Rubber Science, **25**(2): 164-172, 2012

CHANGING DIMENSIONS OF INTERCROPPING IN THE IMMATURE PHASE OF NATURAL RUBBER CULTIVATION: A CASE STUDY OF PINEAPPLE INTERCROPPING IN CENTRAL KERALA

T. Siju, K. Tharian George and Radha Lakshmanan*

Rubber Research Institute of India, Kottayam-686 009, Kerala, India

*Regional Research Station, Padiyoor, Kerala, India

Received: 18 June 2012 Accepted: 14 August 2012

Siju, T., George, K.T. and Lakshmanan, R. (2012). Changing dimensions of intercropping in the immature phase of natural rubber cultivation: A case study of pineapple intercropping in Central Kerala. *Rubber Science*, **25**(2): 164-172.

Intercropping in the immature phase of rubber plantations had been the outcome of a major policy decision implemented in 1957 with the core objective of achieving self sufficiency in NR production. However, the priorities and strategies of intercropping have undergone important changes during the past five decades due to a number of factors including changes in the socio-economic determinants, crops grown, objectives and R&D efforts. The study revealed the growing popularity of contract farming of pineapple as intercrop in the immature phase of NR in central Kerala. The results of the analysis highlighted the growing divergence between the recommended and adopted agro-management practices in intercropping of pineapple under contract farming and the potential challenges to the agronomic sustainability of NR cultivation.

Keywords: Contract farming, Intercropping, Natural rubber, Pineapple, Socio-economic

INTRODUCTION

The evolution of farming systems from the primitive shifting cultivation to the modern high precision farming has traversed various milestones guided by a host of historical and region-specific factors. The shift to commercial agriculture contained a specified package of recommended inputs and farm management practices to maximise yield and production. Though the input intensive farming systems led to significant increase in yield, the cost of cultivation also increased with important policy implications for both annual and perennial crops in the era of market uncertainty. Concurrently, the excessive use of fertilizer and pesticides posed many health and ecological hazards. The achievements in high productivity based on higher consumption of chemical inputs lead to environment degradation and human health effects in the long-run, as is evident in many countries, where commercial agriculture is widespread (Wilson, 2000). However, the cumulative impacts of the changes varied across regions, crops and farming systems. The steady increase in

Correspondance: T. Siju (Email : siju@rubberboard.org.in)

cropping intensity to maximise production in the backdrop of fragmentation of the holdings also has emerged as a major policy challenge (Nelliat, 1978). The concomitant changes underlined the limitations imposed by the growing scarcity of agro-climatically suitable land for commercial cultivation. Hence, the spatial and temporal dimensions of farming received considerable attention in the process of structural transformation and changes in the cropping systems. Thus, multiple cropping, *i.e.,* growing two or more crops in the same piece of land in one calendar year for intensification of cropping gained paramount significance. Multiple cropping includes mixed cropping, sequence cropping, agroforestry and intercropping. While mixed cropping and sequence cropping are more popular among annual crops, intercropping and agroforestry are generally followed in perennial crops (Reddy and Reddi, 2007). Mixed cropping is growing of two or more crops simultaneously intermingling without any row pattern. Sequence cropping is growing of two or more crops sequentially for achieving temporal crop intensification on the same piece of land in a farming year. Agroforestry is an integrated approach for utilizing the interactive benefits of combining different species by adjusting the crop architecture. In intercropping two or more crops with varied economic life span are grown simultaneously on the same piece of land with a definite row pattern. Thus, the spatial and temporal dimensions of cropping intensity are achieved. However, two broad types of intercropping systems are identified based on the comparative shares in plant population[1]. A successful intercropping system shall comply with the following conditions: (i) the time of peak nutrient demands of component crops should not overlap, (ii) competition for light should be minimised among the component crops and (iii) complementarity should exist between the component crops (Balasubramanian and Palaniappan, 2001).

Technically, an intercropped system may generate a higher level of mean output and less variability than a single crop system (Trenbath, 1986; Abalu, 1976). As a risk aversion strategy, farmers choose a crop mix characterised by greater crop diversity which is positively related to the productivity and negatively correlated with variability in production and income. (Salvatore and Perrings, 2003). In the case of annual crops, multiple cropping systems are followed to stabilise and improve farm income and as a risk coping mechanism against complete crop failure due to unforeseen climatic factors or pest and diseases infestation. However, intercropping in perennial crops is undertaken with the main objectives of earning valuable income during the cash trap period of immature phase and as an insurance mechanism against price fluctuations in the mature phase. In perennial crops like natural rubber (NR), intercrops such as pineapple, banana, vegetables and yams are cultivated during the immature phase whereas coffee, cocoa

[1]The two types of intercropping systems are: the additive series and the replacement series. In additive series, the 'base crop' population is maintained at its recommended pure stand and another crop known as intercrop is introduced into the base crop by adjusting or changing crop geometry. The population of intercrop is less than its recommended population in pure stand. On the other hand, in replacement series, both the crops are called component crops. By adjusting the population of one component, another component is introduced.

and medicinal plants are recommended for the mature phase (Rubber Board, 2011).

The main objectives of the present study are: (i) to study the evolutionary dynamics of intercropping in the immature phase of NR (ii) to analyse the emerging trends in pineapple intercropped holdings and (iii) to highlight the policy implications.

MATERIALS AND METHODS

The study is based on a critical analysis of earlier studies on intercropping in NR conducted in India and other major NR growing countries. Primary data were collected from 56 smallholdings having pineapple intercropped area in Central Kerala using a well structured interview schedule[2]. The survey was conducted during October 2011. Simple statistical tools were employed to analyse the data.

RESULTS AND DISCUSSION

Evolution of intercropping in Kerala's rubber sector

Historically, rubber was grown as a monocrop in Kerala. Monoculture of any crop may be due to climatological and socio-economic factors as well as specialization of farming community in a region in growing a particular crop (Reddy and Reddi, 2007). Agronomically, a monoculture field is planted with same crop for each succeeding vegetation cycle (Ruthenberg, 1971). Larger estates usually prefer to cultivate pure stand, in order to make optimum use of husbandry techniques specifically required by one crop. Conversely, smallholdings are inclined to adopt intercropping to overcome the inherent limitations imposed by the size of holdings and to avail the benefits of a more diversified production (Ruthenberg, 1971). The genesis of organised attempts to promote intercropping in Kerala's rubber plantations was the replanting subsidy scheme (RSS) launched in 1957.

The twin objectives of the institutional interventions to promote the intercropping were: (i) to replant the old and low yielding rubber plants and (ii) to ensure adequate farm income during the gestation period of rubber plantations. The responses of the planting community had been encouraging and the socio-economic conditions prevailed in the region during the initial phase influenced them to select intercrops which provided both income and employment to the family labour (Krishnankutty, 1977; Mathew *et al*., 1978). However, priorities and strategies of intercropping in the immature phase of rubber plantations have undergone important changes due to various contributory factors such as the structural changes in the smallholder sector, significant increases in the sources of non-farm income of the planting community and changes in the source and availability of labour employed in the holdings. Despite the three distinct phases observed in the evolutionary dynamics of intercropping in the immature phase of rubber plantations in Kerala, it has been followed as an additive series. Nevertheless, there are marked differences in the intercrops selected, main objectives and the determinants of intercropping as well as the compatibility between R&D

[2]The survey was conducted in Kottayam, Ayarkunnam, Pallikkathode, Vazhakulam and Karimannoor regions covering 56 NR growers with pineapple intercropping, during October 2011.

Table 1. **Evolutionary phases of intercropping in the immature phase of rubber plantations in Kerala**

Phase (period)	Major crops grown	Main objectives	Determinants	R&D efforts
Phase I (1957 to 1970's)	Tapioca, Banana, Rice, Yams, Ginger	Food security, employment and farm income	• Virtual dependence on farm income for livelihood and availability of family labour	• Focused on crops which ensured food security, employment and income • Convergence in the focus of R&D efforts and farm management practices
Phase II (1980's - 1990's)	Banana, Pineapple, Yams	Maximization of farm income	• Emergence of part time farmers with alternative sources of income, shortage of family labour and growing dependence on hired labour	• Focused on crops such as pineapple and banana which ensured higher income • Convergence in the focus of R&D efforts and farm management practices
Phase III (2000's)	Pineapple, Banana, Vegetables	Rental income	• Predominance of part-time farmers, growing share of non-farm income, shortage of hired labour and dependence on contract farming	• Continue to focus on crops with higher farm income. Attempts are also being made to popularize shade tolerant annual and perennial crops for intercropping in the mature phase • Growing divergence between R&D efforts and farm management practices

efforts and farm management practices during the three phases (Table 1).

During the first phase (1957-70's) the major concerns for undertaking intercropping in the immature phase of rubber plantations were food security, income and employment to family labour. The crops chosen during this phase included tapioca, banana, rice, yams and ginger. Tapioca, paddy, ginger and nendren variety of banana were the preferred intercrops. Ginger was attractive being labour intensive, could provide gainful employment to family members and higher net returns. The greater attraction towards tapioca was that its cultivation was easy and it served as a family staple (Krishnankutty, 1977). A virtual dependence on farm income for livelihood and predominance of family labour were the major determinants of the farm management practices followed during this phase. The R&D efforts during this phase reinforced the focus on crops which ensured food security, employment and income.

In the second phase (1980's – 1990's), there had been a marked shift towards crops with higher potential income. While banana and yams continued to be intercropped, the two major food crops, *viz*. tapioca and rice, were increasingly replaced by pineapple. This shift was propelled by the growth of part-time farmers with alternative sources of income and growing dependence on hired labour. This transitional phase had also been remarkable for three important changes, *viz*. (i) emergence of size of holdings and sources of supply of labour as key determinants of intercropping and intercrops chosen, (ii) growing importance of pineapple among the intercrops chosen in Central Kerala and (iii) a visible shrinkage in the supply of family labour. The R&D support during the phase endorsed the intercropping priorities of the planting community.

The current phase beginning with the decade 2000 has been in sharp contrast to the two previous phases for the priorities and strategies and the growing divergence between the R&D efforts and the farm management practices. The priority in the current phase is centred on rental income rather than farm income as the intercropping has been systematically transformed into contract farming. Large scale leasing out of land to pineapple farming contractors was observed in many regions due to assured marketing facilities and relative profitability (Anilkumar and Jessy, 2005). The pilot survey conducted among the pineapple intercropped smallholdings in Central Kerala revealed the underlying factors behind its popularity and emerging issues from a long-term policy perspective.

Contract farming

A remarkable growth in the share of part-time farmers with alternative sources of income, shortage of hired labour and frequent fluctuations in the prices of the intercrops led to the emergence and subsequent prominence of new players in NR cultivation and intercropping in Kerala *viz*. the service providers or contractors as they are commonly known among the NR growers. Among the 56 smallholders covered under the survey in Central Kerala, 84 per cent have leased out their new planted/replanted area to these contractors for intercropping pineapple. Three different types of contractual arrangements were observed in Central Kerala for pineapple intercropping under contract farming. Table 2 summarises the details of the contractual arrangements of pineapple intercropping under contract farming.

In the first category, the intercropping contractor is entrusted with all tasks from procurement of rubber planting materials to maintenance of the plantation till the third year of planting and no monetary compensation is paid to the grower as rent. In the second category, except the procurement of rubber planting materials all the operations are carried out by the contractor and no rent is paid to the grower. In the third category, the sphere of operations of the contractor is restricted to land preparation and pineapple intercropping whereas the grower is responsible for the procurement of rubber planting materials and maintenance of the immature plantation. The grower is paid a rent ranging between ₹ 10,000 to ₹ 25,000 per acre. The major casualty in the contractual arrangements is that in more than 58 per cent of the sample holdings (Type 1) the procurement of rubber planting materials is by the contractors and the consequent issues related to the quality of the materials. This point assumes added

Table 2. **Contractual arrangements in pineapple intercropping**

Operation	Type		
	1	2	3
Land preparation	Contractor	Contractor	Contractor
Pineapple intercropping	Contractor	Contractor	Contractor
Procurement of planting materials	Contractor	Grower	Grower
Maintenance of plantation (first three years)	Contractor	Contractor	Grower
Type of compensation to growers	All expenses related to planting and maintenance for 3 years	All expenses as in Type 1 except the cost of planting materials	Rent paid ₹ 10000/- to ₹ 25,000/- per acre
Share of growers (%)	58.93	5.36	35.71

significance in the context of growing apprehensions on the quality of planting materials since the decontrol in 1986 (George, 2011). Moreover, the contractors undertake land preparation using earth movers in all the three categories with its concomitant implications for the top soil. More than 89 per cent of the respondents reported soil erosion due to indiscriminate use of earth movers and the pits made for rubber plants were less than (1.5 – 2.0 feet) the recommended depth[3]. Another agronomic practice posing potential threat to the growth of rubber plants is the density and spacing of pineapple suckers. The average density of pineapple suckers under contract farming is found to be 22,245 per ha against the recommended density of 13,500 per ha. The recommended distance of 5 feet was not maintained between rows of rubber and pineapple among the sample holdings, and in more than 16 per cent of the cases suckers were planted between and across rows of rubber. These agro-management practices considerably affect the recommended cultural operations in the rubber plantations. Moreover, the indiscriminate use of agro-chemicals by the contractors for maximizing the output of pineapple was also observed[4]. In 90 per cent of the cases, the same mixture of fertilizers was applied to rubber also. Majority of the growers (89%) were unaware of the type and dosage of fertilizers applied by the contractors. The deleterious consequences of the short-sighted and

[3] Recommendations published in the 'Rubber Grower's Companion - 2011' were considered as the official recommendations of Rubber Board for the present study.

[4] Factomphos (20:20:0:15 NPKS), urea and potash were used in different combinations and dosage by the contractors for pineapple in central Kerala. The most commonly used combination was factomphos (3 bags) + potash (1 bag) + urea (1 bag). This mixture (250 kg) was applied to 5000 plants thrice a year. Thus, the applied quantities of N, P and K were higher by 150, 180 and 40 per cent respectively that the recommended dosage for pineapple by the KAU. When the same mixture is applied to rubber thrice a year, it gives N, P and K higher by 200, 80 and 350 per cent respectively than the recommended dosage.

aggressive cultural operations may result in degradation of physical, chemical and biological properties of soil and cause imbalances in soil fertility status as observed in Muvattupuzha taluk (Ambily *et al*., 2000)[5]. In sum, the two core issues emerging from the analysis are: (i) the steady growth in the share of part-time farmers languishing on rental income from contract farming of pineapple intercropping during the immature phase and (ii) the resultant potential threats to the agronomic sustainability of NR cultivation.

Emerging Issues

In retrospect, the adoption of suitable intercrops across the three phases was vindicated by their role as nurse crops for better establishment, growth and tappability of rubber in the initial years (Mathew *et al*., 1978; Jessy *et al*., 1998, 2001; Roy *et al*., 2001; Anilkumar and Jessy, 2005; Jayasree *et al*., 2005). Growth of rubber was also found to be enhanced significantly when intercropped with annual and perennial crops (Jessy *et al*., 1998). Similar findings were also reported from other NR producing countries (Chandrasekera, 1984; Noor *et al*., 1989; Rodrigo *et al*., 1997; Senevirathna *et al*., 2002). Studies have also shown that population of soil microflora was enhanced in NR plantations with intercrops as compared to that of pure stands. The population of rhizosphere microflora varied depending upon the type of intercrops (Vimalakumari, 2001). In the rubber growing regions of Kerala, the popularity of intercropping and choice of crops varied significantly (Rajasekharan and Veeraputhran, 2002). The extent of intercropping during the immature phase of rubber plantations varied from 61.5 (North Kerala) to 85 per cent (South Kerala). The choice of intercrops depended mainly on size of holdings, local preferences, marketing facilities, price of produce, availability of family labour, irrigation facilities *etc*. (Anilkumar and Jessy, 2005).

Not withstanding the reported gains from intercropping in the immature phase of rubber plantations, varied impacts of intercrops were observed in Kerala since the late 1970's (Mathew *et al*., 1978). Intercropping tapioca and non nendran banana was found to have affected the growth of the main crop (rubber) compared to nendran variety of banana. The experimental results of a recent on farm trial revealed that girth and tappability of rubber was significantly affected in plots intercropped with pineapple (George *et al*., 2010). Despite the region wise differences in the crop chosen for intercropping, three recent interrelated developments deserve attention from a long-term policy perspective. First of all, intercropping in the immature phase of rubber plantations has been increasingly guided by maximisation of rental income in the short-term by ignoring the long-term implications of farm management practices pursued under the contract farming. Secondly, the emergence of pineapple as the choicest intercrop under contract farming, especially in Central Kerala, has been heralding a paradigm shift from the recommended package of practices. Thirdly, the terms and conditions followed under the contract farming pose important R&D and policy challenges on the

[5] Pineapple is extensively grown in Muvattupuzha taluk for the past three decades. It is the choicest intercrop in NR in the region with 85% of farmers opting for the same (RRII 2011).

agronomic sustainability of NR cultivation in Kerala.

The growing popularity of contract farming and the consequent detachment between the R&D efforts and farm management practices signal a wider adoption of the indiscriminate use of chemical inputs with ruinous consequences on physical, chemical and biological properties of soil and soil fertility status. The growing prominence of contract farming in Central Kerala is a matter of grave concern given the convergence of structural changes in other rubber growing regions. The observations emerging from this study assume relevance due to the inherent limitations associated with the perennial nature of the crop and market uncertainty. In this backdrop, it is imperative to initiate a larger study to understand the current status of intercropping systems followed in different rubber growing regions of the state to identify the issues and to design research programmes to evolve sustainable crop management systems from a long-term perspective.

REFERENCES

Abalu, G. (1976). A note on crop mixtures under indigenous conditions in northern Nigeria. *Journal of Development Studies*, **12**: 212-220.

Ambily, K.K., Karthikakuttyamma M., Mary C.P., Mathew,V. and Jacob, M. (2000). Fertility status of rubber growing soils of Muvattupuzha taluk in Kerala. *Rubber Board Bulletin,* **27**(4): 42-45.

Anilkumar, D. and Jessy, M.D. (2005). Intercropping in immature rubber plantations - Indian experience. *Proceedings of ANRPC Conference*, pp.122-127.

Balasubramanian, P. and Palaniappan, S.P. (2001). *Principles and Practices of Agronomy*. Agrobios (India), p. 486.

Chandrasekera, L. B. (1984). Intercropping *Hevea* replantings during the immature period. *Proceedings of the International Rubber Conference*, Colombo, **1**(2): 389-393.

George, E.S., Joseph,P., Jessy, M.D. and Nair, N.U. (2010). Influence of intercropping on soil physico-chemical properties and growth of rubber. *Abstracts PLACROSYM XIX*, 7-10th December, RRII, pp.123-124.

George, K.T. (2011). From control to decontrol: The evolution of rubber propagation policy in India (1949-1986). *Working paper ER/5*, Rubber Research Institute of India, Kottayam, 44p.

Jayasree K.R., Jessy, M.D., Nair, A.N.S. and Punnoose, K.I. (2005). Intercropping and its effect on growth of young rubber: A survey report. *Rubber Board Bulletin,* **28**(1): 2-5.

Jessy, M.D., Philip, V., Punnoose, K.I. and Sethuraj, M.R. (1998). Evaluation of a multi-species cropping system during immature phase of rubber. *Indian Journal of Natural Rubber Research,* **11**(1&2): 80-87.

Jessy, M.D., Punnoose, K.I. and Nayar, T.V.R. (2001). Crop diversification and its sustainability in young rubber plantations. *Journal of Plantation Crops,* **33**(1): 29-35.

Krishnankutty, P.N. (1977). A Study of intercrops in small holdings in India. *Proceedings of ANRPC Conference*, Cochin: pp. 191-195.

Mathew, M., Potty, S.N., Punnoose, K.I. and George, C.M. (1978). Intercropping in Rubber Plantations. *Proceedings of PLACROSYM-I*, pp. 431-437.

Nelliat, E.V. (1978). Multiple cropping in plantation crops. *Proceedings of PLACROSYM-I*, pp. 451-452.

Noor, Mohd., M.Y., Mahmud, A.W., Bachik, A.T., Zainol, E., Norhayati, M., Mohd. Johari, H. and Grundon, N. (1989). Intercropping under young rubber. *Proceedings of Rubber Growers Conference*, Persidangan, Penanam Getah, pp. 166-180.

Rajasekharan, P. and Veeraputhran S. (2002). Adoption of intercropping in rubber smallholdings in Kerala, India: A tobit analysis. *Agroforestry Systems,* **56**(1): 1-11.

Reddy, Yellamanda T. and Sankara Reddi, G.H. (2007). *Principles of Agronomy,* Kalyani Bublishers, pp. 458-463.

Rodrigo, V.H.L. Stirling, C.M., Teklehaimanot, Z. and Nugawela, A. (1997). Effect of planting density on growth and development of component crops in rubber/banana intercropping systems. *Field Crops Research*, **52**(1/2): 95-108.

Roy, S., Raj, S., Choudhury, M., Dey, S.K. and Nazeer, M.A. (2001). Intercropping of banana and pineapple in rubber plantations in Tripura. *Indian Journal of Natural Rubber Research*, **14**(2): 152-158.

RRII (2011). Preliminary results of the analysis of adoption of planting materials based on time series data from RPD files, Rubber Research Institute of India, Kottayam, India.

Rubber Board (2011). *Rubber Grower's Guide*, pp.17-19.

Ruthenberg, Hans (1971). *Farming Systems in the Tropics*, Clarendon Press, Oxford.

Salvatore Di Falco and Perrings, C. (2003). Crop genetic diversity and productivity Scottish. *Journal of Political Economy,* **50**(2): 207-216.

Senevirathna, A.M.W.K., Stirling, C.M., Rodrigo, V.H.L., Karunathilake, P.K.W. and Pathirana, P.D. (2002). Photosynthetic performance of rubber and banana under natural shade. *Journal of the Rubber Research Institute of Sri Lanka,* **85**: 39-52.

Trenbath, B.R. (1986). Resource use efficiency by intercrops. In: *Multiple Cropping System*. C.A. Franic (Ed), MacMillan Pub. Co. New York: pp. 57-81.

Vimalakumari, T. G. (2001). Influence of intercropping on the rhizosphere microflora of *Hevea*. *Indian Journal of Natural Rubber Research,* **14**(1): 55-59.

Wilson, Clevo (2000). Environmental and human costs of commercial agricultural production in South Asia. *International Journal of Social Economics,* **27** (7/8/9/10): 816 – 846.