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Intercropping in the Immature Phase of Natural Rubber Cultivation in Kerala: Emerging Trends and Policy Challenges

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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 integration. Concurrently, the excessive use of fertilizer and pesticides posed many health and ecological hazards. A visible parallel correlation between high productivity, high chemical input use and environment degradation and human health effects 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 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, multicropping, i.e., growing two or more crops on the same piece of land in one calendar year for intensification of cropping gained paramount significance. Multicropping includes mixed cropping, intercropping, sequence cropping and agroforestry. 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 Di Falco *et al.*, 2003). In the case of annual crops, multicropping 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 and medicinal plants are recommended for the mature phase (Rubber Board, 2011).

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Evolution of intercropping in Kerala's rubber sector

Historically, rubber was grown as a mono-crop 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 (ibid.). 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 and 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 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 (RRII, 2011[a]). 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 *et al.*, 2005). The contributory factors for the transformation have been 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. The results of a recent survey revealed that majority of the pineapple intercropped holdings in Kerala are under contract farming (RRII, 2011[a]). However, there are three different types of organizational arrangements for pineapple intercropping under the contract farming (Table 2). The current phase is also marked by attempts to popularise shade tolerant annual and perennial crops during the mature phase. The most important impact of the growing popularity

of contract farming has been an implicit detachment between the R&D efforts and farm management practices.

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 *et al.*, 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 (Anon, 1973; Chandrasekera, 1984; Noor *et al.*, 1989; Rodrigo *et al.*, 1997; Senevirathna *et al.*, 2002). Studies have also shown that population of soil micro-flora 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 *et al.*, 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 per cent (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 *et al.*, 2005).

Emerging issues

Notwithstanding the reported gains from intercropping in the immature phase of rubber plantations, varied impacts of intercrops were observed in Kerala since the late 1970s (Mathew *et al*, 1978). The intercropping of 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 (Elsie *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 agronomic sustainability of NR cultivation in Kerala. The apprehensions on the implications of contract farming have been confirmed by the results of a recent survey undertaken among pineapple intercropped immature rubber plantations in five regions of Central Kerala[2]. Table 2 summarises the details of the contractual arrangements of pineapple intercropping under contract farming.

Among the 56 smallholders covered, 83.93 per cent have leased out their new planted/replanted area under NR to pineapple intercropping. Three types of contractual arrangements are prevalent in the case of leased out holdings for intercropping. 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 plating materials and maintenance of the immature plantation.

The major casualty in the contractual arrangements is that in more than 58 percent 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 significance in the context of growing apprehensions on the quality of planting materials since the decontrol in 1986 (George, 2011). Moreover, the contractor undertakes 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 use of earth movers and the pits made for rubber plants were less than (1.5 – 2 feet) the recommended depth.

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/ha against the recommended density of 13,500/ha. The recommended distance of 5 feet was not maintained between rows of rubber and pineapple among of the sample holdings and in more than 16 percent of the cases suckers are 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[3]. The same mixture of fertilizers is applied to rubber also under the contract farming. Very often, the growers are unaware of the type and dosage of fertilizers applied by the contractors. The deleterious consequences of the short-sighted and 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)[4]. 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 in Kerala.

The observations contained in this paper are circumscribed by the analysis of the agro-management practices followed in pineapple intercropping under the contract farming in Central Kerala. However, the growing prominence of the contract farming signals a wider adoption of the practices in other rubber growing regions in the state given the convergence of structural changes in the rubber smallholder sector. Therefore, it is imperative to initiate an interdisciplinary reconnaissance 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.

Table 1: Evolutionary phases of the intercropping in the immature phase of rubber plantations

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.

Table 2: Contractual arrangements in pineapple intercropping

Operations	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 Rs. 10000/- to Rs. 25,000/- acre
Share of growers (%)	58.93	5.36	35.71

Notes

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.

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

3. Factomphos, 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 bag) + potash (1 bag) + urea (1 bag). This mixture (250 kg) was applied to 5000 plants. Thus, the applied quantities of N, P and K were higher by 108 percent, 300 percent and 108 percent respectively than the recommended dosage.

4. 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[b]).

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., Valsamma Mathew and Mijo Jacob (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.

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

George, Tharian (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.

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

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

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

Reddy, Yellamanda T. and G.H. Sankara Reddi, (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[a]). Sample survey among pineapple intercropped smallholdings in Central Kerala, Rubber Research Institute of India, Kottayam, India.

RRII (2011[b]). 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 Charles Perrings (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.

Policy Implications

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 with the growing popularity of contract farming and the consequent changes in the pattern and composition of agro-management practices. The choice of rubber planting materials and the cultural practices followed under the contract farming raise important policy questions on the sustenance of the widely applauded commercial yield performance in the rubber smallholder sector and the agronomic sustainability of NR cultivation in Kerala. This proposition assumes significance in the backdrop of the predominance of part-time farmers, growing labour shortage, mechanization of land preparation operations and indiscriminate agro-management practices followed under contract farming. Therefore, it is imperative to initiate interdisciplinary studies to understand the current status of intercropping systems followed in different rubber growing regions of the State/country and to identify the issues so as to design research programmes to evolve sustainable crop management systems from a long-term perspective.