soil types for coconut cultivation in Sarawak are as reported in the Soils Management Division of the Department of Agriculture, Sarawak (Teng, 2005) and listed below:

Coastal sandy soils: This is the traditional coconut belt along the beach, usually on raised dunes where elaborate man-make drainage system is not required. The soil is normally cultivated with local tall coconut. Due to the low inherent soil nutrient content, the fertility may be a limitation
for hybrid or dwarf coconut which require higher nutrient levels for good growth and productivity.

**Marine gley soils:** This is located at the coastal zone, or deltaic region of major rivers or estuarine zone with strong marine influence. Extensive drainage and flood protection by dyking is required and such infrastructure is provided by the State Government through the Drainage and Irrigation Department (DID). The soil types are potentially acid sulphidic, but otherwise fertile. The soil is suitable for all varieties of coconut, including local tall, hybrids, as well as dwarf coconuts. This zone is the main coconut area in Sarawak, including the Beliong, Asajaya, Sebangan-Bajong, Kabong-Nyabor and other smaller DID schemes.

**Riverine alluvial soils:** Riverine alluvial is found at the flood plains away from the marine influence and usually requires drainage and flood protection measures. Soils are generally fertile and is suitable for all varieties of coconut, including local tall, hybrids as well as dwarf coconuts.

### 1.2.4 Coconut as an intercrop

Coconut cultivation is integrated with other economic activities such as the intercrop of cocoa, coffee, fruits such as banana, citrus, cempedak, and nangka. Some enterprising farmers even diversify their activities and undertake rearing of cattle, goats, poultry, sheeps, and aquaculture (especially tiger prawn rearing in dug out ponds) within the vicinity of the coconut garden. Some coastal farmers in Sarawak plant citrus, melons, and papaya as alley crops or intercrops during the establishment period for coconut, or when the coconut palms are matured. Animal husbandry include kampung chicken and sheep rearing and on very sandy coastal soils, cattle rearing are encouraged. Under the coconut rehabilitation scheme, crops encouraged under coconut-based system are fruits, including banana, ciku, citrus, papaya, pineapple, rambutan, and star fruit. Short term crops include vegetables, such as cangkor manis and ginger, and field crops such as cassava.