

**APPLICATION FOR GRANT FOR AD-HOC RESEARCH FOR CONSIDERATION OF
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)**

1. Title of the scheme : Survey, collection, evaluation and standardisation of agrotechniques for betelvine (Piper betle L.) in Kerala
2. Location
- a) Name and address of Institute/University : Kerala Agricultural University
Vellanikkara, Thrissur-680 654
Kerala
- b) Name and address of Head of University : Dr.A.M.Michael
Vice-Chancellor
Kerala Agricultural University
Vellanikkara, Thrissur-680 654
Kerala
- c) Actual location where the research work will be carried out : Agronomic Research Station
Chalaky and Sub Centre at
Vellanikkara
3. Information regarding the Principal Investigator:
- a) Name and designation : Sri.V.Sreekumaran
Associate Professor (Agronomy)
Agronomic Research Station
Chalaky, P.O. PIN 680 307
Kerala
- b) Brief bio-data : Annexure-1
- c) List of important publications in this or related field : Annexure-2
- d) List of other research scheme(s) being carried out by the Principal Investigator with financial support from various agencies/organisation (including ICAR)

Name of the agency	Title of the scheme	Period		Grant (Rs. in lakhs)	Remarks
		From	To		
ICAR	AICRP on Water Management	1993	1994	15.0	Scheme will continue till the end of VIII plan period

4. Information regarding other research scientists to be associated with investigation

a) Name and designation:

1. Smt.G.Santhakumari
Associate Professor (Soil Science & Agrl. Chemistry)
Agronomic Research Station
Chalaky, P.O., Kerala - 680 307
2. Dr.Koshy Abraham
Associate Professor (Plant Pathology)
Department of Plant Pathology
College of Horticulture
Vellanikkara, Thrissur - 680 654
3. Dr.Jim Thomas
Associate Professor (Agrl. Entomology)
Department of Entomology
College of Horticulture
Vellanikkara, Thrissur - 680 654

b) Biref bio-data

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c) List of important publication in this or related field

Annexure-3

d) List of other research scheme(s) with the Scientist(s) is/are associated and which are being carried out with financial support from various agencies/organisations (including ICAR)

Name of the agency	Title of the scheme	Period From To	Grant Rs.in lakhs	Remarks
1. ICAR	All India Co-ordinated Project on Watermanagement	1993-94	15.0	Scheme will continue till the end of VIII plan
2. Central Water Resources and Command Area Development Authority(50:50)	Onfarm Water-management	1993-94	2.0	-
3. Cadbury India Ltd.	Cadbury KAU Co-operative Cocoa Research Project	1993-94	12.0	Scheme will continue till 1998

5. Objectives

The homegarden agroforestry system - a multi-species multi-tier perennial tree crop combination, unique to Kerala, is highly conducive for the successful production of betelvine. The coconut and arecanut based cropping systems prevalent in the State offer much scope for betelvine as a component crop, as they provide natural shade - a pre-requisite for its excellent growth conditions. The area under this crop in Kerala is only about 1000 ha, concentrated mainly in the districts of Malappuram, Trichur, Quilon and Trivandrum. Despite, having the natural resource in abundance, viz., well distributed rainfall, high humidity, well drained soil types etc. the spread of this crop to non-traditional areas is far from satisfactory. Among other things, low yielding cultivars, lack of adequate planting material, high incidence of disease such as foot rot and bacterial leaf spot, lack of appropriate agronomic management practices, inadequate storage techniques, and fluctuating market price are considered to be major constraints for the low production and productivity of this crop in Kerala.

The feasibility of growing betelvine using dead standards requires investigation as the same practice in black pepper has been proved to be yielding high returns as there is zero competition for inputs of production. The cuttings taken from the orthotropic mature vines are quite insufficient to meet the large scale planting requirement, and, therefore, rapid multiplication techniques are to be standardised. Integrated use of manures and fertilizers for sustained production needs elaborate study. Screening for host resistance to disease pathogens emphasises the minimal use of chemicals as betel leaves are meant for chewing purpose. As this crop responds well to irrigation, measures to optimise its requirement are to be evolved. Since the research work carried out on these aspects is scanty, the present study is proposed with the following objectives.

1. Collection, evaluation of cultivars of betelvine and maintenance of promising cultivars with high yield potential and quality.
2. Screening of cultivars against major diseases and pests.
3. Standardisation of management practices.

6. Practical/Scientific utility

Betelvine is a small farmer's crop, the extent of its cultivation in each homestead is only less than 5-10 cents. The betel leaves are in great demand both in internal and international market as this is now being exported to countries like Pakistan, Afghanistan, UAE and other European countries, from Northern Kerala. Superior genotypes with high yielding potential coupled with good quality marketable leaves, if introduced, would be well received by the small holders and would replace the existing uneconomic and low-yielding cultivars.

As the betel leaves are consumed raw, use of chemicals for the control of disease should be with utmost caution, and hence, screening cultivars for host resistance to disease pathogens is of great practical importance. It has been the experience that use of inorganic fertilizers alone not only invites much of a disease problem, but impairs the quality of foliage as well. This calls for the integrated use of organic and inorganic sources for the sustained production of this crop. Methods of improved storage techniques would definitely reduce the post harvest losses as the leaves being easily perishable, and open up prospects for exporting to other countries. Moreover, the results of various studies on the agrotechniques envisaged in this scheme would serve as a basis for formulating a package of practices suitable for the agroclimatic conditions of Kerala.

7. Review of research conducted/being conducted on the subject in India and abroad

- a) At the sponsoring institution (State preliminary work already done, techniques standardised, data collected etc.)

The review of research work so far carried out on various aspects in the Kerala Agricultural University is presented below:

Abraham and Mathew (1981) reported that of the seven cultivars of betelvine screened against Xanthomonas campestris pv. betlicola none was resistant. However, the cultivars Thulasivettila and Karilanchikarpooram were less susceptible to the disease.

Abraham (1986) noted that application of nitrogen, phosphorus and potassium had no significant effect on the development of bacterial leafspot of betelvine. According to him, the combination of plantomycin and one per cent bordeaux mixture was found to be more inhibitory to the bacterium than antibiotics and fungicides alone. He further pointed out that cultivars viz., Pozhikodi, Nadan-kodi and Thulasivettila Type I were found to be resistant to the disease, among the cultivars screened for host resistance.

In an experiment on betelvine conducted at Vellayani, Kerala, revealed that application of nitrogen (60 kg/ha) and phosphorus (50 kg P_2O_5 /ha) was effective in enhancing the yield of marketable leaves. The study also revealed that plant height, number of functional leaves, number of branches and LAI were highly correlated with yield of marketable leaves. Among the different cultivars, Thulasikodi and Cheelanthikarpooram - red recorded higher yield of 43.87 and 39.65 lakhs of marketable leaves/ha respectively, and were superior in the number of functional leaves, number of branches/plant, LAI and quality aspects like reducing, non reducing and total sugars (Chandini, 1989).

From the results of the experiment on betelvine trained on the Koottakodi system, receiving FYM alone, FYM with N at 0.5, 1.0 or 1.5; P_2O_5 at 0.4 and K_2O at 1.4 t/ha or FYM with either N, P_2O_5 or K_2O alone applied in 18 split applications over the two year trial period, Jaikumaran et al. (1990) found that the highest leaf yield was obtained with FYM at 40 t/ha + N (as urea) at 1.0 t/ha, with little effect of both P and K.

b) Research work done and in progress in India

Subramanian and Rao (1970) reported that application of superphosphate reduced the mortality of betelvine plants infected with Phytophthora nicotiana var. parasitica. Thyagarajan et al. (1972) found that application of FYM in combination with superphosphate reduced the wilt of betelvine caused by Phytophthora nicotiana var. parasitica, while application of potassium had the reverse effect. It was reported from Jabalpur that betelvine plants receiving more phosphorus than nitrogen and potassium showed less mortality due to the foot rot and wilt pathogen (Jain et al., 1982). They also found that the cultivars Bangla and Bilhari were highly susceptible to Xanthomonas campestris pv. betlicola.

An experiment conducted at the Betelvine Research Station, Utkur, A.P., revealed that among the non-pungent types studied, Tella alin was the best variety in respect of quality and aroma. Among the pungent types studied Peddakammeri, Kavapari and Gundu varneri of Andhra Pradesh, Chanchipan of West Bengal, Kaker and Belhari of Bihar and Bangla of Gujrat were found to be high yielding during different cropping seasons (Anon, 1983). Results of an experiment at Utkur, showed that application of 107.5 tonnes of compost recorded significantly higher yields followed by 113.37 tonnes of groundnut cake and 113.75 kg potash per ha (Anon, 1983). It was also found that 60 kg N, 50 kg P_2O_5 and 50 kg K_2O /ha over basal dose of 80 tonnes of compost recorded superior leaf yields.

Seshadri (1983) reported that N applied in the form of organic manure improved the quality and yield of betel leaves. Vines receiving 22.68 kg N as groundnut cake and 22.68 kg P_2O_5 as Superphosphate + 9.07 kg K_2O + 9.07 kg Ammonium sulphate produced leaves with finer texture and slightly higher pungency. From an onfarm replicated trial in a cultivator's field Debnath et al. (1985) observed that best yields are obtained if 25 or 50 per cent of N in the form of fertilizer (urea) and the rest in the form of organic manure (oil cake) are applied along with P and K.

Siddappa and Anilkumar (1985) noted that Thiram was the best soil drench against Fusarium solani f sp. piperis affecting betelvine, while Saikia and Addy (1987) found that Carbendazim (bavistin) was the most effective against the natural infection of Colletotrichum gloeosporoides in betelvine. Nair et al. (1986) stated that cultivar Ambadi had a higher disease index and a lower phenolic content (7.76 mg/g) than the more resistant Kareyele (11.38 mg/g) against anthracnose disease.

From a survey of 190 farmers of varying sizes in West Bengal on which arecanuts were intercropped with 5 species, it was concluded that betelvine was the most profitable inter crop (Singh et al., 1986).

Preliminary studies conducted at Velur, Tamilnadu, with white polythene mulching on beds revealed that high reduction (76.6%) in nematode population. Soil temperature increased to 44.1°C in uncovered areas, while black polythene mulching reduced rematode population by 69.2% and increased soil temperature upto 39.6°C (Sivakumar and Marimuthu, 1987).

From the results of the study conducted at Kalyani, West Bengal, Pal (1987) reported that betel leaf yield at the highest N rate was nearly 4 times greater than at zero N, when N at 0, 46, 230 or 460 kg/ha, P_2O_5 at 0, 16, 32 or 64 kg/ha over 50 kg K_2O /ha uniformly, applied to a two year old betelvine.

Acharya and Padhi (1989) stated that neem oil cake at 1 t/ha applied in trenches at the time of lowering of vines of cv. Gudibangla was most effective in controlling nematode Meloidogyne incognita. The maximum number of marketable leaves was produced by the same treatment followed by saw dust 2 t/ha.

In an experiment carried out at Dharwad, Karnataka, to evaluate different cultivars, the highest yield was recorded by Lakkaballi followed by Chikodi. The leaves of Lakkaballi and Nagaballi cultivars were fit for consumption upto 14 days after harvest when stored in polythene bags. Among the 7 cultivars studied, Chikodi, Cholachagudda and Ambadi were found non-pungent and Sweetish, while Nagaballi, Mysore Chiguru, Kareyele and Lakkaballi were pungent and non-sweetish. Cholachagudda and Chikodi showed the minimum disease index against Colletotrichum gloeosporoides (Prabhuprasad, 1989).

Balasubramanyam and Rawat (1990) suggested that the characteristic clove-like aroma of Bangla and Sanchi leaves is due to phenolic compounds including eugenol (63.56 and 33.22% respectively) and the sweet fennel-like taste of Meetha leaves is due to anethole (19.31%).

From the results of the experiment conducted in Assam, Saikia and Dutta (1991) observed that single node cuttings taken from the mature, orthotropic terminal stem of two year old betelvine had a higher percentage survival and sprouted slightly earlier than 3 noded cuttings.

c) Research work done and in progress in abroad

Studies on these aspects are not seen published.

8. TECHNICAL PROGRAMME

1. Survey, collection and evaluation of available cultivars of betelvine from the different tracts of Kerala and from the neighbouring states like Tamil Nadu and Karnataka and maintaining a germplasm of betelvine.
2. Screening of cultivars for host resistance against diseases and pests both under natural and artificial condition.
3. Standardisation of various agrotechniques;
 - i) Studies on the growth and yield of betelvine as influenced by live and dead standards.
 - ii) Studies on the rapid multiplication of betelvine from orthotropic, primary and secondary branches.
 - iii) Studies on the integrated use of both organic and inorganic sources to evolve an appropriate manurial schedule.
 - iv) Studies on the effect of mulching and water regimes on the growth and yield of betelvine.
 - v) Studies on the post-harvest handling and storage of betel leaves.

Yearwise plan of work

Ist year : Survey of betelvine growing areas, collection of cultivars, maintenance of germplasm, evaluation of cultivars for yield and quality, screening for host resistance, pot culture experiment, rapid multiplication studies, collection of data.

2nd year : Planting of the experiments on agrotechniques with promising cultivars, recording of observation, chemical analysis.

3rd year : Recording of observations, chemical analysis, compilation of data, statistical analysis, interpretation of results, preparation and submission of final report.

a) Main items of observations to be recorded

- i) Biometric observations
- ii) Scoring for disease incidence and pest infestation
- iii) Yield of marketable leaves
- iv) Analysis for quality attributes
- v) Chemical analysis of soil and plant parts for nutrient uptake
- vi) Rooting characteristics
- vii) Soil moisture for consumptive use of water
- viii) Economics of treatments

b) Arrangement for analysing data and the name and designation of the statistician associated in the programme planning

The Computer facility to be provided for the scheme would be utilized for statistical analysis using MSTAT package, in consultation with the statistician available at the University Headquarters as the centre does not have one.

c) Items of investigation for which collaboration is required

The analysis of quality attributes of leaves will be done at the phytochemical laboratory established at the Aromatic and Medicinal Plants Research Station (KAU) Odakkali. The facilities available at the Division of Plant Pathology and Agricultural Entomology, College of Horticulture, Vellanikkara will be utilized for screening studies against diseases and pests.

9. Facilities (Give details of facilities required for conducting the scheme)

- a) Already available and can be provided free of charges

i) List of equipments and apparatus:

Equipments available at the centre would be utilized for the scheme (List appended Annexure-4)

ii) Area of land/number of livestock: Available for experimentation

iii) Laboratory and office facilities : Available etc.

b) Additional facilities required which are chargeable to the scheme

i) Equipments and apparatus : Leaf area meter (portable)

ii) Land/livestock : Nil

iii) Laboratory and office facilities: Personal Computer with printer

10. Duration : Three years

11. Staff requirements

Designation of post	No.	Scale of pay Rs.	Qualification prescribed (for technical/scientific posts only)
Research Associate (Agronomy)	1	2700-3200	M.Sc.(Ag.) with two years experience
Research Associate (Plant Pathology)	1	2700-3200	M.Sc.(Pl.Path.) with two years experience

12. Estimates of costs

Sl. No.	Name of post	Scale of pay	No. of posts	1st year	2nd year	3rd year	Total (Rs. in lakhs)
1.	Research Associates	2700-3200	2	0.648	0.672	0.696	2.016
2.	Pay of establishment			-	-	-	-
3.	Allowances and Honoraria						
a)	Dearness allowance			-	-	-	-
b)	House rent			-	-	-	-
c)	City compensatory allowance			-	-	-	-
d)	Other allowances (including medical)			-	-	-	-
e)	Travelling allowance			-	-	-	-
				0.200	0.150	0.100	0.450
			Total	0.848	0.822	0.796	2.466

4. Contingencies

a) Recurring

i) Glassware	0.050	-	-	0.050
ii) Chemicals	0.150	0.200	-	0.350
iii) Labour charges	0.400	0.600	0.600	1.600
iv) POL charges	0.050	0.030	0.020	0.100
v) Other items viz., manures, shade, mulch, standards for trailing vines, etc.	0.400	0.300	0.400	1.100
Total	<u>1.050</u>	<u>1.130</u>	<u>1.020</u>	<u>3.200</u>

b) Non-recurring

i) Leaf area meter (Portable)	2.000	-	-	2.000
ii) PC/386 with printer	1.000	-	-	1.000
Total	<u>3.000</u>	<u>-</u>	<u>-</u>	<u>3.000</u>

Total	Recurring	Non-recurring	Grand Total
2.446	3.200	3.000	8.666

Share of council : Rs.8.666 lakhs (100%)

Share of the University : Nil

Justification for the purchase of equipments (Leaf area meter and PC)

The betel leaves are the economic part of the plant and periodical sampling for leaf area measurement through destructive sampling is undesirable. Moreover, to fix up the optimum stage of harvest of leaves in relation to its development as well as the alkaloid content, in situ measurement of leaf area becomes essential. It would be easy to quantify the interrelationships of developmental physiology and maximum leaf area required for higher production.


The enormous bulk data generated from different trials could be stored, retrieved and analysed if a PC is available at the centre.

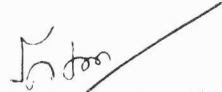
13. Receipts anticipated : Rs.50,000/- through the sale of betel leaves

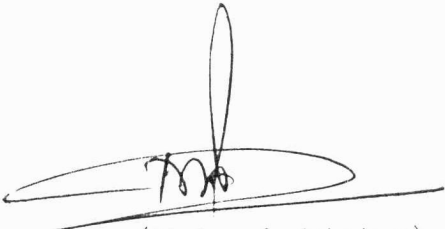
Undertaking

14. Certified that:

- i) The research work proposed in the scheme does not in any way duplicate the research work already done and carried out elsewhere on the subject.
- ii) The scale of pay, allowances etc. proposed above are those admissible to persons of corresponding status employed under the Kerala Agricultural University.
- iii) The present scheme can not be combined with any scheme financed by the Council, Central and State Governments, Universities or Private Institutions of their own funds.
- iv) Necessary provision for the scheme will be made in the Institute/University/State budget in anticipation of sanction to the scheme by the Council.
- v) We have read the memorandum of understanding between the Indian Council of Agricultural Research and the sponsoring Institution in respect of ad-hoc research projects from Agricultural Produce Cess Fund of the Revised Guide lines for ad-hoc schemes. We undertake to abide by the guidelines provided by the Council for the implementation of the ad-hoc projects.


12/11/1993.
(V. Sreekumaran)
Associate Professor
Principal Investigator


(G. Santhakumari)
Professor & Head i/c


(M. Aravindakshan)
Director of Research &
Executive Authority of
University

List of references

- Anonymous (1983). Annual Report. Betelvine Research Station, Utkur, Andra Pradesh.
- Abraham, K. (1986). Study of bacterial leaf spot of betelvine - biochemical changes and control. Ph.D. thesis submitted to Kerala Agricultural University.
- Abraham, K. and Mathew, J. (1981). Screening of betelvine cultivars for host resistance against leaf spot pathogen Xanthomonas betlicola Patel, Kulkarni and Dhande. Agri. Res. J. Kerala **19**:63-65.
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- Balasubramanyan, V.R. and Rawat, A.K.S. (1990). Studies on morphology and chemistry of Piper betle L. J. Pln. Crops. **18**(2):78-87.
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- Jain, A.C., Nayak, M.L., Deshpande, A.L. and Bhale, M.S. (1982). Studies on betelvine diseases. JN. Agri. Univ., Jabalpur, pp.24.

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- Prabhu Prasad, C.B. (1989). Evaluation of betelvine (Piper betle L.) cultivars. M.Sc.(Ag.) thesis submitted to Dharwad Agricultural University, Karnataka.
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- Seshadri, K.V. (1983). Annual Report, Agricultural Research Station, Utukur, Cuddapah.
- Siddappa, M.K. and Anil Kumar, T.B. (1985). Factors affecting efficacy of fungicides against Fusarium solani f. sp. piperis in soil. J. Soil Biol. Ecol. **5**(2):92-97.
- Singh, R.K., Bhalerao, M.M. and Reddy, M.J.M. (1986). Costs and returns of intercrops in arecanut. Indian Cocoa Arecanut Spices J. **9**(4):99.
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Subramanian, K.S. and Rao, A.V. (1970). Some experiments on the betelvine wilt at Pothanur in Tamil Nadu. Indian Phytopath. **23**:603-605.

Thyagarajan, R., Rao, A.V., Varadarajan, S. and Sundararajan, R. (1972). Studies on betelvine wilt disease. Influence of nitrogen and phosphorus in the control of betelvine wilt disease. Madras Agric. J. **59**:187-189.

ANNEXURE - 1

BIO-DATA OF THE PRINCIPAL INVESTIGATOR

1. Name : V. SREEKUMARAN
2. Designation : Associate Professor (Agron.)
3. Date of birth : 30-11-1955
4. Institution : Kerala Agricultural University
Agronomic Research Station
Chalakydy
5. Whether belongs to SC/ST : No

6. Academic qualifications

<u>Year</u>	<u>Degree</u>	<u>Institute</u>
1977	B.Sc.(Ag.) Agriculture	Kerala Agricultural University
1982	M.Sc.(Ag.) Agronomy	Kerala Agricultural University

7. Trainings/Summer Institute attended

- i) ICAR Summer Institute on "Saline and Alkali soils and Water-management" held at Mahatmaphule Agricultural University, Rahuri, Maharashtra (27-6-1983 to 16-7-1983)
- ii) ICAR (NARP Phase II) Training Course on "Watermanagement Research for Scientists of State Agricultural Universities" held at Water Technology Centre, IARI, New Delhi (2-4-1992 to 29-4-1992)

8. Positions held

- i) Junior Assistant Professor, Kerala Agricultural University - Regional Agricultural Research Station, Ambalavayal; Sugarcane Research Station, Thiruvalla and Rice Research Station, Moncompu (26-12-1977 to 4-12-1983)
- ii) Assistant Professor, Kerala Agricultural University (Tribal Area Research Centre, Amboori (5-12-1983 to 25-12-1987)

iii) Associate Professor, Kerala Agricultural University (Tribal Area Research Centre, Amboori; Kelappaji College of Agricultural Engineering and Technology, Tavanur; Agronomic Research Station, Chalakudy (26-12-1987 - Till date)

9. Award/Prize/Certificate won by the Principal Investigator

Awarded a Good Service Entry for meritorious service by Kerala Agricultural University in recognition of my work in Tribal Area Research Centre, Amboori as per Order No.GA/C2/28151/86/K.Dis. dt.10-12-1986.

10. Research publications

Books	: Nil
Research papers	: 11 (Annexure-2)
Popular articles	: Four
Research Reports	: Two

The information given above is true to the best of my knowledge and belief.



Signature of the Principal Investigator

ANNEXURE - 2

LIST OF PUBLICATIONS

1. Sreekumaran, V., Balasubramanian, P.P., Indrasenan, G. and Sreekantan Nair, G. (1981). Effect of time and method of planting on the yield of second crop of ginger in Wynad. Indian Cocoa Arecanut Spices J. 5(1)
2. Sreekumaran, V., Balasubramanian, P.P., Vasanthakumar, K. and Mammen, M.K. (1981). A comparative performance of six varieties of ginger for second crop in Wynad. Indian Spices 17(1)
3. Sreekumaran, V., Indrasenan, G. and Mammen, M.K. (1980). Studies on the quantitative and qualitative attributes of different ginger (Zingiber officinale Rosc.) types. Proc. Nat. Seminar on Ginger and Turmeric, 8-9 April 1980.
4. Vasanthakumar, K. and Sreekumar, V. (1981). Effect of growth substances on yield and quality of Pisum sativum. South Indian Hort. 28(4)
5. Indrasenan, G., Sreekumaran, V., Jim Thomas and Mammen, M.K. (1981). On the varietal resistance of some rice varieties to udbatta disease in Wynad. Agric. Res. J. Kerala 14(ii)
6. Indrasenan, G., Jim Thomas, Sreekumaran, V. and Mammen, M.K. (1981). On the chemical control of udbatta disease of rice incited by Ephetis oryzae (Syd.). Agric. Res. J. Kerala 19(1)
7. Indrasenan, G., Sreekumaran, V., James Mathew and Mammen, M.K. (1981). The mode of survival of Pseudomonas solanaeearum (Smith) causing bacterial wilt of ginger (Zingiber officinale Rosc.). Agric. Res. J. Kerala 19(2)

8. Nair, C.S.J., Nair, K.H., Jayakrishnakumar, V., Sreekumaran, V., Rajkamal, P.J., Nirmala, C. and Aiyer, R.S. (1989). Ecologic and economic development of tribal habitats of Amboori. Proc. Kerala Sci. Cong., Cochin, pp.349-360
9. Jayakrishnakumar, V., Sreekumaran, V. and Geethakumari, V.L. (1990). Integrated Development of Kanikkar tribals dispersed in the Western Ghats of Trivandrum district in Kerala. Indian J. Adult Education. **51(1):31-40**
10. Nair, K.H., Nair, C.S.J., Sreekumaran, V., Lekha Sreekantan and Aiyer, R.S. (1990). Integrated approach on rural development for the tribal people in Amboori. Proc. Kerala Sci. Cong. 23-25 Feb. 1990, Trivandrum
11. Annie Koruth; Sumam George; Chandrasekharan Nair, K., Sreekumaran, V. and Joseph, C.A. (1993). Effect of seed soaking in solutions of Zn and Cu for lowland rice. Proc. Vth Kerala Science Congress, 28-30 Jan., Kottayam, pp.208-209

Research Reports

1. Sreekumaran, V., Jayakrishnakumar, V., Aiyer, R.S. and Nair, K.H. (1988). In situ budding - A technique for upgradation of non-descript rubber plants in tribal holdings, TARC, Amboori.
2. Jayakrishnakumar, V., Sreekumaran, V., Aiyer, R.S., Nair, K.H. and Nair, C.S.J. (1989). Experiences with rubber as an ecologic and economic alternative for the tribal habitats of Amboori. TARC, Amboori.

ANNEXURE - 3

BIO-DATA OF ASSOCIATES

1. A. Name : **Smt.G. SANTHAKUMARI**
B. Date of birth : 28-8-1943
C. Institution : Kerala Agricultural University
Agronomic Research Station
Chalakydy
D. Whether belongs to SC/ST : No.
E. Academic (M.Sc. onwards) and professional career
Degree/position held

<u>Year</u>	<u>Degree</u>	<u>Institute</u>
1975	M.Sc.(Ag.) in Soil Science & Agricultural Chemistry	Kerala Agricultural University

Position held : Associate Professor

- F. Award/Prize/Certificate etc. won by the associate

Awarded a Good Service Entry for meritorious service in connection with the implementation of Group Farming in KAU.

- G. Publications (Number only)

Books : Nil
Research papers : 15
General articles : 3
Patents : Nil
Others (specify) : Nil

2. A. Name : **DR.KOSHY ABRAHAM**
B. Date of birth : 01-12-1955
C. Institution : Kerala Agricultural University
College of Horticulture
Vellanikkara
D. Whether belongs to SC/ST : No

E. Academic (M.Sc. onwards) and professional career

Degree/position held

<u>Year</u>	<u>Degree</u>	<u>Institute</u>
1980	M.Sc.(Ag.) in Plant Pathology	Kerala Agrl. University
1986	Ph.D. in Plant Pathology	Kerala Agrl. University

Position held : Associate Professor

F. Award/Prize/Certificate etc. : Nil
won by the associate

G. Publications (Number only)

Books : Nil
Research papers : 21
General articles : 3
Patents : Nil
Others (specify) : Nil

3. A. Name : **DR. JIM THOMAS**

B. Date of birth : 25-5-1956

C. Institution : Kerala Agricultural University
College of Horticulture
Vellanikkara

D. Whether belongs to SC/ST : No

E. Academic (M.Sc. onwards) and professional career

Degree/Position held

<u>Year</u>	<u>Degree</u>	<u>Institute</u>
1981	M.Sc.(Ag.) in Agrl.Entomology	Kerala Agrl. University
1988	Ph.D. in Agrl. Entomology	IARI, New Delhi

Position held : Associate Professor

F. Award/Prize/Certificate etc. : Nil
won by the associate

G. Publication (Number only)

Books : Nil
Research papers : 10
General articles : 10
Patents : Nil
Others (specify) : Nil