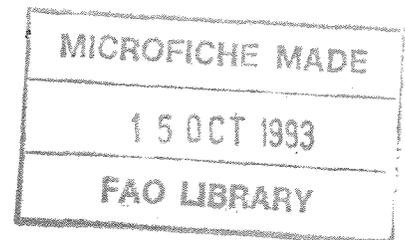
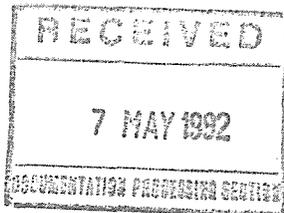


COFFEE PRODUCTION AND PROCESSING
IN YUNNAN - P.R./CHINA

STATUS OF PROJECT IMPLEMENTATION WITH AN
EMPHASIS ON PRODUCTION AND BREEDING ASPECTS

Report of third mission undertaken
24 October - 26 November, 1991

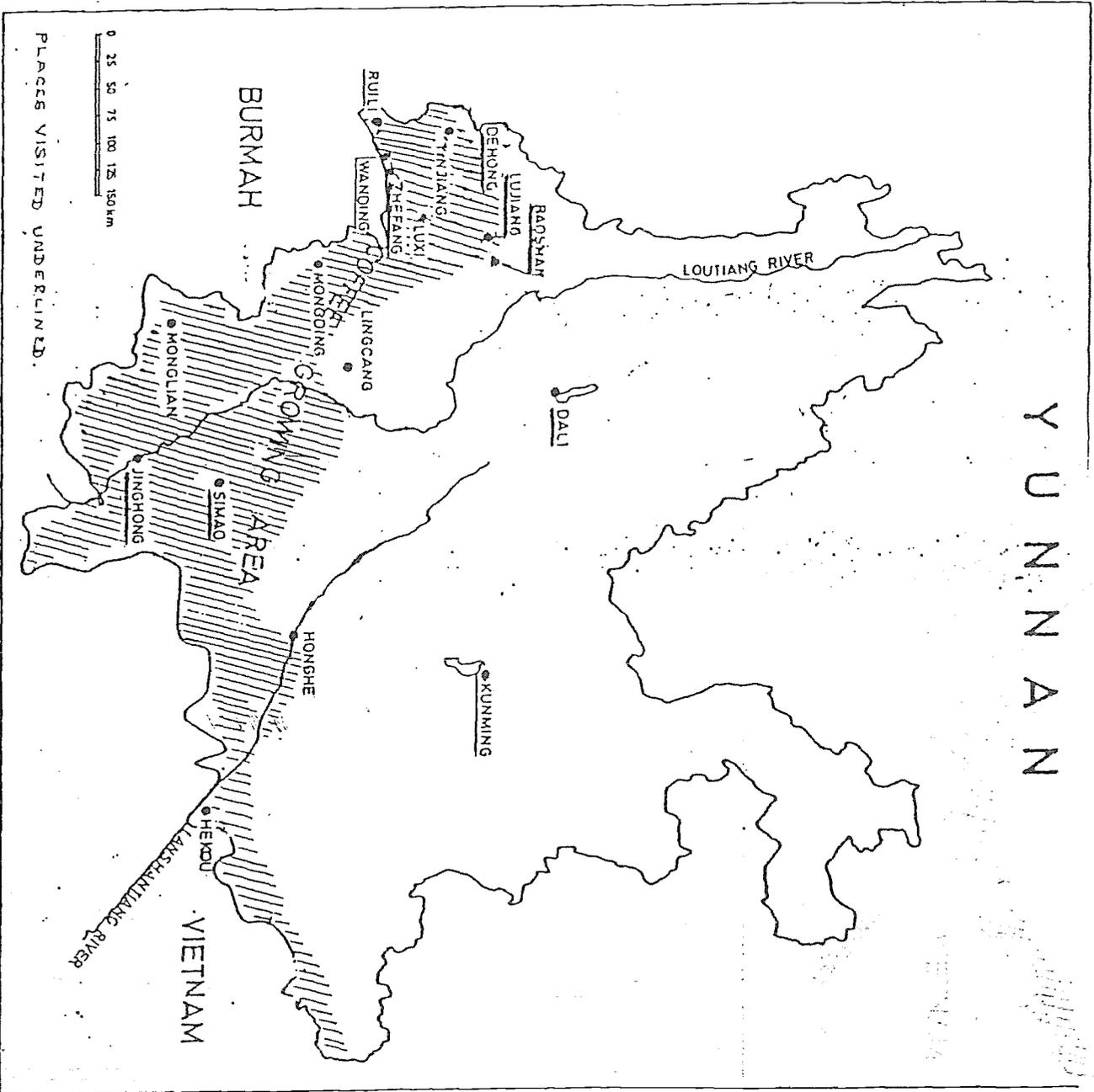


by
D.J. Walyaro
Coffee Production Consultant/CTA
Residence: Mzuzu, Malawi

TABLE OF CONTENTS

| | |
|---|-------|
| Map of Yunnan | (i) |
| List of Abbreviations | (ii) |
| Foreword | (iii) |
| Summary of conclusions and recommendations | (v) |
| I Introduction | 1 |
| II Main findings and conclusions | 2 |
| - Project input delivery | 2 |
| - Coffee production | 4 |
| - Extension service and training aids | 6 |
| - Coffee research | 7 |
| III Recommendations | 10 |
| - Project implementation | 10 |
| - Coffee cultivation and extension system | 12 |
| - Coffee research | 13 |
| <u>Annexes</u> | |
| 1. Terms of references covered during the mission | 17 |
| 2. Travel itinerary | 18 |
| 3. Characters to be recorded during evaluation..... | 20 |
| 4. References | 23 |

Y U N N A N



L I S T O F A B B R E V I A T I O N S

CICETE - The China International Centre for Economic and Technical Exchange, Ministry of Foreign Economic Relations and Trade.

TCRI - Tropical Crops Research Institute (Ruili)

ton - Metric Ton

UNDP - United Nations Development Programme

YTCRI - Yunnan Tropical Crops Research Institute (Jing Hong)

YSFAC - Yunnan State Farms Agribusiness Corporation

FOREWORD

The project aims at increasing coffee production as well as upgrading coffee processing technology in Yunnan. This is to be achieved through providing technical assistance for the extension of coffee cultivation area to 2,000 ha, increasing annual production to between 1500 - 1800 tons as well as transfer of roast coffee processing technology. This project is assisted by UNDP and executed by Government with YSFAC as implementing agency and FAO as the cooperating agency.

The first mission by the present consultant in October/December 1989 was to assist initiate and co-ordinate various project activities, review coffee cultivation practices and the set up of extension service, and propose plans for research development. The second consultancy between August and September 1990 was a follow-up of the first and involved assessment of the status of project activities while undertaking further training of national staff on coffee cultivation and production. The mission also initiated work on practical research on coffee agronomy and breeding. This third mission was essentially a continuation in monitoring implementation of project activities and providing assistance to on-going research in agronomy and breeding.

The principal briefing and debriefing officers for the mission were Mr Mitra, CPO, FAO HQ, Mr G. Blaak Senior Officer AGPC FAO HQ, Rome, Mr Dall, FAOR, Beijing and Mr Ad Spijkers, Senior Programme Officer, FAO office, Beijing.

The mission was conducted between 24 October and 26 November 1992, refer Annex 2 for full itinerary. The project duty station was Kunming in Yunnan but visits were made to the coffee growing areas in Xishuang Banna, Baoshan and Dehong (see the map page (i))

The Author wishes to gratefully acknowledge the assistance provided by the following persons during the course of the assignment:

- Mr Tang Chao Cai, the former NPD, Mr Liu Yan Ren the NPD and Mr Zhou Shi Zheng, Chief of the Project Office for arranging visits to different coffee areas and for fruitful discussions on project activities. Ms Yan Tang, Project Officer at the Project Office for accompanying the consultant on all visits and for her active involvement in project activities during the mission; Ms Jiang Qingnian and Mr. Yuan Lifeng both for their assistance.

- Mr Chen Xian Chu, Programme Officer CICETE for his many valuable suggestions and comments during our meetings in Kunming.

- The FAOR, Beijing, Mr Hans Dall, Mr Spijkers the Senior Programme officer and Mr Xu Lingfeng, Programme Officer, for facilitating the mission and for the discussions on various issues of the project; Mr Shun-Ichi Murata, Assistant Resident Representative, UNDP Beijing for his useful comments during debriefing in Beijing.

- Mr Mitra CPO, Mr Blaak, Senior Officer AGPC for arranging the assignment and for briefing and debriefing the consultant. Mr Kouthon AGS, FAO HQ for his advice and comments on the project during his technical backstopping mission in Kunming.

Finally the opinions, conclusions and recommendations in this report are those of the consultant and do not necessarily reflect the view point of the Food and Agriculture Organization of the United Nations.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Significant improvements were noted in delivery of project inputs. In particular, most of the equipment had been delivered. There was also progress in fielding project consultants. The major drawback however, was implementation of fellowship programme where only a few man months have been utilized so far.
2. Coffee management practices are improving on a number of farms especially plantations with young coffee. Intercropping in young coffee or coffee undergoing rejuvenation is becoming widely practiced. Some of the problems mentioned in the previous report, i.e pruning of older coffee, rust control and stem borers infestation, were still evident on many farms.
3. Significant positive changes were observed in the extension service. The stipulated level of staffing has been achieved and the organizational structure is in place. Training activities continued to be conducted by both national professional staff and FAO consultants. Preparation of training aids including growers handbooks and video series on coffee management was in progress.
4. Though some work on coffee research is in progress on the two main Tropical Crops Research Institute, most of the experimental trials designed by the consultants had not been established. In particular no trials were observed on plant protection. The major limitation was the lack of experienced key persons to take charge of each trial.

RECOMMENDATIONS

1. The consultancy on soil analysis and fertilizer is becoming long overdue. Efforts should be made to field this consultant as soon as possible to review current fertilizer practices and advise on establishment of fertilizer and coffee nutrition work aimed at determining the optimal fertilizer dressing on coffee.
2. FAOHQ should identify a marketing economist consultant to be fielded September/October 1992 for 1 month to assist the project in harmonizing the price structure for coffee producers and exploring alternative market outlets for roast coffee produced by the YSFAC factory in Kunming.
3. There is need for a second mission by the on-farm coffee processing consultant toward the end of 1992 to assist in the commissioning and operation of the on-farm processing equipment and in demonstrating precautions to be observed during wet processing of coffee.
4. Though there may be justification for arranging another study tour on introduction of germplasm, acquainting staff with modern coffee production practices as well as instant coffee processing technology, priority must however be given to the fellowship programme. In particular, Government should nominate 2 new fellows for 6 months training in plant breeding at IFCC Oeiras Portugal, and for 3 months in plant pathology at University of Vicosa Brazil.
5. As indicated earlier, most items of project equipment have been received. However there are a number of other essential items connected with coffee grading, classification and standardization which were not included in the list of equipment. Some of these items are contained in this report. Project management should try to request additional funding to cover their purchase.
6. In the previous consultancy report (1990) the consultant provided details of management practices that have proved suitable in maintaining high production levels on high density and hedge row coffee plantations. This is in regard to pruning and rejuvenation

methods. Every effort should be made to acquaint all coffee farmers with these practices.

7. There are immense benefits in intercropping food crops in coffee during establishment and change of cycle. Farmers must be encouraged to view this system as a general practice in coffee establishment. At the same time, certain basic precautions associated with intercropping must be brought to their attention.
8. Training of extension staff should be intensified, and the operation of the system in terms of transfer of technology improved through regular monitoring. This will show on continuous basis, the effectiveness of the system as well as constraints that need to be addressed.
9. The three agronomy trials designed by the consultant on coffee rejuvenation and spacing in relation to pruning and training should be established at both research institutes during the course of 1992. Information from these trials is essential for formulating more specific recommendation under coffee growing conditions in Yunnan. The other trials suggested by plant protection consultants on coffee rust control and on pest management should likewise be started without further delay.
10. Though intercropping coffee in rubber has some benefits on early production of coffee trees, the system is not sustainable as coffee has eventually to be replaced. Nonetheless, efforts should be directed towards identifying a spatial arrangement that allows successful interplanting of both crops for as long periods as possible.
11. Most of the materials recommendations by the consultant have not yet been introduced. However, advantage should be taken of the few introductions now available to start work mainly on adaptive breeding. The first stage of the breeding scheme is to establish a couple of variety comparative trials. These would be followed within a period of two to three years with a series of multilocational variety trials of fewer entries consisting of the most promising types. Details are provided on the characters to be evaluated on these trials as well as procedures for selection of progenies on basis of genetic yield potential.

I INTRODUCTION

1. The project aims at an initial production target of 1500 tons of coffee per annum through extension of coffee area and simultaneous increase in per ha yields. During the initial stages, a number of constraints to increased coffee production were identified. These included lack of proper extension service, serious incidence of coffee rust and various pests on already established coffee and general lack of technical knowhow on improved coffee management practices. The success of this programme was therefore to depend largely on the following: (1) establishment of a fully functional extension service (2) implementation of a well planned expansion programme (3) strengthening of the technical capability for coffee research of the two main tropical research institutes, in Xi Shuangbanna (Jing Hong) and Ruili. The cooperating agency is assisting the project through arranging overseas fellowship training and fielding consultancies on project monitoring, in-country training, and implementation of coffee research programmes.
2. The project is expected eventually to produce sufficient quantities of good quality coffee to meet the capacity of a modern roast coffee processing plant to be installed soon at Kunming. The plant will thus also provide a reliable market outlet for the coffee growers. As indicated in earlier reports the immediate beneficiaries with regard to the production component of the project are the minority nationalities farmers of the province while at the processing level, the YSFAC will be the direct beneficiaries of this project.
3. The present mission involved the following aspects of the project (1) monitoring overall implementation of project activities, 2) assisting on research activities on improved crop husbandry practices and 3) further elaboration of the breeding programme especially experimental protocols and requirements of the programme.

II MAIN FINDINGS AND CONCLUSIONS

PROJECT INPUT DELIVERY

4. So far 7½ m/m of consultancies have been fielded. These included 4½ m/m by the production/breeding consultant/CTA, 1 m/m each of consultants in Plant Pathology and on-farm processing.

The second mission of consultants on plant protection Dr De Lima and Prof Chaves planned for 1991 was postponed with agreement of project management to March/April 1992 for Dr De Lima and between July and October 1992 for Prof Chaves. Both missions for 1 month duration. The on-farm processing consultant will also be fielded for a further 1 month towards end of 1992 to supervise commissioning and operation of on-farm processing equipment, which had not been installed during his first mission.

5. The position regarding overseas training was as follows:
 - a) Nomination forms for 9 fellows were submitted to FAOHQ and 5 were successfully placed, 2 in Kenya and the rest in Portugal, Cameroon and Brazil. However due to various reasons given by the project authorities the programmes arranged for coffee breeding in Portugal (6m/m), Coffee pathology in Brazil (3m/m) and coffee production/processing in Kenya (6m/m) were cancelled the last minute. Only 2 fellows eventually followed training in coffee production in Kenya (6m/m) and in coffee soil and leaf analysis (3m/m) in Cameroon.
 - b) FAO HQ is trying to place the remaining 4 fellows for coffee breeding originally planned for 6 m/m, on-farm processing, 3m/m, soil analysis and fertilizer use 6m/m, and pest control 3 m/m. The training has tentatively been arranged to be conducted at CRF Ruiru, Kenya, but for far shorter periods than originally planned. Apart from the 4 fellowships, the project management have not proposed any new candidates. The consultant has the impression that the project management are not in favour of further fellowship training. They would rather have a study tour to focus on the following areas: 1)

introduction of germplasm, 2) review disease and pest control strategies in a number of producer countries 3) familiarize with technical aspects of instant coffee processing.

6. Procurement of equipment for the project is executed by CICETE.
 - a) Two Nissan vehicles, a minibus and a trooper were delivered in April 1991.
 - b) Final coffee processing plant i.e the coffee roasting machine from Germany and the packaging machine from Italy were to be installed by December 1991. The capacity of the roaster is 1000 kg of coffee per year. All construction work on the factory including storage area and warehouse were already completed.
 - c) Two modern coffee pulping units consisting of 3 disk main pulpers, Aargard pregrader and repasser pulper had been delivered to Lu Jiang and Ze Fang farms. The motors however were to be delivered towards end of November. Construction work on the washing stations was in progress on sites.
 - d) Regarding laboratory equipment a gas chromatograph from Japan had been delivered at the YTCRI Jing Hong and was to be installed shortly. The centrifuge however was cancelled.

CONCLUSIONS

7. There has certainly been an improvement in delivery of project inputs especially equipment, though of course with considerable delays. Fielding of consultants has also progressed fairly well given the difficulties - usually associated with their availability. The most serious drawback in implementation of project activities however, is the fellowships programme where out of 42 mm stipulated in the Project only 9 mm have been utilized. The major course no doubt has been the non-availability of fellows at the time of training.

COFFEE PRODUCTION

8. The consultant visited a number of coffee farms in the main coffee growing areas in South West of Yunnan i.e. Baoshan and Dehong. These included Lu Jiang farm, in Baoshan, Ruili farm, Kala farm in Ruili county, Ze fang and Long Kan in Dehong. Varieties mostly grown are Typica and Bourbon especially in Lu Jiang and S288 in most of the other farms. Lu Jiang in particular maintains a variety collection, the more interesting ones including Mibirizi, Jacksons, Catuai and Catimor.
9. Coffee in most farms is normally grown as high density or hedge rows at spacings of 2 x 1, 2 x 0.8m, 2 x 1.5 but occasionally 2.5 x 1.5. Trees are trained as single or multiple heads which are sometimes capped. Pruning usually presents problems during the later stages of production. A few farms were observed rejuvenating some of the old coffee mainly through rotational block stumping or alternate row stumping. Severe incidence of rust was again observed in certain blocks in Lu Jiang while pest infestations consisting of the girdling stem borer and white stem borer were fairly widespread on most farms.
10. Production levels were high on the farms visited. The average production in 1990/91 in Lu Jiang was about 1.7 tonnes/ha in Ruili farm 1.8 tonnes/ha, Long Khan 2.0 tons/ha. However, Ze phang farm recorded only 750 kg/ha. These yield levels apart from Ze phang are quite impressive. This is to be expected with the high density or hedgerow type of planting that is common on most farms. Furthermore most coffee trees are still fairly young. Concern however, was expressed by some farmers in Dehong regarding variety S288 which they claimed was less productive than Typica and Bourbon and quality also tended to be inferior.
11. Of considerable interest was the intercropping that is widely practiced on these farms during coffee establishment and after change of cycle. A range of crops were observed properly intercropped between coffee rows including cabbage, maize, peas, beans, yam,

groundnuts and soybeans. Another practice common on state farms is interplanting coffee in rubber. In Ruili farm rubber is planted at spacing of 12 x 2 m while coffee is planted as hedges within rows at 0.8m. It is claimed that if coffee and rubber are planted at the same time, it is possible to keep coffee trees in production up to 10 years after which they have to be uprooted. During the early years however, very high production levels have been recorded in Ruili farm up to 3.75 tons/ha. In Long Kan one block had three tier levels of intercropping with Rubber, forming the upper canopy, coffee the middle canopy and sweet potatoes on ground level. Sweet potatoes leaves are normally used as pig feed.

12. Total coffee area under the project for 1990 was estimated at 1600 ha representing an increase of about 300 ha over the 1989 statistics. State farms owned about 1000 ha while 600 ha is under smallholders. On state farms, coffee plots are contracted to individual families. Of the total coffee area, 725 ha contained mature coffee which gave total production of about 900 tons representing overall average yield level of about 1.23 tons/ha.

CONCLUSIONS

13. Coffee performance in general seems to be improving steadily. Positive aspects that were evident, included increased awareness of the benefits of rejuvenation and proper intercropping practices during establishment and after change of cycle. The performance of young coffee in particular was most impressive. Though interplanting coffee in rubber has observable initial benefits to coffee arising from shading and provision of wind barrier, the system unfortunately is not sustainable as coffee has eventually to be replaced when rubber trees mature and the shading becomes excessive.
14. A number of problems however persist on these farms. These include, pruning of mature coffee to regulate cropping and minimize biennial bearing, the rust epidemics in areas where variety S288 is not commonly grown and pest problems especially the white stem borer and the girdling borer. Incidentally the more dense growth common in compact varieties tends to discourage stem borer infestation.

15. Producer prices for coffee appear to vary widely in different coffee areas. For example in Baoshan in 1990 the price paid was 7.7 Yuan/kilo, while in Kala Division it varied between 3.3 - 5.5 Yuan/kilo. These variations partly reflected differences in quality but more important, lack of a properly structured marketing system. The establishment of the roast coffee processing plant in Kunming may help in overcoming part of the problem.

EXTENSION SERVICE AND TRAINING AIDS

16. As indicated in the consultant's 1990 report a properly structured coffee extension service is now in place. Extension network consists of 67 extension workers distributed in the project office and throughout the production units. So far, 12 training courses have been organised; the consultants have participated in 7 of the courses. A total of 600 coffee growers have attended these courses about 1/3 were minority nationalities mainly Jinpo and Dhai nationalities.
17. A revised handbook on coffee production and processing prepared by project authorities and based on more recent recommendations on coffee production technologies is soon to be published. A simpler version of the same for use by farmers is also being prepared.
18. During the visit of the consultant to Lujiang, Ruili and Ze Phang, he was accompanied by a film crew from the TV Agricultural School in Kunming. The crew prepared video series on the following aspects: nursery management, coffee establishment, field management practices ie pruning, rejuvenation and weed control, identification of diseases particularly coffee rust and coffee harvesting and sorting. The video clips and the publications will no doubt be an important addition to the training materials.

CONCLUSION

19. It is clear that important positive changes are taking place in the coffee extension service under the project. Stipulated level of staffing has been achieved and the organizational structure is in

place. A number of training activities have been conducted by both the national staff and various consultants. As a result the technical knowhow of the extension staff on modern coffee technology is improving. The development of various training aids including extension manuals and video series is expected to further strengthen the effectiveness of extension system in transfer of improved technology to coffee growers.

COFFEE RESEARCH

20. At the Yunnan Tropical Crops Research Institute (YTCRI) Jinghong, a number of research activities on coffee are in progress. Details of some of this work were given in the consultants report of 1989.
21. Regarding coffee breeding, the Institute has germplasm collection consisting of about 41 arabica coffee varieties plus a few other coffee species. The work in progress has essentially involved making single crosses among varieties Typica, Bourbon, Caturra and S288. S288 is the source of rust resistance in this programme. This variety though grown fairly widely, suffers a number of drawbacks for example rather low productivity, high incidence of biennial bearing and berry scab. The performance of its single crosses to varieties Typica and Bourbon was however quite impressive. The major goals of the breeding programme are, rust resistance - source S288, improved yield and quality, from Bourbon and Typica, compact growth from caturra and better synchronized flowering and berry maturation.
22. The consultant devoted considerable time discussing strategies of future breeding with the staff. Priority areas that were stressed included, addition to the germplasm of more diverse sources of rust resistance as well as varieties known to contain some level of drought and cold tolerance.
23. Other research programmes in progress included interplanting trials where coffee is grown at varying spacings, 2 x 1, 2 x 0.8, 2 x 0.5 and 1 x 1 m, among coconuts spaced at 10 x 10 m. There are also similar interplanting trials involving rubber and coffee, black pepper and coffee. Results of an irrigation trials were discussed in the

consultant's report of 1989. Some work is also conducted on rejuvenation, comparing effect of stumping coffee at 2 different levels.

24. The situation at the other Tropical Crops Research Institute at Ruili (TCRI) differs to some extent from Jing Hong. The Institute has a collection of about 30 varieties which include introductions from Burundi i.e. Jacksons, Mibirizi, Bourbon and Catuai and a more recent introduction of variety Catimor received via Hainan. Evaluation of these collections is in progress. The main characters considered include rust resistance, growth and yield parameters, flowering habit, bean characteristics and yield itself. No crossing programmes have been attempted.

25. The other trials in progress are,

i) Spacing trials with variety S288 which have shown that the optimum spacing under their conditions is 2 x 1 m followed by 2 x 0.8 m.

ii) Rejuvenation trial suggested and designed by the present consultant, involving a comparison of 3 rejuvenation methods, alternate row stumping, side pruning and rotational block stumping. The first and last appeared to be superior to side pruning. One other method of rejuvenation ie intermediate capping is being tried on a separate coffee block.

iii) The trial on intercropping rubber with coffee has given some interesting initial results. 2 rows of rubber are planted at 4 x 4 m with 8m alley between the double rows. In the alleys, are double rows of coffee at a spacing 2 x 1 m. Coffee was planted in 1987 and has given remarkably high yields during the first 3 years, 1989, 1990 and 1991 equivalent to 2.25, 3.45 and 4.05 tons/ha respectively. The trial continues in order to determine at what stage coffee yields will start declining.

26. As in Jing Hong, the consultant discussed with the research team future breeding strategies including breeding protocols. The consultant was shown a new area about 2 ha earmarked for establishment of further germplasm collections as well as future breeding trials.

CONCLUSIONS

27. Though some work on coffee research is in progress in both research Institutes, a lot more remains to be done. None of the agronomy trials suggested by the consultant in 1990 have been established in Jing Hong though one trial has been established in Ruili. Trials suggested by the consultants on Plant Pathology, Prof Chaves, to be conducted in Lu Jiang and the Entomologist, Dr De Lima, in Jing Hong and Ruili have likewise not been initiated. The major constraint seems to be lack of experienced key persons to supervise the work. Secondly, there has been lack of funds to sustain planned research activities. The YSFAC however, has now pledged a sum of 50,000 Yuan for research activities. This may help to some degree in improving the present situation.

III RECOMMENDATIONS

PROJECT IMPLEMENTATION

CONSULTANCIES

28. The previous consultancy report pointed out an urgent need to have a consultant review the present fertilizer practices in relation to soil fertility status and production levels. On basis of this he was to advise on the set up of fertilizer and coffee nutrition studies to determine optimal fertilizer dressing. Since the need still exists, recruitment of a consultant on soil analysis and fertilizer application ought to be given priority. Dr. Snoek, formerly of IRCC, Montpellier, has been identified as suitable candidates for this post. The consultant should be fielded as soon as he is available.
29. During discussions with project personnel, representative of CICETE and Dr. Kouthon FAOHQ, it was agreed that the project needed further assistance in preparing a harmonized pricing structure for producers based principally on quality. This would sensitize producers on the need to improve on-farm processing practices. The assistance would also cover strategies of marketing the finished product. FAOHQ should assist in recruitment of Marketing - Economist consultant, to be fielded for 1 month, September/ October 1992.
30. As indicated in para 4 on Project input delivery, so far 7½ m/m out of 22 m/m of consultancies had been utilized by the end of 1991. This has arisen because of 1) the CTA having combined duties of coffee production with breeding which initially would have required two consultants 2) consultant on soil analysis and fertilizer application for 3 m/m having not yet been fielding 3) mission of 2 plant protection consultants being postponed to 1992. Even with the fielding of all the remaining consultants in 1992, there will still be some extra m/m of consultancies. It is suggested that out of the extra m/m, 1 m/m be utilized for the second mission of the on-farm coffee processing consultant due towards end of 1992, and 1 m/m for the marketing economist consultant.

FELLOWSHIPS AND STUDY TOURS

31. There may be a justification for undertaking a further study tour to discuss arrangement for introduction of more germplasm as well as getting abreast with advances in disease and pest control strategies in other producer countries. However, instant coffee processing technology requires a separate study tour to be mounted unless such technology exists in nearby countries for example Hong Kong. It needs to be emphasized however that the study tour programme should not be held at the exclusion of fellowships. It has been pointed out in this report that among the limitations at the Research Institutes in mounting research programmes suggested by various consultants is lack of experienced key persons to take charge of the work. Implementations of the fellowship programme is absolutely essential in strengthening research capabilities of two main Tropical Crops Research Institute in the Province.

It is therefore proposed that apart from the 4 fellowships mentioned before, Government should nominate additional fellowships in breeding (6 months) and Plant Pathology (3 months). These fellows should be substitutes of the earlier ones that were unable to follow the training at International Rust Research Centre Portugal and University of Vicosa, Brazil. On submission of nominations, FAOHQ should try to make further contacts with above 2 institutes.

EQUIPMENT

32. Though most items of project equipment have been delivered, project management should make a request for additional funds to cover items so far not included that are essential for coffee classification, and standardization of the final product. These include among others,
- 1) Spares for the final roast coffee processing plant
 - 2) Milling and grading equipment including,
 - Combined unit Huller and Polisher
 - Coffee grader
 - Preumatic separator
 - Gravity seperator
 - Bichromatic colour sorter

- 3) Liquoring laboratory equipment
- Laboratory grinder
 - Coffee cupping table plus accessories

COFFEE CULTIVATION AND EXTENSION SERVICE

33. Efforts should be made to bring to the attention of coffee farmers recommendations contained in the consultant's 1990 report (paras 27 and 28) on two basic practices in coffee cultivation, i.e pruning and rejuvenation methods appropriate for high density and hedge row coffee planting. Basically for high density coffee only a single stem should be maintained. Pruning involves opening up the centre of the tree and removing lowermost primaries trailing on the ground . Rejuvenation is through either rotational stumping, intermediate capping or side pruning. For hedgerow planting, with a spacing of 2 x 1.5 or wider, training is on multiple heads, limited to 2 heads and change of cycle is through successive replacement of old exhausted heads by young vigorous heads.
34. The intercropping of food crops in coffee during establishment and change of cycle should be adopted as a general practice by coffee growers. Not only does it lead to more efficient utilization of the limited available land, it offers an alternative source of income and augments the farmers food resources. Also as indicated in the earlier reports, during the dry season the crop stubble could be utilized as mulch. It is worth pointing out that only those crops that are compatible with coffee should be encouraged i.e. those with a short growing cycle and which do not unduly compete with coffee for nutrients. Most popular intercrops include Phaseolus beans, soy beans, peas, chillies, groundnuts, sweet potatoes and a range of vegetables.
35. Training of extension staff should be intensified so that staff become thoroughly familiar with both theoretical and practical aspects of improved coffee cultivation and plant protection practices. Another aspect that needs emphasis is a systematic approach to their work. Evaluation of the extension service should be undertaken on yearly basis to give an indication of the effectiveness of the system as well as any constraints that need to be addressed.

COFFEE RESEARCH

AGRONOMY EXPERIMENTS

36. In the consultant's 1990 report, designs of a number of agronomy trials were proposed (see page 32). The trials were to be laid out during the course of 1991 at the two main Tropical Crops Research Institutes in Yunnan. These included:

- 1) Comparison of 4 methods of converting old coffee
- 2) Further comparisons of rejuvenation methods.
- 3) Spacing - pruning/training.

The first trial was established at the TCRI (Ruili), while none was established at the TCRI (Jing Hong). It is vital that every endeavour be made to lay out all these trials during the course of 1992. Information from such trials is urgently required in order to form the basis for recommendations that will be more specific to coffee growing conditions in Yunnan.

37. Intercropping of coffee in rubber has demonstrated some benefits the system has on initial production of coffee. However as mentioned earlier because of excessive shading when rubber trees are 10 - 15 years old, the coffee trees have eventually to be removed. It may be worthwhile to investigate which spatial arrangements allow interplanting without adversely affecting per unit area yields of either crop for as long as possible. Fortunately various different spacings and arrangements are being tried on several plantations. A further arrangement that could be assessed is the chequered arrangement where square or rectangular plots of rubber are alternated with similar plots of coffee on the same piece of land.

BREEDING

38. Though most of the materials the consultant recommended for establishment of a germplasm collection have not been received, advantage should be taken of the few introductions that are now available to start the short-term breeding work. The programme would

expand as more materials become available. The following varieties are available among the collections:

- 1) Catimor - received via Hainan and some more Catimor seeds introduced from Kenya.
- 2) SL 28 - from Kenya
- 3) K7
- 4) Mibirizi
- 5) Jacksons (from Burundi)
- 6) Bourbon
- 7) Catuai

- 8) S288
- 9) Typica local commercial varieties
- 10) Bourbon

39. As indicated in the 1990 consultancy report the short term breeding work is mainly adaptive breeding. This entails selecting for example among the above varieties one or two varieties that show superior performance in terms of productivity, rust resistance and adaptation to local conditions compared with existing cultivars. The main selection criteria would thus be genetic yield potential, quality, rust resistance and adaptation to more intensive cultivation systems. Some degree of tolerance to drought and cold conditions would be desirable.

40. The first stage of the breeding scheme is to establish a number of variety comparative trials. The entries would include 2 Catimor introductions, varieties SL 28, K7, Mibirizi, Jacksons, Bourbon, Catuai, S288, and Typica. S288 and Typica are used as checks. The trials should be laid out as a randomized block design in four replications with 25 tree plots, the nine central trees being recorded. Initially, 2 variety comparative trials should be planted at the TCRI Ruili and YTCRI Jing Hong. The primary reason is to facilitate proper evaluation which is only possible when the trials are within the Research Institutes. Assuming a uniform spacing of 2 x 1m, each trial would occupy a maximum of 0.3 ha.

41. For proper evaluation of these trials, the following characters should be recorded:

- Growth characters:

These are recorded on individual trees and include: girth of stem, height of the tree, internode length on main stem and on primaries, number of primary branches, radius of the canopy and rate of node production and extension growth.

- Yield characters:

On individual trees, number of bearing primary branches, % bearing nodes, flowers per node, berries per node, yield of cherry and clean coffee.

- Berry and bean characters:

These can be determined on coffee samples obtained from say 4 or more randomly selected trees per plot. Determinations made within two successive years of production are normally sufficient. The following characters should be recorded: Single berry weight, single bean weight, % pulp, % outturn and proportion of various bean grades depending on market requirements.

- Cup quality characteristics

These are determined by organoleptic evaluation. Expert liquorers at Kunming Roast Coffee Processing Plant liquoring laboratory would assist in assessment of the liquor attributes of the different varieties at each location.

- For the various characters in the evaluation programme, details of their assessment and time schedule and frequency for their measurements are given in Annex 3.

42. Selection for most of the above characters i.e compact growth, bean size, cup quality, rust resistance is fairly straight forward. Selection for yield on the other hand requires successive yield records accumulated over a fairly long time in order to get a proper

picture of the most productive types. It was found however, that if selection is based on the yield of the first 2 - 3 years of production in combination with a number of yield and growth characters (see first 2 paras of 39) it is possible to shorten the breeding cycle in coffee to 4½ - 5 years (Walyaro and van der Vossen, 1979, Walyaro, 1983). This represents a gain of 8 - 9 years without much loss of selection efficiency. Determination of genetic yield potential essentially involves construction of preselection indices based for example on girth, canopy radius or internode length on primaries, bearing primaries or % bearing nodes and yield of the first 2 - 3 years of production. Selection for yield is then based on the simplest and most efficient index relative to direct evaluation of yield potential on basis of early yield alone.

43. As explained in the consultant's 1990 report, it is possible to eliminate many of the varieties that prove unsuitable even before carrying out the final selection in the above variety comparative trials. Advantage can be taken of this to lay out multilocational variety trials of fewer entries consisting of the more promising types. Design of such trials comprising variety - spacing - pruning is given in the same report see para 34 (10). The objective of such trials is to determine the interaction between these varieties with different locations, and their behaviour to varying densities and systems of pruning. This information would thus be the basis of making new recommendations on spacing and pruning appropriate for the new selected variety or varieties.

A N N E X 1

ITEMS OF THE TERMS OF REFERENCE COVERED DURING THE MISSION

1. Advise on operation of extension service and preparation of training materials.
2. Advise on practical research/experiments for the introduction of improved agricultural practices including planting and pruning.
3. Assist project authorities in coordinating the activities of specialized consultancies in areas of coffee production and plant protection, and monitor the overall implementation of the project.
4. Consider formulation of long term objectives of a basic breeding programme. Based on this, prepare the layout of a basic breeding programme including the experimental protocols, land requirements, equipment needs.
5. Training staff on various breeding activities based on lectures presented during the previous two missions of the consultant.
6. The consultant to prepare a report according to guidelines provided by AGPC/Industrial crops.

A N N E X 2

TRAVEL ITINERARY

- 25/10/91 Depart Lilongwe
- 28/10/91 Arrive Rome - Briefing Mr. Mitra, CPO, Mr Blaak, AGPC, Mr Snell and Ms Kharas
- 29/10/91 Depart Rome
- 31/10/91 Arrive Beijing - Met Mr. Xu Lingfeng, FAO Office, Beijing.
- 01/11/91 Beijing - Kunming - Met Ms Yan Tang, Project Officer, held discussions on Project and arrangements of field tours.
- 02/11/91 Kunming - Mujiang, by car, in company of Mr Xu and Ms Yan Tang
- 03/11/91 Mujiang - Jing Hong - Met Messrs Yiu Yan Ren, the NPD, Tang Chao Cai, former NPD, Yang Xiong Fei, Deputy Director, YTCRI, Li Cong Hui, Chief of Cash Crops Division YTCRI and Research Officers Liu Jiange and He Ligang. Held discussions on the Research Programmes at the Institute.
- 04/11/91 Jing Hong - Discussions with the NPD on Project Implementation.
- 05/11/91 " - Discussions on Coffee Breeding, visit research facilities at the Institute.
- 06/11/91 " - Tour of coffee research trials at the Institute. Jing Hong - Kunming by air - Evening.
- 07/11/91 Kunming - Met Dr. Kouthon FAO HQ and Mr Zhou Shi Zeng, Chief of the Project. Discussions of Project activities. Visit to Roast Coffee Processing Plant.
- 08/11/91 " - Held further discussions on Project activities with Mr Chen Xian Chu, Programme Office CICETE, Dr. Kouthon and Mr Zhou Shi Zheng.
- 09/11/91 Kunming - Dali - by car
- 10/11/91 Dali Lu Jing by car - Met the following staff of Lu Jiang Farm, Mr Jiang Pin, Chief Agronomist, Mr Qian Tong Wei, Head Production Division, Mr Chen Wei Qiang, Agronomist and Mr Dong Guo Zhang, Chief of Administration. Discussions of coffee production situation on the Farm.

| | | | |
|----------|----------|------------|--|
| 11/11/91 | Lu Jiang | | - Field tour of the farm including on-farm processing facilities. |
| 12/11/91 | Lu Jiang | Ruili | - by car |
| 13/11/91 | Ruili | | - Meeting with TCRI staff including Messrs Yan Shui Liang, Deputy Director, Xing Zheng Xiu, Agronomist, Zhang Hong Buo, in-Charge of Plant Protection, Li Wen Wei, Breeder. Tour of Field trials in the afternoon. |
| 14/11/91 | " | | - Tour of other state farms in Ruili Country including Moli farm and Kala farm. |
| 15/11/91 | " | | - Discussions with Research team on Agronomy and Breeding work to be initiated. |
| 16/11/91 | " | - Ze Phang | - visited on-farm processing factory under constructions and nearby farms. Toured Long Khan farm in the afternoon. |
| 16/11/91 | Ze Phang | - Ruili | - Evening |
| 17/11/91 | Ruili | | - Holding final discussions with research staff at the TCRI. |
| 18/11/91 | Ruili | | - Dali (by car) |
| 19/11/91 | Dali | | - Kunming (by car) |
| 20/11/91 | Kunming | | - Final discussions on project implementation and preparation of PPER forms. |
| 21/11/91 | Kunming | | - Beijing (by air) |
| 22/11/91 | Beijing | | - Debriefing Mr H. Dall, FAOR, Mr Spijkers, Senior Programme Officer, FAO Beijing, Mr. Ich-Shuni Murata, Assistant Resident Representative UNDP, Beijing |
| 23/11/91 | Beijing | | - Zurich |
| 24/11/91 | Zeruch | | - Rome |
| 25/11/91 | Rome | | - Debriefing Mr Mitra, CPO, Mr Kouthon, Snr Officer AGS, Mr Snell, Fellowships and Ms Kharas study tours, Dr Barbosa, AGPP, and Mr J. Novoa, Marketing economist FAOHQS. |
| 26/11/91 | | | Depart Rome (by air). |
| 28/11/91 | | | Arrive Lilongwe. |

A N N E X 3

CHARACTERS TO BE RECORDED FOR EVALUATION

I ASSESSMENT OF THE CHARACTERS

(a) Growth characters

1. Girth of stem - measurement of the circumference of the stem to be taken about 5 cm from the ground level.
2. Height of the tree - obtained as the length from the base of the tree to the tip.
3. Internode length of the stem, or primary - obtained from each tree as the height of the tree divided by the number of nodes on the main stem, or the average length of 4 primary branches divided by average number of nodes on these primaries.
4. Primaries - the number of primary branches counted per tree.
5. Radius of canopy - estimated as the average length of 4 primaries situated around the middle of the Crown. On very young trees the mean length of the 2 longest primaries.
6. Leaf shape - for average of 10 leaves of comparable age, the ratio (as a fraction) of the length to the width (at the broadest portion).

Leaf area is estimated from above value as $(\text{Length} \times \text{width}) \times 0.88$, 0.88 is a constant.
7. Angle of primaries, the angle of insertion on the main stem of 4 primaries located between the 14th - 18th node from the apex or tip.
8. Extension growth - is measured as the mean increase in length on 4 primaries, initially tagged at 3 nodes from the tip, after a period of every 6 to 12 months.
9. Node production - the mean number of nodes per primary produced on the above primaries (No. 8) over the same periods of time.

(b) Yield Characters

1. Bearing primaries - recorded as the number of primary branches which are having berries, flowers or flower buds.
2. Bearing nodes - on young trees the total number of nodes with berries, flowers or flower buds counted on the whole tree and expressed as a percentage of the total number of nodes on the same tree. Recording on older trees over 3 years can be done on 4 selected bearing primaries.
3. Flowers per node - the number of flowers per node calculated from 4 selected primaries. This is done during the main flowering period.
4. Berries per node - obtained as the mean number of berries per node on 4 selected primaries.

5. Yield of cherry - the weight of fresh fruits harvested per tree in kg.

6. Yield of clean coffee - the weight of sun-dried coffee beans (at about 11% m c) per tree, expressed in kg.

(c) Berry and bean characters

i) For characterization the following records are taken:

- 1) Fruit shape: 1 elliptic rounded, - 2 elliptic pointed or 3 rounded. 2) Fruit colour: 1 red, 2 yellow, 3 red with yellowish stripes.
- 3) Persistancy of sepals; 1 non-persistent, 2 persistent.
- 4) Bean shape (profile of the flat side): 1 elliptic, 2 narrowly elliptic and 3 rounded.
- 5) Endosperm colour: 1 green or 2 yellow.
- 6) Type of centre cut: 1 single straight, 2 single s-shaped, 3 double.

ii) For evaluation for berry and bean size and density:

- 1) Single berry weight - the mean weight in g per berry from several samples each of 100 fresh berries.
- 2) Single bean weight - the mean weight in g per bean from several samples each of 100 dry seeds (at 11% m c).
- 3) Pulp - weight of the fleshy pericarp expressed as a percent of the fresh cherry weight. This can be omitted if the coffee is not wet processed.
- 4) Outturn - percent clean coffee over fresh cherry weight.

Determination of bean quality characteristics is based on defect counts and fractions of various categories of bean size and density in a given sample. The standards differ from one country to another depending on the range of bean sizes common in the country. The Coffee Processing Consultants will assist in preparing standards for classification of green coffee in Yunnan.

(d) Liquor quality characters

The assessment of liquor quality is organoleptic and is based on a number of attributes the scoring system depends on the liquorers. For example the Mild coffee Trade Association of East Africa in Kenya uses the following system:

- 1) Quality of raw beans - the size and colour of raw beans.
- 2) Quality of roast beans - the general appearance and centre cut of roast coffee.
- 3) Liquor quality assessed according to the following attributes 'acidity', 'body' and 'flavour' of the brewed coffee.
- 4) Overall standard - the overall evaluation of liquor quality on basis of the above attributes.

Normally only liquor quality attributes and the overall standard need to be used in analysis of data from liquoring reports.

II SUGGESTED SCHEDULE FOR RECORDING GROWTH AND YIELD CHARACTERS

| | <u>Character</u> | <u>No. of months from the time of field planting</u> |
|----------------------|--|--|
| Growth characters | Girth of stem, | 6, 18, 30, 48 |
| | height of tree, | |
| | internode length on stem and primaries, | 12, 24, 36, 48 |
| | radius of canopy | |
| | internode length (primaries) | 24, 48 |
| | leaf area | 12, 36 |
| | angle of primaries | 16 - 28, 30 - 42 |
| | extension growth | |
| | node production | |
| | | Extension growth node production |
| Yield characters | bearing primaries | 12 - 30, 36, 48 |
| | bearing nodes | 12, 36 |
| | flowers/node | 24, 36 |
| | Fruit set | 28, 40 |
| | berries/node | 24, 36, 48 |
| | yield | 30, 42, 54 |

REFERENCES

1. Walyaro, D.J., 1983. Considerations in breeding for improved yield and quality in arabica coffee (Coffea arabica L.) Dr Agric. Sc thesis. Wageningen, The Netherlands.
2. Walyaro, D.J., 1989. Implementation of project activities including a review of coffee cultivation and the extension service and suggestions for research development. UNDP/CPR/86/016. Coffee Production and Processing in Yunnan - P.R. China. First Consultancy Report.
3. Walyaro, D.J., 1990. Status of the project, training of national staff and a follow-up of previous recommendations. UNDP/CPR/86/016, Coffee Production and Processing in Yunnan, P.R. China. Second Consultancy Report.
4. Walyaro, D.J., and H.A.M. van der Vossen, 1979. Early determination of yield potential in arabica coffee by applying index selection. Euphytica 28: 465 - 472.