Journal of Plantation Crops 11 (1): 1–12 June, 1983

TRANSFER OF TECHNOLOGY IN PLANTATION CROPS*

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In recent times, the constraints analysis in transfer of technology from the research centres to the field in annual crops has been receiving much attention of the extension educationists. In the case of plantation crops, such analysis in transferring the technology to the growers effectively has not received the attention commensurate with the economic importance of these groups of crops. According to Nelliat and Iyer (1977, cited by Nelliat, 1977) plantation crops are a group of commercial crops of perennial nature, cultivated extensively in tropics / sub–tropics and demand employment of labour throughout the year. The term plantation crops, under Indian conditions normally refers to crops like tea, coffee, rubber, coconut, oil palm, arecanut, cashew, pepper, cardamom and cocoa.

The plantation crops such as tea, coffee, cardamom, pepper and cashew earn to the country foreign exchange worth about Rs. 8500 million which works out to about 12.7 per cent of the total export earnings. About 41 per cent of tea, 35 per cent of coffee, 57 per cent of cardamom and 77 per cent of pepper, produced in India are exported to other countries.

Because of their importance in the national economy, most of these crops received considerable research and developmental efforts in the past few decades. The changes in the national average yield of different plantation crops over the past three decades are given in Table I. The per hectare yield of coffee increased three-fold during the last three decades while that of rubber doubled. The yield of the tea also increased by about 70 per cent. The increase in productivity of arecanut was marginal while there was not much change in coconut, cardamom and pepper. In the case of cashew there was a steady decline in productivity.

The four sets of basic activities involved in the task of transfer of technology are:

1. Research / technology production system to evolve new technology,
2. Extension/ dissemination/communication system to transfer the technology from research station to farmer's field,
3. Technology utilisation system/ farmers system which adopts the technology and takes benefits from it, and

* *Presidential address delivered at the Tenth Annual Meeting of the Indian Society for Plantation Crops, December 15, 1982, Kasaragod, Kerala, India.*

Table I. *Productivity of plantation crops for the last three decades*

Year	Coconut (nuts/ha)	Arecanut (Kg/ha)	Cashewnut (Kg/ha)	Cardamom (Kg/ha)	Pepper (Kg/ha)	Coffee (Kg/ha)	Rubber (Kg/ha)	Tea (Kg/ha)
1950–51	5284	695	NA	NA	271	202	284	901
1955–56	6523	NA	720	NA	318	340	353	963
1960–61	6428	844	634	60	277	567	365	1070
1965–66	5775	868	596	27	219	493	448	1089
1970–71	5813	843	584	41	213	814	653	1221
1975–76	5449	901	465	52	277	490	772	1405
1980–81	5249	1037	314	55	248	601	790	1519

NA=Not available

4. Support system which supports the technology transfer process by providing necessary inputs required for the use of technology and also by providing facilities for processing and marketing of the products.

Each set of activities is performed basically by a system which is interlinked with others for running the process.

The research system takes care of the technology production; its output becomes the input of the technology utilisation system. A process of feed back operates at all levels. The support system provides the required inputs and manages the agricultural output through various agencies.

The research system consists of Agricultural Universities, Research Institutes of Indian Council of Agricultural Research and Commodity Boards and other organisations which evolve new knowledge and innovations through applied research. An innovation may be a new variety of crop, a new chemical to protect crops from insect pests and diseases, a new implement to use in the field for farm operation or a new technique/method to perform any agricultural operation such as sowing, planting, weeding, hoeing, manuring, processing etc.

The extension system consists of extension personnel belonging to government and non-government agencies who act as links between the research system and farmers system. Besides transferring new technology to the potential users, the extension system is

also expected to supply research system with feed back about the field problems. The extension system establishes direct contact with the farmers in person, in groups or through indirect media like newspapers, magazines, leaflets, radio and television.

The farmers system/technology utilisation system consists of ultimate users of the technology. In the case of farm technology, this term refers to farmers of all categories, marginal, small and big, literate and illiterate, land owners and tenants residing in different agro-climatic regions.

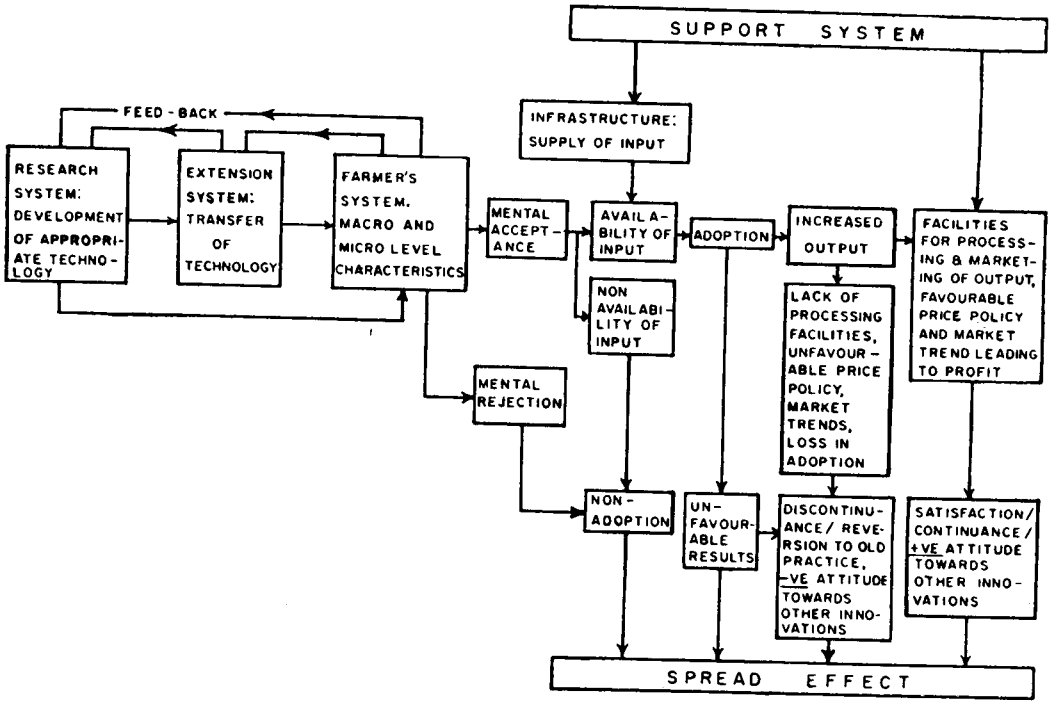
The support system consists of government as well as private agencies dealing with credit and input supplies such as Co-operative institutions, Banks, Agro-Industries Corporation, Commodity Boards etc., and those agencies dealing with processing, marketing and storage of agricultural output, the Marketing Co-operatives, Corporations and private dealers. This system also includes the agencies responsible for the creation and management of other infrastructure in rural areas like electricity, transport and other service facilities.

A farmer's decision to accept or reject an innovation depends not only on personal characteristics but also on the effectiveness of various agencies engaged in this process. Ideally, the first step in the process of transfer of technology is not the development of new ideas or technology by the scientists, but it is communication of existing levels of technology use and problems of the farmers to scientists in order to evolve relevant and need-based technology.

Information regarding improved technology released by the research system can reach the farmers either through the extension system or directly to farmers through mass media like news papers, radio and television. After receiving this information, in the first stage of the decision making process the farmer may either mentally accept the practice or reject it. In case the practice is accepted by the farmers, infrastructure support for timely and adequate supply of input is needed to facilitate actual use of the practices by the farmers. The non-availability of input naturally leads to non-adoption. Adoption of innovation involves a decision by the farmers for its continued use so that it becomes part of their regular practice in farming. The use of improved practice for the first time may lead to discontinuance if the result of adoption of the practice is unfavourable. Even if adoption of the practice lead to increased output, discontinuance of the use of improved practice and reversion to the old practice may occur due to lack of processing and marketing facilities for the output, or due to unfavourable price policies and market trends.

All the three components of technology transfer process, decision for non-adoption, discontinuance of new practice after initial adoption and decision for continued use of practice have their own spread effect which creates either positive or negative climate for the reception of technological innovation by the farmers. The linkages among elements and the various stages in the process of transfer of technology are presented in Fig. 1.

FIG. 1. PROCESS OF TRANSFER OF FARM TECHNOLOGY



Now let us consider how these four systems operate in respect of each plantation crop.

TEA

The entire tea growing in the country is divided into two zones *i.e.*, north and south. The research and development of tea in the north zone are looked after, by the Tea Board while United Planters' Association of South India (UPASI) looks after research and development in the south zone. Since all the crops discussed in this paper are grown mostly in South India, the discussion on tea is also restricted to this region. In South India, tea is grown over an area of about 75,000 hectares with a production of 1,30,000 tonnes. The linkage between the different elements (research, extension, farmers and support) has been established in a unique way with respect to South Indian tea. The clients themselves have formed into an association and created the research and extension systems which function under a single executive who is answerable to the association. Here, the research system is fully aware of the needs of the clients or they are made known to the system, which facilitates the production of only appropriate technology. Once the appropriate technology is developed, it is communicated to the clients through the extension

system without losing much time. This is possible because the research and extension systems are functioning under a single head or policy maker on one side and the clients themselves are looking for the new technology on the otherside. Another reason for the effective transfer of technology in this crop is that it is grown mostly in large holdings which are maintained on commercial lines. Therefore, the gap between the yields of best managed garden and national average or the extension gap in tea is 78% (Table II).

COFFEE

The research and extension systems and a part of the support systems of this crop are looked after by the Coffee Board which is an autonomous body under the Commerce Department, Government of India. The linkage between the research system and extension system is good, since the heads of the research system and extension system are under the same organisation. There is smooth flow of information from the research system to the extension system and *vice-versa*. All the developmental programmes in this crop are routed through the extension system to the technology utilisation system. The extension system is strong with a grass root level functionary for every 2000-3000 holdings. All these grass root level functionaries are trained in the research institute frequently and their knowledge is updated. This helps them to provide the latest information to the technology utilisation system. Marketing a part of the support system again is looked after by the Coffee Board itself and this benefits the technology utilisation system directly, and helps in making the activities of the extension system more effective. Compared to tea, the percentage of small holders is more in coffee; therefore the effectiveness of technology transfer process is slightly reduced in coffee, thereby increasing the gap to 110% (Table II).

RUBBER

The Rubber Board, another autonomous body under the Commerce Ministry looks after the research and extension systems relating to rubber. As in tea and coffee, in this crop also, there is a good linkage between the research and extension departments, as these are divisions under the same organisation, functioning under a single executive. The information from the research system flows to the technology utilisation system through extension system. The extension system is very strong with a grass root level functionary for every 800-1250 holdings. All the subsidies and loans from the government to the grower are routed through the extension system. The extension system links the technology with the subsidies and loans, and passes them on to the planter. This linkage functions in a unique way *i. e.*, unless the grower adopts the technology, he won't be able to get the subsidies or loans. The Rubber Board also plays the role of the support system to some extent by producing and providing the growers, their major requirements of quality planting materials.

The Rubber Board is implementing a massive Rubber Plantation Development Scheme to accelerate new planting and replanting with loan and subsidy

assistance. Because of its very efficient extension system, the Board was able to exceed the target of new planting and replanting of 12,000 hectares per year by 25 per cent. There has been 178 per cent increase in the per hectare yield of rubber in the last three decades and existing level of yield gap is only 153 per cent (Table II) indicating that the linkage between the four systems is very efficient.

CARDAMOM

The basic research on this crop is the responsibility of the three southern agricultural universities (Kerala, Karnataka and Tamil Nadu) and the Central Plantation Crops Research Institute. The adaptive research and development programme are carried out by the Cardamom Board. The extension system also consists of Cardamom Board and departments of agriculture/horticulture. The linkage within the research system and between the research and extension systems are very weak. All the technologies, developed by the research system are not accepted in toto by the extension system. On the other hand the research system does not get the full feed back on field problems. Both the systems operate in isolation to some extent and the technology utilisation system does not get the full benefit of the research and development efforts. The yield per unit area of cardamom has not improved over the last two decades and the yield gap is found to be 317 per cent (Table II).

COCONUT

The research activities on coconut is taken care of by the Central Plantation Crops Research Institute and the Agricultural Universities, which form the research system. The extension system consists of the Coconut Development Board and the Directorate of Extension at the national level and Agriculture/ Horticulture Departments at the state level. Publications of the research institute/agricultural universities and the training programmes organised at varying intervals at the research institute/ agricultural universities for the personnel of the extension system are the only linkage between the research and extension systems. Though there exists a certain level of information flow between the research and extension systems at the lower level functionaries, this does not happen at the policy makers level; mainly because they belong to different organisations.

The extension system, though consists of functionaries exclusively for coconut at higher levels, it is looked after by the general extension functionaries at the grass root level making the transfer process difficult.

In the case of coconut, the technology utilisation system is also quite different, compared to tea, coffee, rubber and cardamom. Coconut is a small holders crop and many of the growers pay little attention to it. Ninety per cent of the holdings are less than one hectare and it is difficult for the extension system to handle them effectively. The schemes of the Coconut Development Board are implemented by the state agencies without any direct control, which weakens the transfer process.

A part of the support system is handled by the extension system *i. e.,* production and supply of quality planting materials. In this front, the achievements so far made are not upto the desired level. Selected material of the local variety has been made available to the technology utilisation system in sufficient quantity. But so far no massive effort has been made in the production and supply of the planting materials of the desired hybrids, for which the technology was developed some five decades ago. Because of the weak linkage between research, extension, technology utilisation and support systems, the per unit area yield has not increased over the years, and a wide yield gap exists which is of the order of 340 per cent (Table II).

ARECANUT

The research and extension systems of this crop is more or less similar to that of coconut. But here the technology utilisation system is somewhat different from that of coconut. The growers are comparatively well informed and economically well placed which facilitate easy flow of information from the extension system to the technology utilisation system. However, in this case also the linkage between the research system and extension system is very weak. The per hectare yield has increased marginally from 695 kg in 1950-51 to 1037 kg in 1980-81. But still there exists 288 per cent of yield gap (Table II).

CASHEWNUT

The research and extension systems with regard to cashewnut is similar to that of coconut. But the research system has not developed to that of coconut. The extension system consists of the Directorate of Cashew Development and Directorate of Extension at the national level and the department of agriculture/horticulture at the state level. Training programmes organised at the research institute for the benefit of the personnel of the extension system is the only link between the two systems which is very weak. In cashew, the technology utilisation system consists of two categories, the private growers having very small sized uneconomic holdings and the Plantation Corporation/Forest Departments under the state governments having very large holdings. As in any other crop, technology transfer to the first category is quite difficult due to their large number and poor economic condition. But there should be no difficulty in transferring the technology to the second category. The importance of increasing area and production has been felt only recently and developmental programmes have already been initiated. The per hectare yield has come down drastically over the last three decades. This is mainly because of the increase in area and the new plantings are coming up only in marginal lands, with poor quality planting materials and with least management. The extension gap in yield is 219 per cent (Table II).

BLACK PEPPER

The research and extension systems concerning this crop is similar to that of coconut, arecanut and cashewnut. The linkage between the research system and extension system is weak. The per

hectare yield has come down from 271 kg in 1950–51 to 248 kg in 1980–81. This may be due to the fact that the traditional black pepper is now mostly grown as a mixed crop with other perennials. The extension gap in yield is wide, which is in the order of 372 per cent (Table II).

Table II. *Yield gap between national average and best managed gardens in plantation crops*

Crop	Yield (Kg/ha)		Gap	
	National average	Best managed garden	Actual	Percentage
Tea	1743	3100	1357	77.9
Coffee	750	1575	825	110.0
Rubber	790	2000	1210	153.2
Cardamom	48	200	152	316.7
Coconut	5249*	23100*	17851*	340.0
Arecanut	1037	4025	2988	288.1
Pepper	233	1100	867	372.1
Cashew	314	1000	686	218.5

* Number of coconuts

Constraints in the different systems

Research system

The research system has developed various technologies in production, protection and processing of plantation crops, but much breakthrough has not been achieved in transferring them to the planters in most of the crops, and also the research system has not been able to develop technologies to solve many of the field problems because of constraints. The long pre-bearing period, the time lag between the treatment and response and the number of years required to conclude an experiment are some of the major constraints. The consequent impact of these problems is that scientists working on plantation crops are not able to contribute much to either their original field of specialisation or the task of increasing production levels in these crops. This slowest rate of output by scientists compared to their counterparts working on annual crops also dulls their enthusiasm. The location of the research centres are mostly in remote areas, where basic amenities like housing, schooling and transport are not available. Hence talents are not attracted and the available talents are also getting eroded.

Extension system

A number of studies in India show that the result demonstration is one of the best methods of communicating agricultural innovations effectively. Conducting result demonstrations in plantation crops needs some special attention and flexibility. The procedure used for conducting result demonstrations in plantation crops is similar to the one followed for annual crops. Because of this, most demonstrations in plantation crops are stopped abruptly even before the impact of the technology

adopted in these plots is visually observable. Transfer of ownership of land due to sale or partition and frequent transfers of extension personnel contribute significantly to this problem. Thus, the basic objectives of utilising result demonstration as an educational tool is not being achieved in plantation crops.

The extension unit available within the research system organises the training programmes for the personnel of the extension system and produces the literature on the technologies developed and serves as a link between the research and extension systems. This unit is responsible for the first level of transfer of technology. If this unit is strong in the research system, the transfer process will be more effective. Unfortunately, this unit is very weak in most of the research systems concerning plantation crops.

The linkage between the extension system and support system is also very weak. The extension system may be popularising a certain technology, but the support system may not be able to make available the required inputs to the planters in time, resulting in non adoption of the improved technology.

Technology utilisation/Farmers system

About two-thirds of the holdings of the plantation crops except tea, coffee and rubber, are less than one hectare in size. When the holding size becomes small, the small or marginal farmer must look for sources of additional income to make a living. Because of the divided interest, the time and money bestowed towards the better management of these crops also are alarmingly very low. Barring a few farmers growing coconut and arecanut, most of the farmers growing crops like cashew and pepper will come under this category.

Since most small and medium farmers live in a cycle of poverty, they do not have much capital for heavy investment in the better management of plantation crops. Though profitability of such innovation is comparatively very high, the rate of immediacy of return is very low and hampers wide adoption. Lack of irrigation facilities, lack of timely and adequate input supply and poor contact by extension workers also add to the poor response of the planters towards adoption of improved technologies.

Support system

Extensive adoption of some innovations like planting hybrid coconut, cashew and pepper is being curtailed because of the non-availability of improved planting materials. Taking advantage of factors like long prebearing age and higher time lag between the treatment and response, some traders cheat the farmers with spurious planting materials, wrong fertiliser mixtures and 'wonder cure' plant protection chemicals for many of the pests and diseases of plantation crops using the name of some reputed institutions and agencies. After few years, the farmers realise that they have been cheated by some unscrupulous elements. Thereafter they look to any new technology only with suspicion. Factors like, lack of processing and marketing facilities, unfavoura-

ble price policies of the government, nonavailability of inputs when the farmer wants them and lack of coordination between the different input agencies also dull the enthusiasm of farmers to adopt any new technology.

Suggestions to improve the process of transfer of technology

Research system

The allocation of funds for research should be enhanced, so that the infrastructural facilities available in the research centres such as large area of land for conducting field experiments, could be acquired and basic living amenities could be provided to the staff. The opportunities for career advancement of the scientists must be improved to attract and retain the talents in plantation crops research. The linkage between the research and extension systems must be strengthened, by having a common head who will integrate and supervise the activities of the two systems.

Extension system

The procedure used for conducting result demonstrations in plantation crops needs immediate attention of all those who are concerned with plantation crops development. A group of extension scientists as well as policy makers may work out a detailed methodology for conducting result demonstrations in plantation crops as was done for the National Demonstration Programme. It should be ensured that such guidelines are followed in all the plantation crop demonstrations sponsored and executed by various organisations in the country.

The extension unit available within the research centres, which is responsible for the first level of transfer of technology should be strengthened so that it could meet the entire training needs of the personnel in the extension system. A Trainers Training Centre should be established under the research system to achieve the above objective. The extension literature brought out by the research centres should carry the actual gain obtained in the research/farmer's field by adopting the recommended technologies. The subsidies should always be linked with technology and routed through the extension system to get the transfer process accelerated as is being done in rubber.

Technology utilization/Farmers system

Considering the extent to which the plantation crops contribute to the national economy, especially in the sphere of export–import balances, the government should think of starting a number of special schemes for subsidising the input costs and liberalising the credit policies. The agencies implementing such schemes should also ensure that the concessions given are used in the right manner for the development of plantation crops.

In plantations, where improved technologies are adopted, the yield is found to vary considerably between years due to extraneous factors (Table III). In the years when the yield is abnormally low, the planter must be protected suitably through insurance, subsidy schemes etc.

Table III. *Variations in annual yield of plantations under best management*

Year	Arecanut		Coffee	
	Actual (Kg/ha)	Deviation from mean	Actual (Kg/ha)	Deviation from mean
1976	4542	+23	977	—36
1977	3816	+03	1024	—33
1978	4030	+09	2275	+48
1979	3283	—11	609	—60
1980	2387	—35	2951	+92
1981	4137	+12	1385	—10
Mean	3699	100	1537	100

Support system

The Government should come forward to produce and supply the improved planting materials in sufficient quantities. Suitable statutory regulations must be brought in, to curtail the trading in spurious planting materials, substandard fertilisers and plant protection chemicals.

Farmers should be provided with better facilities for processing and marketing of their produce either individually or on a co-operative basis to ensure in getting a higher proportion of money paid by the ultimate consumers.

The sudden fall in price of arecanut in the early seventies created some difficulties for arecanut farmers which was overcome by the formation of Central Arecanut Marketing and Processing Co-operative Society (CAMPCO), a joint venture of the government of Kerala and Karnataka. Recently the cocoa farmers also had to face the same kind of situation for want of marketing facilities. The position is improving because of the CAMPCO's entry into the market.

Most of the produces of plantation crops can be stored for about an year without any deterioration in quality. So there should be ample opportunities available to farmers to store their produce and get consumption loans on the mortgage value of their produce with minimal interest in the event of a sudden fall in prices. The crops like arecanut get a premium price if it can be stored upto the next crop season.

Government should also formulate favourable price policies, especially relating to export and import in such a way as to ensure maximum returns to the producers.

Till now, meagre amount of research input has been invested on research aspects of the constraints involved in the transfer of technology on plantation crops. Special problems are involved in these crops, which play a role in the livelihood of a number of small and marginal farmers and thereby on the national income. Therefore, the scientists should make an in-depth analysis of various factors involved in the transfer of technology and formulate

suitable strategies to ensure the effective transfer of technology in these crops.

ACKNOWLEDGEMENT

I record my sincere thanks and appreciation to Mr. V. Ranganathan, Deputy Director and Dr. V. S. Sharma, Head, Division of Botany, UPASI Tea Research Institute; Dr. M. J. Chacko, Deputy Director and Mr. W. Krishnamoorthy Rao, Head, Division of Soil Science, Central Coffee Research Institute, Balehonnur; Dr. M. Sethuraj, Director, M/s P. K. Narayanan, Public Relations Officer and P. Mukunda Menon, Rubber Production Commissioner of Rubber Board and Mr. A. Shahjahan, Chief Editor, Cardamom Board for providing me valuable information for developing the contents of the talk. I am also thankful to my colleague Mr. C. Kailasam for all the help and co-operation rendered in preparation of the manuscript.

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