FOUR DECADES OF COFFEE RESEARCH AND DEVELOPMENT IN ETHIOPIA

A NATIONAL WORKSHOP

14 – 17 AUGUST 2007

ADDIS ABABA, ETHIOPIA

PROGRAM AND BOOK OF ABSTRACTS

ORGANIZER: JIMMA AGRICULTURAL RESEARCH CENTER
ETHIOPIAN INSTITUTE OF AGRICULTURAL RESEARCH

EIAR EU MoARD CPDE Agri-CEFT MOPLACO ROBERA

Program

Date	Time	Activity	Presenter/Resource Person
14. 8.07	**08:30 – 09:00**	Registration	Workshop Secretariats Desk
	09:00 – 09:10	Welcome & Program Introduction	Workshop Organizers
		Welcome address	Dr. Solomon Assefa, Deputy DG of EIAR
	09:10 - 09:25	Opening address	H.E Ato Addisu Legesse, Deputy PM
	09:25-09:45	Keynote Speech	Dr. Biru Abebe, Agri-CEET, Ethiopia
	09:45-10:30	**Group Photograph & Coffee Break**	**All Participants**
SESSION I. LEAD PAPERS ON COFFEE RESEARCH AND DEVELOPMENT IN ETHIOPIA **Chairperson: Dr. Charles Agwanda, Regional Coordinator, Coffee Research Network, CABI Africa, Kenya** **Rapporteurs: Mr. Arega Worku, Senior Adviser, MIDROC Ethiopia (ex – IACO Secretary General)** **Mr. Abayneh Alemu USAID Ethiopia**			
14. 8.07	**10:30 – 11:00**	Retrospect and Prospects of Coffee Research in Ethiopia	Dr. Paulos Dubale
	11:00 – 11:40	Institutional Analyses in Coffee Industry of Ethiopia (Part I & II)	Yilma Yemane-Brehan Dr. Teklu Tesfaye
	11:40-12:30	**Discussions**	
	12:30-13:30	**Lunch Break**	
SESSION II. COFFEE BREEDING, GENETICS AND BIOTECHNOLOGY **Chairperson: Prof. Endeshaw Bekele** **Rapporteurs: Drs. Amsalu Ayana and Getachew Belay**			
14. 8.07	**13:30-13:45**	*In Situ* Conservation of the Genetic Resources of Wild Arabica Coffee in the Montane Rainforests of Ethiopia	Dr. Tadesse W/mariam
	13:45-14:00	Genetic Diversity and Population Structure Analyses of wild *C. arabica* Populations in Ethiopia Using Molecular Markers	Dr. Kassahun Tesfaye
	14:00- 14:15	Genetic Diversity and Heterosis in Arabica Coffee (*Coffea arabica* L.)	Dr. Bayetta Bellachew
	14:15-14:30	Inheritance of Resistance to Coffee Berry Disease in Indigenous Arabica Coffee	Dr. Bayetta Bellachew
	14:30-14:45	Cultivar by Environment Interaction and Stability Analysis of Arabica Coffee Genotypes within and across Regions. A Review	Yonas Belete
	14:45 – 15:00	Development of Improved coffee (*Coffea arabica* L.) varieties for Different Coffee Growing Areas of Ethiopia: Part I – Pure-lines	Fikadu Tefera
	15:00 -15:30	**Coffee Break**	
	15:30-15:45	Development of Improved coffee (*Coffea arabica* L.) varieties for Different Coffee Growing Areas of Ethiopia: Part II – Hybrids	Behailu Atero
	15:45 – 16:00	A Review of Tissue Culture Multiplication Techniques for Coffee Arabica: Potentials and Practical Experiences on Protocol Optimization for Rapid *in vitro* Propagation of the Ethiopian Coffee Hybrids	Dr. Wondyifraw Tefera
	16:00 – 17:00	**Discussion**	

SESSION III. COFFEE ECOLOGY, AGRONOMY AND PHYSIOLOGY **Chairperson: Prof. Masresha Fetene/ Dr. Biru Abebe** **Rapporteurs: Drs. Kidane Giorgis and Tadesse W/mariam**			
15.8.07	**08:30 - 08:45**	Species Diversity in the Coffee Forests of Southwestern and Southeastern Ethiopia and Integration of Their Use Value	Dr. Feyera Senbeta
	08:45 - 09:00	Agrometeorology and Geographic Information System as Decision Tools in Enhancing Coffee Research and Development in Ethiopia	Dr. Girma Mamo
	09:00 - 09:15	Some Ecophysiological Aspects of Wild *Coffea arabica* Populations in the Montane Rainforests of Ethiopia	Dr. Taye Kufa
	09:15 - 09:30	Variability among Indigenous Arabica Coffees for Drought Tolerance under Controlled Environment	Dr. Tesfaye Shimber
	09:30 - 09:45	Pre-planting Management of Arabica Coffee in Ethiopia: A Review	Anteneh Netsere
	09:45 – 10:00	Field Management Research on Arabica Coffee in Ethiopia: I: A Review of Modern Coffee Plantation	Endale Taye
	10:00 - 10:30	**Coffee Break**	
	10:30 –11:15	**Discussion**	
SESSION IV. COFFEE SOILS, NUTRITION, SOIL AND WATER MANAGEMENT **Chairperson: Dr. Paulose Dubale** **Rapporteurs: Drs. Abayneh Esayas and Tanaw Workayehu**			
15.8.07	**11:15 - 11:30**	Potentials and Constraints of Nitisols and Acrisols: Case Studies of Agaro, Metu Teppi and Haru Research Centers	Dr. Zebene Mikru
	11:30 - 11:45	Inorganic Fertilizer Management and Coffee Production in South-Western Ethiopia: Research Achievements and Constraints. A Review	Solomon Endris
	11:45 - 12:00	Organic Fertilizer Management in Coffee: Challenges and Opportunities. A Review	Solomon Endris
	12:00 - 12:30	**Discussion**	
	12:30 - 13:30	**Lunch Break**	
SESSION V. COFFEE PROTECTION (Pathology, Entomology, Weed Science) **Chairperson: Dr. Eshetu Bekele** **Rapporteurs: Dr. Abreham Tadesse and Rezene Fesehaye**			
15.8.07	**13:30 – 13:45**	Management of Coffee Berry Disease (*Collototrichum kahawae*) in Ethiopia: Overviews of Success Story in Coffee Research	Arega Zeru/ Dr. Girma Adugna
	13:45 – 14:00	Review of Research on Coffee Wilt Disease caused by *Gibberella xylarioides* in Ethiopia	Dr. Girma Adugna
	14:00 – 14:15	Coffee Insect Pests Research in Ethiopia: A Review	Esayas Mendesil
	14:15 – 14:30	Review of Coffee Weed Research Activities in Ethiopia	Tadesse Eshetu/ Getachew Zeleke
	14:30 – 14:45	The Nature and Management of Mycotoxin Contamination in Coffee	Dr. Eshetu Derso
	14:45 – 15:30	**Discussion**	
	15:30 – 16:00	**Coffee Break**	

Coffee Print

SESSION VI. COFFEE QUALITY AND PROCESSING **Chairperson: Abreham Begashaw** **Rapporteurs: Alemayehu Teshome and Zerihun Tessema**			
15.8.07	**16:00 - 16:15**	Quality Profiles of Ethiopian Coffee: Mapping by Origin	Dessie Nure
	16:15 - 16:30	Physical Quality Standards and Grading Systems of Ethiopian Coffee in Demand –Supply Chain	Dessie Nure
	16:30 – 16:45	A Review of Coffee Processing and Quality Research in Ethiopia	Behilu W/Senbet
	16:45 - 17:00	Environmental Contamination from By-Products of Wet Coffee Processing in Southwestern Ethiopia: Current Status and Suggested Management Options	Solomon Endris
	17:00 - 17:30	**Discussion**	
SESSION VII. COFFEE RESEARCH-EXTENSION AND SOCIOECONOMICS **Chairperson: Dr. Assefa Admassie** **Rapporteurs: Drs. Teklu Tesfaye and Beyene Tadesse**			
16.8.07	**08:30 – 08:45**	Review of Research Center-Based Extension Interventions on Improved Coffee Technologies: Achievements and Challenges	Negussie Efa
	08:45 – 09:00	Adoption of Coffee Production Technologies in Ethiopia: Benchmarking to the Frontier	Admasu Shibru
	09:00 – 09:15	The National Production Effect of 30 Years Investment in the Coffee Berry Disease (CBD) Resistant Selections in Ethiopia: Impact of Coffee Research Technologies	Admasu Shibru
	09:15 – 09:45	**Discussion**	
SESSION VIII. COFFEE DEVELOPMENT AND MARKETING **Chairperson: Ato Yilma Yemane-brehan** **Rapporteurs: Dr. Seid Ahmed and Assefa Tigneh**			
16.8.07	**09:45 – 10:00**	Status of Coffee Production and Marketing in Oromia Regional State	Damenu Tulu
	10:00 – 10:30	**Coffee Break**	
	10:30 – 10:45	Status of Coffee Production and Marketing in Southern Nations, Nationalities and Peoples Regional State	Simayehu Tafesse
	10:45 – 11:00	Status of Coffee Production and Marketing in the Amhara Regional State	Sintayehu Miskir
	11:00 – 11:15	Coffee Development and Marketing Improvement Plan (CDMIP): A Review	Alemayehu Teshome
	11:15 – 11:30	Technology Transfer and Adoption by Coffee Plantation Development Enterprise	Baye Mekonnen
	11:30 – 11:45	Technology Transfer and Adoption by Private Coffee Growers in Ethiopia.	Girum Tamirayehu
	11:45 – 12:00	Coffee Marketing in Ethiopia: A Review of Performance, Structure, Contributions, Reforms, Impacts and Future Prospects	Kassahun Hirutu
	12:00 – 12:15	The Role of Ethiopian Coffee Exporters' Association in Coffee Industry	Abdurezak Sherif/ Amelework Getahun
	12:15 – 13:00	**Discussion**	
	13:00 – 14:00	**Lunch Break**	

SESSION IX. COFFEE DIVERSIFICATIONS
Chairperson: Dr. Mulugeta Diro
Rapporteurs: Dr. Assefa Ta'a and Asrat Zena

16.8.07	**14:00 – 14:15**	Research Achievements on Major Spices in Coffee-based Farming Systems of Southwestern Ethiopia: A Review	Girma H/michael
	14:15 – 14:30	Achievements, Challenges and Future Prospects in Producing and Commercializing Fruits as Diversification Crops in Coffee-based Systems of Ethiopia	Dr. Wondyifraw Tefera
	14:30 – 14:45	Production and Marketing of Tea in Ethiopia: A Review	Melaku Addisu
	14:45 – 15:00	Review of Major Cereals Breeding Research with Reference to Coffee Growing Regions of Ethiopia	Leta Tulu
	15:00 – 15:30	**Coffee Break**	
	15:30 – 15:45	Agronomic Research Efforts for Resource Use Optimization in Maize-Coffee Based Farming Systems	Dr. Tesfa Bogale
	15:45 – 16:30	**Discussion**	
	16:30 – 17:30	**General Discussions and the Way Forward**	
17.8.07	**8:30 – 10:00**	Group Discussions	
	10:00 – 10:30	**Coffee Break**	
	10:30 – 12:30	Preparation for Presentations	
	12:30 – 13:30	**Lunch Break**	
	13:30 – 14:45	Group Presentations	
	14:45 – 15:30	General Discussions	
	15:30 – 16:00	**Coffee Break**	
	16:00 – 16:15	**Presentation of the Workshop Recommendations**	
	16:15 – 16:30	**Closing speech**	
	18:30 – 21:00	**Diner Party**	

dinner

ABSTRACTS

PART I: ORAL PRESENTATIONS

SESSION I. LEAD PAPERS ON COFFEE RESEARCH AND DEVELOPMENT IN ETHIOPIA

1. Retrospect and Prospects of Coffee Research in Ethiopia

Paulos Dubale
Ethiopian Kale Heywot Church, Central Office, Addis Ababa, Ethiopia, P. O. 5829, Addis Ababa,
(email: paulse2002d@yahoo.com)

2. Institutional Analyses in Coffee Industry of Ethiopia

Ato Yilma Yemanebrehan[1] and Dr. Teklu Tesfaye[2]
[1]AGRI-CEFT Ethiopia, Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia

SESSION II. COFFEE GENETICS, BREEDING AND BIOTECHNOLOGY

1. *In Situ* Conservation of the Genetic Resources of Wild Arabica Coffee in the Montane Rainforests of Ethiopia

Tadesse Woldemariam Gole[1], Mafred Denich[2], Franz Gatzweiler[2], Girma Balcha, Demel Teketay
[1]Ethiopian Coffee Forest Forum, P. O. Box 28513, Addis Ababa, Ethiopia, [2]Center for Development Research, University of Bon, Walter-Flex-Str.3, 53113 Bonn, Germany

Coffea arabica originates from Ethiopia. Wild Arabica coffee grows in the undergrowth of the Ethiopian montane rainforests. The wild coffee populations are highly endangered by deforestation due to the demand for agricultural land and settlement areas. This development is alarming as wild coffee is not only consumed by local people; it is also an important cash crop for local markets as well as the international specialty market. Above all, it is an invaluable genetic resource for future coffee breeding worldwide. Over the last four years, a multi-disciplinary research project carried out intensive research on coffee forests in southwestern and southeastern parts of Ethiopia to develop a concept for sustainable use and conservation of coffee genetic resources. Our floristic and molecular-genetic studies show high species diversity of the forest and high genetic diversity of the wild coffee, respectively. Eco-physiological studies indicate site-specific differences in the water-use efficiency of wild coffee populations. Research on fungal pathogens reveals the existence of disease-tolerant wild coffee plants. Wild coffee collection is based on traditional use rights rather than on governmental regulations for forest access. The global economic value of the Ethiopian coffee genetic resource for breeding was estimated between US$ 0.5 and 1.5 billion. For the implementation of there research findings, the Ethiopian Coffee Forest Forum was established. Based on the findings, strategies for the conservation and use of wild *Coffea arabica* in the montane rainforests is being developed and implemented at pilot sites. The conservation and use concept for implementations and its prospects are discussed.

Key words: *Coffea arabica,* montane rainforest, in situ conservation, wild population

2. Genetic Diversity and Population Structure of wild *C. arabica* Populations in Ethiopia using molecular markers

Kassahun Tesfaye[1], Tamiru Oljira[2], Kim Govers[3], Endashaw Bekele[4] and Thomas Borsch[3]
[1]Ethiopian Coffee Forest Forum, P. O. Box 28513, Addis Ababa, Ethiopia, [3]Center for Development Research, University of Bonn, Walter-Flex-Str.3, 53113 Bonn, Germany

Eight non-coding and three coding chloroplast (cp) regions and ten ISSR (Inter Simple Sequence Repeat) primers were used to study the genetic diversity and relationships among nine wild *C. arabica* forest regions. Representative landraces were also included in the study in order to compare them with wild *C. arabica* populations in southwestern and southeastern Ethiopia. The result of more than 7.2kbp sequence analysis of *Coffea* cpDNA indicated that the origin of *C. arabica* is of single allopolyploidization event. The phylogenetic analysis of this data indicate that *C. eugenioides* is only a maternal parent with 100% statistical support. The interregional ISSR marker analysis of *C. arabica* from wild coffee regions showed a complex patterns of genotype distribution where by individuals from some regions (Bonga and Yayu/Geba Dogi) spread allover the trees generated where as others form their own groups (possessing their own genotypes; Boginda, Daphe and Bench Maji). Both the Nj (neighbor-joining) and UPGMA (unweighted pair group method with arithmetic mean) analyses of interregional data set of ISSR marker showed that wild *C. arabica* generally form a distinct group. In-depth analysis of the structure of the wiid coffee was carried out for Yayu (Geba Dogi) and Berhan Kontir populations with more than 100 individuals from each region. The result showed a clear differentiation among wild population where individuals collected from the same plot (50m X 50m) is clustered together. Moreover, individuals from undisturbed plots tend to form strong group as compared to individuals collected from the semi-disturbed plots. These results suggest the need for multi-site *in situ* conservation approach and also utilization of the observed divergence of populations via heterosis for national breeding program. The ISSR marker system studied is found to be very useful for fingerprinting coffee genetic materials and certification of wild coffee.
Key words: allopolyploidization, landraces, molecular diversity, population structure, wild coffee

3. Genetic Diversity and Heterosis in Arabica Coffee (*Coffea arabica* L.)

Bayetta Bellachew, Behailu Atero, Fikadu Tefera, Ashenafi Ayano and Tadesse Benti
Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia,
(Corresponding author: bbellachew@yahoo.com)

Genetic diversity between the parents has long been recognized as a prerequisite for the expression of heterosis. This effect has been investigated in arabica coffee using six-parent diallel cross to (1) see the effect of parental diversity in terms of geographical origin and morphology on the magnitude of heterosis and (2) facilitate selection of parental lines for heterosis breeding. The six parental lines were originated from fairly distant geographical regions of Ethiopia, viz., Illubabor – I (parents P1 and P2), Kaffa – K (P3 and P4) and Sidamo – S (P5 and P6). Morphologically, the parents were characterized as compact – C (P1and P2), medium open – MO (P3 and P4) and open – O (P5 and P6) growth habit. The within-region better-parent heterosis ranged from -2.4% (P1 x P2, I x I cross) for stem diameter to +54% (P3 x P4, K x K cross) for yield of fresh cherry. The corresponding better-parent heterosis for between region crosses was far greater varying from 1.2% (P1 x P5, I x S) for canopy diameter to 120.3% (P2 x P3, I x K) for yield of clean coffee. For all the characters considered, the mean mid-parent and better-parent heterosis of the within-region crosses was consistently lower than the corresponding means of any one of the three between-region groups of crosses implying the importance of parental diversity in geographical origin to

maximize heterosis. On the other hand, the I x K and I x S groups of crosses involving C x MO and C x O morphological groups, respectively, consistently exhibited higher mean better-parent heterosis for all or most of the characters considered over the K x S crosses which involved parents with fairly similar morphology, MO x O, but distinctly different origin. This result may suggest that morphological variation is more important than geographical origin to maximize heterosis and cultivars with high genetic diversity could be obtained from both within- and between-region populations. Implications of the results in coffee breeding program are discussed.

Key words: *Coffea arabica*, heterosis, genetic diversity

4. Inheritance of Resistance to Coffee Berry Disease in Indigenous Arabica Coffee

Bayetta Bellachew and W. E. Peat

[1] Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia, [2]Imperial College at Wye, University of London, UK

Coffee berry disease (CBD) is the most important disease of arabica coffee (*Coffeea arabica* L.) caused by the fungus *Colletotrichum kahawae* sp.nov. A five-parent half diallel experiment involving resistant (R1, R2), intermediate (R3) and susceptible (R4, R5) parents to the disease were used to generate F1, F2 and backcross generations. Diallel and generation means analysis were conducted after seedling test to investigate the inheritance of resistance to coffee berry disease (CBD) and determine proper breeding method for resistance. In all cases, resistance was found to be recessive to susceptibility. Both additive and nonadditive gene actions were important in controlling the inheritance of resistance, additive effects being predominant. Different resistant cultivars possessed different resistance genotypes and the expression of resistance required the accumulation of several recessive homozygotes. Generation means analyses revealed the presence of epistatic variation, in addition to additive and dominance effects, which were predominantly of the duplicate type. In most of the crosses, two to five genes were estimated to control resistance. Implications of these results in breeding arabica coffee for yield and resistance to CBD are discussed.

Key words: *Coffea arabica*, coffee berry disease, inheritance of resistance, gene action

5. Cultivar by Environment interaction and Stability Analysis of Arabica Coffee Genotypes within and across Regions. A Review

Yonas Belete and Bayeta Belachew

Jimma Agriculture Research Center, P. O. Box 192, Jimma, Ethiopia

A cultivar by environment interaction of Arabica coffee genotypes was evaluated within and across regions in two sets. The first set of the study included four locations in different coffee growing regions. These were: Teppi, Metu, Wonago and Bedessa. But the locations in the second set of the study were all taken from a single coffee growing region of south west Ethiopia. These locations were: Jimma, Agaro, Gera and Metu. The genotypes included in the two sets of the experiments were different. The combined analysis of variance across environment within and over regions revealed that the interaction sum of square were highly significant for yield showing the differential performance of genotypes. But, the interaction observed over regions was found to be much stronger than the interaction observed within a region. No cultivar or set of cultivars was identified that exhibited high performance at all locations over regions. The result of this experiment clearly shows that the locations over different regions comprise different type of environments

and the performance of the Ethiopian coffee cultivars showed specificity over these regions. The Ethiopian coffee cultivars also exhibited high specificity of performance over altitudes even within a region. But several cultivars were identified that exhibited high performance across locations within the south west coffee growing region of Ethiopia showing that it is possible to identify stable cultivar within a region provided that the Ethiopian coffee growing regions are sub-divided in to sub-regions. In this regard genotypes: 8143, 75187B and 8019 were found to be the most superior cultivars that exhibited stable performance across environments within a region. On the other hand cultivar 8213 exhibited specific adaptation at optimum environments. Generally, the results of the experiments in this study show that the Ethiopian coffee types are region specific in performance.

Key Words: Yield, stability, cultivar by environment interactions

6. Development of Improved Coffee (*Coffea Arabica* L.) Varieties for Different Coffee Growing Areas of Ethiopia: Part I – Pure-lines

Fikadu Tefera, Melaku Adisu, Bayetta Bellachew, Behailu Atero, Tadesse Benti, Ashenafi Ayano
Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia
(Corresponding author, email:* feka_tefera2@yahoo.com*)*

Arabica coffee (*Coffea arabica* L.) is a predominantly self-pollinated species which originated in Ethiopia. The availability high genetic diversity of the species for yield, pest resistance, quality and several other traits has provided immense opportunities for genetic improvement. On the other hand, the wide ecological diversity of the crop and its perennial nature were the great challenging features in coffee variety development program in Ethiopia. Development of pure-line varieties for each specific coffee growing area using the high genetic variability available in the respective areas has been adopted as an essential strategy even though hybrid varieties are also important. In pure-line variety development, germplasm collection and evaluation, variety trial under different environments, and verification of superior cultivars before final selection for release are the major steps. In cases of urgency, however, a short-term program also known as 'crash' program (simultaneous execution of multiple step-wise activities) has been employed. These breeding approaches, short- and long-term programs were further improved by employing a special program known as 'local landrace development', very useful to maintain the typical quality of each area or locality, minimize adaptation problem and maintains farmers and consumers preference. The implementation of the earlier crash program has resulted in producing 13 coffee berry disease (CBD) resistant pure-line varieties in a very short period of time when the Ethiopian coffee industry was in severe crises due to the outbreak of the disease. Considerable progress has also been made in developing 10 additional high yielding disease resistant pure-lines for different agro-ecologies using the conventional long-term program. Currently, as a result of the application of the improved breeding program, local landrace development, with special emphasis to uniquely high quality coffee areas, viz., Harerge, Sidamo (Yirgachefe), Wollega (Gimbi) and Limmu, 40 promising cultivars have been identified and advanced to variety verification trial. The implication of pure-line varieties and the current breeding approach in coffee improvement program are further discussed.

Key words: *Coffea arabica*, pure-line variety, landrace, agroecology

7. Development of Improved Coffee (*Coffea Arabica* L.) Varieties for Different Coffee Growing Areas of Ethiopia: Part II – Hybrids

Behailu Atero, Bayetta Bellachew, Fikadu Tefera, Melaku Adisu, Tadesse Benti, and Ashenafi Ayano
Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia
(Corresponding author e-mail: Behailuate@yahoo.com)

Hybrid coffee variety development program in Ethiopia has been started in 1978. Since the inception of the program, several sets of crosses have been made for genetic studies and hybrid variety development. In the genetic studies, the combining ability analysis revealed the importance of both additive and non-additive gene actions in controlling the expression of yield and some yield related growth characters. These results suggested the importance of selection and hybridization methods to exploit the advantage of both additive and non additive gene actions in the improvement of yield and other characters that are governed by these gene effects. Further combining ability analysis showed the presence of certain elite varieties that have high general combining ability for use in hybrid development program. In all the different sets of crosses among indigenous cultivars, a considerable amount of yield heterosis (a maximum of 60 – 120%) was observed over the better parent (OBP) and the average yield of the hybrids was consistently higher than that of parental mean suggesting the possibility to maximize coffee yield by using hybrids. In effect, three coffee hybrids namely Ababuna, Melko – CH2 and Gawe, have been released for medium altitude areas of south western Ethiopia. The hybrids yielded 24 – 26 Qts/ha on research station and about18 – 20Qt/ha on on-farm verification plot while the best standard check, Vr Dessu, produced 18 Qt/ha on research station and 13 – 15 on on-farm. Currently, from different sets of crosses, a total of 27 F1 hybrids have been identified and advanced to verification in order to release additional hybrids that suit to low-medium- and high-altitude areas. The candidate hybrids gave mean yields and average hetrosis over standard check that ranged from19.5 – 28 Qt/ha and 16 – 43 %, respectively. In addition, hybrid variety development program for each locality or agro-ecology is under way using elite materials of the respective area as part of local landrace development program. The implication and prospect of hybrid coffee development program is discussed in detail in the text.
Key words: *Coffea arabica* L., gene action, hybrid, heterosis, variety, landrace

8. A Review of Tissue Culture Multiplication Techniques for Coffee Arabica: Potentials and Practical Experiences on Protocol Optimization for Rapid *in vitro* Propagation of the Ethiopian Coffee Hybrids.

Wondyifraw Tefera, Ramos A., Martinez F., Alemayehu Teresa And Zerihun A
Jimma Agricultural Reseaerch Center, P. O. Box 192 Jimma, Ethiopia

Unlike its close relatives, Arabica coffee is a predominantly self-pollinated species and is commonly propagated through the sexual means using seeds. However, tissue culture propagation techniques provide a viable alternative to the sexual method in coffee. Tissue culture methods permit the production of relatively uniform plants on a massive scale in a shorter period, and with a narrower genetic base than is possible under the conventional methods. Again, the danger of this narrow genetic base is addressed by mixing clones. Three different methods can be used for the propagation of coffee plants through tissue culture: micro-cuttings, direct somatic embryogenesis, or plant regeneration from callus (indirect somatic embryogenesis). The crop can also be propagated *in vitro* through embryo culture and anther culture. Indirect somatic embryogenesis from leaf pieces had been proved so far to be the best and efficient way for coffee micropropagation due to the possibility to use liquid media, either using shakers or bioreactors,

rather than semi solid. Using temporary immersion bioreactor with optimizing the immersion cycles, i.e. both the duration and the frequency of immersions stimulation of embryos production, has increased from 120 to 3,081 embryos/l of bioreactor. Moreover, the conversion of embryos into plantlets could also be increased from 33 % to 70% through the use of the temporary immersion bioreactor. Encouraging preliminary results have been obtained on aseptic leaf explant implantation, calluse formation and development, embryo induction, embryo development to plantlets, hardening and acclimatization. The use of bioreactor to increase the embryogenic potential of the calluses, the use of cell suspension and the increase in the rate of plant regeneration from somatic embryos are some of the perspective to speed up the coffee micropropagation work. This paper, thus, presents a review on the historical background of large scale clonal propagation of coffee through tissue culture in different parts of the world and its current status in Ethiopia.

Key words: self-pollinated species, micropropagation, tissue culture, callus

SESSION III. COFFEE ECOLOGY, AGRONOMY AND PHYSIOLOGY

1. Species Diversity in the Coffee Forests of Southwestern and Southeastern Ethiopia and Integration of Their Use Value

Feyera Senbeta[1],Tadesse Woldemariam[1], Manfred Denich[2]

[1]Ethiopian Coffee Forest Forum, P. O. Box 28513, Addis Ababa, Ethiopia, [2]Center for Development Research, University of Bon, Walter-Flex-Str.3, 53113 Bonn, Germany

(*corresponding author: feyeras@yahoo.com)

Today, coffee forests are the largest remaining forest fragments in Ethiopia. Vegetation studies were carried out in five coffee forest fragments, namely Harenna, Berhane-Kontir, Bonga, Maji and Yayu. Quadrat of 20 m x 20 m was used to gather relevant information on species diversity of Coffee Forests. All together, 651 plant species and 225,706 individuals of woody plants ≥ 2 cm were encountered. Berhane-Kontir was the richest site with the highest family (91), genera (256), and species (374) diversity of all sites. There was a variation in species richness and forest structure among the sites. Rubiaceae and Fabaceae were the dominant trees and shrubs families, whereas Asclepidaceae and Vitaceae were the dominant climbers' family. Although wild coffee occurs over wide ranges of geographical regions, but local distributior is patchy. Wild coffee populations occur within the altitudinal ranges of between 950 m and 2100 m. The highest abundance of wild coffee plants per plot was observed in Yayu and the lowest in Bonga. In an interview with local people, about 74 plant species and 37 botanical families were quoted plant for medicine, food (edible), timber and construction, beehives and nectar, and plants for spices. These results suggest conservation and sustainable of Coffee Forests should be a high priority for resource managers in order to maintain the diverse genetic bases of wild Arabica coffee and other forest species. Further research in forest fragments which examine individual and a combination of disturbance agents would help clarify the importance of anthropogenic disturbance on species richness and abundance.

Key words: species diversity, forest coffee, biodiversity conservation, floristic composition

2. Agrometeorology and Geographic Information System as Decision Tools in Enhancing Coffee Research and Development in Ethiopia

Girma Mamo[1], Girma Adugna[2], Mezgebu Getnet[1], Gizachew Legesse[1], Degifie Tibebe[1] and Daniel[1] A[1]
[1]Agrometeorology Research Group, [2]National Coffee Research Center
Ethiopian Institute of Agric-Research, P.O.Box, 2003 Addis Ababa, Ethiopia

Ethiopia, Africa's largest Arabica coffee producer is an original home, along with the highest diversity in coffee genetic resources. However, coffee productivity is quite low (4.7 q/ha for smallholders). High climate variability and therefore its high unpredictability form a challenging environment to the coffee research and development system. In context, the high yielding and diseases resistant/tolerant cultivars generated by the National Coffee System Research have only partly addressed the problem, as the agronomic gap is still so wide. This paper provides the analytical results of tempo-spatial climatic variability and coffee suitability map/models for the purpose of future research and development focus. The temporal climate variability was studied for Melko, National Coffee Research Center, while the spatial mapping was done using Geographic Information System technique. The result of rainfall variability analysis on monthly time scale illustrates that December, January and February experience less than 50 mm of rainfall, compared to June, July and August highest rainfall of about 250 mm. December in Melko history experiences rainfall amount to the maximum of 75 mm in 4 out of 5 years' time (80 percentile). On the other hand, the same month exhibits less than 50 mm once in two years time (50 percentile or median value) and drops below 25 mm only once in 5 years period. The monthly maximum temperature data analysis shows the highest to be during January, February and March, with gradual declining down to 24°C during July, August and September periods. The minimum temperature is observed to decline during November, December and January (8-10°C) representing a relatively cold seasons and therefore vital for coffee floral bud dormancy in Ethiopia. Similarly partial regression-correlation of disease parameters (severity and incidence of CBD) recorded for 10 years on the progenies of 13 released CBD resistant selections and a susceptible standard at Gera as dependent variables against major weather factors such as temperature, number of rainy days and relative humidity documented during disease development period as independent variables were analysed. The mean maximum temperature showed significantly negative correlation with CBD severity in berry count ($r = -0.88$) and visual assessment ($r = -0.76$), while the total number of rainy days ($r = 0.72$) and relative humidity ($r = 0.71$) exhibited significantly positive relationship. The analysis demonstrated prevalence of low temperature, accompanied by high rainfall extended over a longer period of time favoured CBD development and increased the disease intensity. Clustering of coffee growing domains into suitability zones using the optimal mix of multiple physical factors (soil, rainfall, temperature and elevation) reveals a close agreement between the traditional and the model output, with major concentration in the south and south western regions. Accordingly, west Welega, Illubaor, Jimma, Kaffa, Bench Maji, Metekel and Assosa make the highly suitable coffee zones. Of these, Metekel and Assosa can be considered as newly added areas for coffee expansion. On the other hand, central Tigray, North Gonder, almost all western and south western parts, as well as north western parts (other than the highly suitable areas), parts of Bale and western Hararghie, parts of eastern Hararghie including Babile, north eastern tip of Tigray can be considered as moderately suitable coffee growing zones. Extended portions of northern, northwestern, central, extreme west (the whole Gambela), eastern, parts of South Omo and Borena on the other hand, form the marginally suitable coffee growing zones. As it offers real opportunity and challenging environment in terms of maximizing coffee profitability from the highly and marginally suitable zones, this information must form an attractive strategy to the research system, government, farmers, investors and development support institutions alike in terms of decisions related to investment, credit and market stability.

3. Some Ecophysiological Aspects of Wild *Coffea arabica* Populations in the Montane Rainforests of Ethiopia

Taye Kufa[1] and Jürgen Burkhardt[2]

[1]Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia; [2]Institute of Crop Science and Resource Conservation, Department of Plant Nutrition, Karlrobert-Kreiten-Straße 13, 53115 Bonn, Germany (Corresponding author: kufataye@yahoo.com)

The montane rainforests of Ethiopia are the origin and the genetic centre of *Coffea arabica*, but they are highly threatened due to the strong pressure on the remaining forests. This study describes native wild *Coffea arabica* populations in the montane rainforests of Ethiopia along a climatic gradient, focusing on the stand conditions, growth and hydraulic characteristics. The Bonga, Berhane-Kontir and Yayu forests are situated in the southwest of Ethiopia, while Harenna forest is located east of the Rift Valley and is the driest site. The forest soils were comparable in most physical and chemical properties. All the soil samples had clayey texture and high soil organic matter, leading to good physical and chemical properties. The montane rainforests were different in the relative plant population density largely due to the impact of human disturbance. Forest coffee trees were irregularly and closely spaced under dense shadings. Coffees of different areas had distinct vegetative, leaf and seed growth characteristics. Compact coffees with short plant height, narrow canopy spread, erect branching, short internode, small leaves and small bean sizes dominated in Yayu and Bonga forests. in contrast, open and intermediate coffee types were more frequent at Berhane-Kontir and Harenna forests. The Harenna coffee trees showed highest predawn leaf water potential and maximum LWP diurnal differences in winter as compared to the southwest sites. Similarly, the highest hydraulic conductance of stems, the highest risk of cavitation, was found for trees from the driest place, Harenna. In general, the findings depict high intra-specific variations in stand conditions, growth and hydraulic characteristics of the wild coffee trees along a rainfall gradient, suggesting the need for multi-site *in-situ* use and conservation strategy of wild *Coffea arabica* gene banks in the montane rainforests of Ethiopia.

Key words: *Coffea arabica*, forest soils, hydraulic conductance, intraspecific variation.

4. Variability among Indigenous Arabica Coffees for Drought Tolerance under Controlled Environment

Tesfaye Shimber[1] and M. R. Ismail[2]

[1]Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia. [2] Crop Science Department, University of Putra Malaysia, P. O. Box 42000Serdang, Selangor, Malaysia (Corresponding address: tesfayeshimer@yahoo.com)

Drought is among the major factors that adversely affects coffee production in most parts of Ethiopia. In an attempt to screen Arabica coffee (*Coffea arabica* L.) genotypes for drought tolerance, two experiments were carried out at Jima Agricultural Research Center. Both experiments were conducted in a rain shelter using 21 released varieties (741; 744; 7440; 7454; 7487; 74110; 74112; 74140; 74148; 74158; 74165; 754; 75227; *Geisha*; F-59; F-35; 7411x F-59; 74110x F-59; 7395x F-59; J-19 and J-21); two lowland materials (8/85 and 77/85) and a promising genotype (7395). In both experiments, seedlings were subjected to two watering regimes (water-stress by with holding irrigation and well-watered control). It was observed that there were significant differences among the cultivars for sensitivity to water stress. Based on mean rate of stress development, cultivar F-59, 7395xF-59, J-19, 7454, 754, 75227 and *Geisha* were identified as more sensitive than 7487, 74110xF-59, 741, J-21, 744, 741xF-59, 74158, 77/85, 7395, F-35, 74148 and 74165, while 7440, 74140, 74110, 74112 and 8/85 were found to be relatively tolerant to the imposed soil drying

treatment. Genotypes selected from the three groups also showed differences in rate of survival and concentration of inorganic solutes (K, Ca and Mg) in leaves. Some of the cultivars, such as F-59 and *Geisha*, exhibited higher rate of survival and recovery, despite higher level of sensitivity to the imposed water stress treatment. Therefore, it appears that accumulation of solutes, and rate of survival and recovery should also be considered in addition to stress scoring during screening genotypes for drought tolerance.
Keywords: Arabica coffee, cultivar, moisture stress, drought tolerance.

5. Pre-planting Management of Arabica Coffee in Ethiopia: A Review

Anteneh Netsere, Endale Taye, Tesfaye Shimber, Taye Kufa, Alemseged Yilma
Jimma Agricultural Research Center, P. 0. Box 192, Jimma, Ethiopia
(*Corresponding author: anetsere@yahoo.com)

Pre-planting management includes all aspects of nursery practices beginning from seed collection, preparation and handling, and planting in the nursery up to the time of transplanting. Results of past trials revealed that coffee seeds with moisture content of >40 and <32% stored in respective moisture vapor barrier, glass jar and polythene bag, and porous (cloth bag, fiber bag and open tray) containers had relatively retained viability and vigor longest. Sowing immediately after harvesting and processing is the best option for higher germination and seedling growth. Using seeds from red ripe cherries with intact parchment dried in shade and ventilated condition enhanced seed germination. Forest soil or a mixture of top soils (TS), compost and sand in 3 : 1: 0 and 2 : 1 : 1 ratios or TS blended with organic manure (M) in IM : 4TS, 2M : 4TS and 3M : 4TS ratios favored maximum germination and seedling growth. Sowing coffee seeds at a depth of 1 cm with the grooved side placed down and embryo tip up had improved germination. Seedbeds covered with 3-5 cm thick mulch after seed sowing and watered at 2 days interval until hypocotyl emergence had higher germination percentage. After emergence, with the removal of mulch, nursery beds provided with 50-75% over head shade and irrigated twice a week until seedlings attained 2 to 4 pairs of leaves and then after at and a week interval produced vigorous seedlings. Sowing parchment removed seeds after soaking in cold water for 24 hours hastened germination and promoted seedling growth. Blends of top soil, manure, and sand in 2 : 2 : 1 ratio and soft wood single node cuttings with one pair of leaves was recommended for propagation of hybrid coffee. Applying P at a rate of 750 mg P or a combination of 2.31 g lime and 250 mg P/pot (2.5 kg sieved TS) ensured production of vigorous seedlings.
Key words: Arabica coffee, nursery management, seedling growth, seed viability

6. Field Management Research on Arabica Coffee in Ethiopia: I: A Review Of Modern Coffee Plantation

Endale Taye, Anteneh Netsere, Taye Kufa, Tesfaye Shimber, Alemseged Yilma, Amanuel Asrat, Tesfaye Ayano
Jimma Agricultural Research Center. P O Box 192, Jimma, Ethiopia
(Corresponding author: endaletw@yahoo.com)

Field management research on modern coffee includes pre-transplanting field operations, and post-planting management. Briefly, during the last four decades emphasis have been given to investigations into hole size, time of transplanting, tillage methods, transplanting practices, soil and moisture conservation, mulching, coffee shade trees, canopy volume, spacing and bearing heads, soil fertility management, methods of rejuvenation and weed control aspects. The purpose of this review paper was therefore to summarize and document available research findings generated in the aforementioned research areas

excluding results of weed science research. In most cases, deeper and wider hole size dug early in the dry season with July/August transplanting increased field survival rate of coffee seedlings. Tillage operations improved early growth performance and survival rate of coffee seedlings. Planting coffee seedlings 10 cm deeper than the collar point and ball root method of transplanting had significantly increased early growth performance and survival rate of coffee seedlings. Soil and moisture conservation techniques such as ridging and banding improved yield response of coffee, particularly on undulated and sloppy areas. Among the various shade tree species evaluated, *Millettia ferruginea, Albizia moronguensis* and *Acacia abyssinica, Albizia tanganica, Erythrina abyssinca, Calpurnea subdecondra* and *Cordia Africana* promoted coffee yield as most of these shade tree species produce large amount of litter fall (1240-4512 kg ha^{-1} $annum^{-1}$) and intercept moderate light intensity (26-60%). In planting pattern studies, strip planting of coffee trees between two shade tree species enhanced coffee yield by 20.40% as compared to intercropping. Canopy volume is an important genetic parameter to classify coffee into different canopy classes. Based on this, three distinct morphological classes (open, intermediate and compact) types of coffee cultivars are identified. Each of theses classes demands its own spacing rejuvenation. For instant, if trained on one or two verticals, open, intermediate and compact types should be planted at respective spacing of 2.00 m * 2.00 m, 1.80 m * 1.80 m 1.60 m * 1.60 m. Close spacing or high density plantings, increased coffee yield, under open sun condition; however its efficiency has been found to vary depending on the agro-ecological condition of the area.

Key words: Modern coffee, tillage, transplanting practices, spacing, shade trees, canopy classes

SESSION IV. COFFEE SOILS, NUTRITION, SOIL AND WATER MANAGEMENT

1. Potentials and Constraints of Nitisols and Acrisols; Case Studies of Agaro, Metu Tepi and Haru Research Centers, Ethiopia

Zebene Mikru and Wondosen Tena

National Soil Research Center, P. O. Box 147, Addis Ababa, Ethiopia
(Corresponding author: zhbiy@yahoo.com)

In order to set priorities among the different plant nutrients for future consideration in soil fertility management field experiments and fertilizer studies, a green house experiment was conducted to investigate limiting nutrients for crop growth on major soils of Tepi, Haru, Agaro and Metu research sub centers. The major soil types considered were Mollic Nitisols of Agaro, Umbric Nitisols of Metu, Distric Nitisols of Tepi and Distric Acrisols of Haru. Bulk of surface soil samples (plough depth) were collected for the green house experiment. Prior to the green house experiment, the soils were characterized for their physical and chemical constituents to evaluate their overall fertility status. Fourteen treatments and three replications arranged in a randomized design were used. The treatments include no fertilization, optimum level or complete fertilization of N, P, K, Ca, Mg, S, Mn, Fe, Cu, Zn, B and Mo. The remaining 12 treatments were created by the omission of one element at a time from the optimum. Sorghum (S.bicolor), variety meku, was used as a test crop. The outcome of this investigation indicated that, Phosphorus was the most limiting nutrient followed by Nitrogen for all experimental soils of Agaro, Metu, Tepi and Haru. Dry matter yield and nutrient uptake were highly significantly affected ($P < 0.001$) by missing of some nutrients when compared with the optimum. On Acrisols at Haru, potassium has been found to be limiting next to phosphorus and nitrogen. Plants deficient in K will easily lodge, are sensitive to disease infestation, and with regard to coffee trees are susceptible to branch dieback and maturity will be affected. Haru is lying in

part of the coffee producing areas of the country, and hence it is important to see the response of the plant to K fertilizer in the area.

Key words: Acrisols, Nitisols, limiting nutrient, missing nutrient

2. Inorganic Fertilizer Management and Coffee Production in South-Western Ethiopia: Research Achievements and Constraints. A Review

Solomon Endris, Tesfu Kebede and Tesfaye Yaekob
Soil and Water Research Division, Jimma Agricultural Research Centre, PO Box 192, Jimma, Ethiopia
(*Corresponding author: solomonendris@yahoo.com)

The review sums up results of various investigations on mineral fertilization and nutrition of coffee accomplished mainly at Jimma Agricultural Research Centre. Results of specific research activities on method of fertilizer placement and time of application are also included. Field research in the last four decades has indicated nitrogen and phosphorus to be the most yield limiting nutrients in soils of southwestern Ethiopia where coffee is dominantly grown. Despite the notion that potassium is rich in Ethiopian soils, there is some indication that this nutrient is limiting in some areas. Therefore, there is a need for further investigation in this line as coffee is heavy feeder of potassium and the nutrient is also known to affect quality characteristics in addition to yield. So far, potassium fertilization is not practiced in most cases; hence, such production system might result in the continuous removal of potassium from the soil and hence imbalance in the major nutrients. Following several years of on-station and on-farm experiments, fertilizer recommendations were given for the major coffee growing areas in the country. Results obtained from studies on phosphorus placement and the status of long term fertilized soils at Melko were also highly beneficial and helped in better fertilizer management and directing further research areas. Currently, a number of improved coffee varieties and hybrids released from the centre are available for users. The clear genetic variation among the varieties and diversity of growing conditions (agro-ecologies) are thought to have significant impact on the mineral nutrition of the plant. Therefore, timely revision and calibration of the recommendations given in the past with currently released varieties and hybrids has become a matter of urgency. Finally, future research needs to focus on revising and calibrating the already available recommendations, assessing and evaluating different fertilizer types which were not previously looked into, investigating easily available and cheap organic nutrient sources to support the booming organic coffee sector and supplement the conventional production system in the region, evaluating specific effects of nutrients on coffee quality, and investigations in to the utilization of soil fertility improving plants and mycorrhiza (VAM fungi) especially for improved phosphorus nutrition of coffee in the region.
Key words: coffee; fertilizer; nutrient; variety

3. Organic Fertilizer Management in Coffee: Challenges and Opportunities. A Review

Solomon Endris*, Tesfu Kebede, Tesfaye Yaekob, Yared Kassahun and Jafar Dawid

Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia
(*Corresponding author: solomonendris@yahoo.com)

Southwestern Ethiopia is one of the biggest coffee producing regions of the country. Large volume of coffee processing byproducts, mainly coffee pulp and husk, is generated annually from wet coffee processing

stations in the region. This paper reviews various attempts made in the past on preparation and utilization of organic fertilizers mainly for coffee production. However, the paper focuses on summarizing results of recent experiments carried out on management of coffee processing by-products (Coffee pulp and husk). In general, activities that were geared towards achieving targets of increased and sustained coffee production through mineral and organic fertilizers have been accomplished in the past at Jimma Agricultural Research Centre. Efforts are still underway to identify cheap and easily available organic materials for use as organic fertilizer and to determine appropriate composting ratios and conditions for coffee processing by-products. Results reported recently have proved successes achieved in the ongoing efforts, especially in the area of composting coffee pulp. Coffee pulp took 6 to 8 months to achieve stabilization of the organic matter when it is left for natural degradation. Therefore result of experiments carried out in the centre indicated that maturity of coffee pulp and husk composts took 2 to 3 months period. Hence, decomposing coffee pulp and husk with different organic residues such as farm yard manure (FYM) and leguminous plants was recommended to hasten compost maturity and achieve nutritional balance in the compost produced. Despite the efforts made so far, much work is still to be done with emphasis on determining the field application rates, evaluating other potentially useful organic materials for composting of coffee processing by-products with varying ratios, and integrated nutrient management.

Key words: Compost; husk; organic fertilizer; pulp; stabilization period

SESSION V. PLANT PROTECTION (Pathology, Entomology and Weed Science)

1. Management of Coffee Berry Disease (*Collototrichum kahawae*) in Ethiopia: Overviews of Success Story in Coffee Research

Arega Zeru, Girma Adugna, Demelash Teferi, Chala *Jafuka, Sisay Tesfaye*
Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia.
(Corresponding author: gadugna@yahoo.com, aregazeru@yahoo.com)

An over view of research achievements in assessment, epidemiology and management of coffee berry disease (CBD) over last decades have been discussed. *Collototrichum kahawae*, the causal pathogenic form, attacks primarily green coffee berries at all stages. The disease was first reported in Ethiopia in 1971 and since then it spread to all coffee growing areas of the country with in 5 to 7 years. The disease incidence, severity and losses vary from season to season and over places depending on the influence of weather conditions. CBD causes up 100% yield losses but the national average crop losses were estimated to range between 25 and 30%. The fungus population seems to be homogeneous indicating no race specialization although there were differences in aggressiveness among the tested isolates. Attached berry test and seedling hypocotyls inoculations are the most reliable methods in developing CBD resistant cultivars through selection from the heterogeneous coffee populations that lead to develop 15 highly resistant selections released within shortest period of time. This is one of the ever success stories in coffee research and development that saved the Ethiopian coffee industry from catastrophe. Subsequently about 8 selections including 7418, 74153, 7514, 7516, 7576, 75129, 8136 and 827, that proved to possess fairly higher CBD resistance than the released *cvs* 741 and 75227 were recommended for release. Selection of coffee mother trees and testing their progenies are major activities to furnish the nation with location specific coffee cultivars. Above all the performances of previously released selections have been regularly monitored for consistent and durability of the host resistance. Chemical control of CBD by fungicide application has been effected and since 1972 more than 20 products were screened and about 6 were

recommended for use. Control of CBD using resistant coffee selections is cost effective, reliable and environmentally safe. Integrated management of CBD is paramount; therefore, research should also focus in areas of cultural and biological control measures.

Key words: coffee berry disease, *Colletotrichum kahawae,* yield losses, CBD resistant selections,

2. A Review of Coffee Wilt Disease (Tracheomycosis) Caused by *Gibberella xylarioides* (*Fusarium xylarioides*)

Girma Adugna, Chala Jefuka, Sisay Tesfaye, Demelash Teferi
Jimma Agricultural Research Centre, PO Box 192 Jimma, Ethiopia
(Corresponding author: gadugna@yahoo.com)

Coffee wilt (tracheomycosis) caused by *Gibberella xylarioides* (*Fusarium xylarioides*) is the most vexing soil borne vascular disease of coffee in east and central Africa. It has been causing more than 5 million Robusta coffee trees in Uganda and hundred thousands of Arabica coffee trees in Ethiopia, that amount to 50% and 10% productive tree losses, respectively. The monetary value estimates ranged from USD 9.65 in Uganda to USD 3.85 in Ethiopia. The disease totally kills coffee plants (irrespective of age) and the symptoms include progressive external wilting accompanied by bluish and/or black internal discolorations on the wood of partially wilting trees. The pathogen produces fruiting bodies (perithecia) in the barks of both mature trees and young seedlings. These characteristic symptoms and signs of the pathogen are significant tools in diagnosis and identification of infected trees in the field. Besides perithecia which contain thousands of ascospores plays great role in the survival and disseminations of the fungus. Coffee wilt transmission is mostly effected through animate and inanimate agents and above all human activities cause wound in the root, stem, branch and suckers of coffee. The population structure studies using cultural appearances, host-pathogen interaction, and microsatellite and RAPD analyses confirmed existence of host specialization into at least two pathogenic forms: isolates attacking *C. arabica,* and those pathogenic to *C. canephora* and *C. excelsa*. However, there has been no genetic diversity within each subpopulation except variation in aggressiveness, which enables successful management of CWD through resistant coffee cultivar deployment. In this line, most coffee selections are being screened using seedling inoculation with the aggressive isolate in the green house. The promising ones are further intensively tested by reinoculation of grown seedlings (9 months old) in screen (lath) house thereby proves the resistance. Among the released selections 7440, 74165, 8136 (Merdacheriko) and 1979 (Catimor-J19) showed moderate to high levels of resistance to CWD. In addition, as the wilt pathogen is known to be passive in its mode of penetration, strict practices of sanitations and disease prevention is unavoidable. Research results on the disease, the pathogen and the host is reviewed and experiences gained from the Regional Coffee Wilt Program are reflected in this document.

Key words: coffee wilt disease, tracheomycosis, *Gibberella xylarioides,* perithecia, population structure

3. Coffee Insect Pests Research in Ethiopia: A Review

Esayas Mendesil*, Million Abebe, Chemeda Abdeta, Mekuria Tadesse
Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia
(*Corresponding author: emendesil@yahoo.com)

Insect pests are one of the biotic factors that affect yield and quality of coffee. Over 47 species of insect pests are known to attack coffee in Ethiopia. Antestia bug, *Antestiopsis intricata*, *A. facetoides* and coffee blotch leaf miner, *Leucoptera caffenia* are the major insect pests of coffee which inflict considerable

5. The Nature and Management of Mycotoxin Contamination in Coffee

Eshetu Derso, Girma Adugna
Debre Zeit Agricultural Research Center, P O Box 24596/1000, Addis Ababa, Ethiopia

Mycotoxins are fungal metabolites which, when ingested, inhaled or absorbed through the skin cause lowered performance, sickness or death in man or animals, they are released by relatively few but universally present fungi growing on grains, legumes and nuts. Mycotoxin production is influenced both by the genotype of the organism and the physicochemical environment in which it is growing. When the moisture content of raw coffee exceeds 14%, spoilage due to fungal growth starts. Many moulds from the genera Aspergillus, Penicillium, Alternaria, and Cladosporium which can produce mycotoxins, have been detected on green coffee beans. Ochratoxin A, (OTA) produced by *Aspergillus ochraceus A. carbonarius* and strains of *A. niger.* has been shown to be nephrotoxic, immunosuppressive, carcinogenic and teratogenic in all experimental animais tested so far. Since 1980, several studies have reported OTA presence in raw coffee. In 2004, the EU set maximum permissible limits for OTA of 5 ppb in roasted and ground coffee. Subsequently, the responsibility of the producing countries regarding the OTA problem is clear. They must make extensive efforts to reduce and prevent the development of molds throughout the coffee supply chain. One important aspect to be considered is that the negative publicity surrounding OTA could cause a sharp decrease in consumption, jeopardizing the economic and social conditions of the producing countries. This poses a particularly serious problem for countries like Ethiopia where coffee is the sole cash crop. Key factors in the successful management of OTA involve good hygiene practices along the chain, rapid drying, and avoiding the re-wetting of coffee by ensuring clean and dry storage and transportation. However, the importance of mycotoxins in coffee should not be dramatized as they do not present an undue toxicological hazard if good manufacturing practices are normally encountered in coffee production.

SESSION VI. COFFEE QUALITY AND POST-HARVEST PROCESSING

1. Quality Profiles of Ethiopian Coffee: Mapping by Origin

Dessie Nure, Elias Gethaun, Endale Asfaw, Workneh Mulat
Coffee Quality Control and Auction Center, Addis Ababa, Ethiopia
(Corresponding address: endhiwe@ gmail.com)

The suitable physical factors like climate and soil have favored Ethiopia. Although coffee grows in all regions of the country, it exists in different forms. In south western tropical rainforest, where it is believed to be the primary source of coffee, it grows mostly under forest and semi-forest. There are also few estate plantations in which recommended agronomic practices are applied; which accounts only five percent of the total coffee production. In southern and eastern part of the country coffee is grown by small holding coffee farmers. It is common to see coffee farm in the garden at the vicinity of residences. In these areas animal manure and house hold waste are used to the coffee farms as organic matters. Farmers practices intercropping staple foods and vegetables in their coffee plantation. Therefore, the absence of using chemical fertilizer, pesticides neither in forest nor in garden coffee areas has enabled to classify Ethiopian coffee as "organic". However, dalliance of certification to confirm the fact has hindered to utilize this potential. The country being the primary center of origin and diversity for Arabica coffee, it has the widest

genetic base and heterogeneity, which does not occur any where in the world. This potential wealth helped the country to have coffee varieties with distinctive qualities that can satisfy the world specialty, gourmet and organic coffee market. Therefore, some of well recognized flavor types and quality profiles are described in this paper.

2. Physical Quality Standards and Grading Systems of Ethiopian Coffee in Demand –Supply Chain

Dessie Nure, Elias Gethaun, Endale Asfaw, Workneh Mulat
Coffee Quality Control and Auction Center, Addis Ababa, Ethiopia
(Corresponding address: endhiwe@gmail.com)

A quality is conform with requirements or a quality is fitness for use in which the parties involved in the industry (customer, processor, supplier, etc) should agree on the requirements and the requirements should be clear to all stakeholders involved in the process. According to the ISO definition of quality best suits our purpose. The totality of features and characteristics of a product or service which bear upon its ability to satisfy stated and implied needs. In order to satisfy these stated and implied needs of the user since the ultimate user is assumed as the one who decides whether a product has quality or not. To effectively implement and maintain such concepts, a nation should establish a quality management systems, particularly in developing a quality control/inspection assurance institutions. However, a standard is a document, established by consensus and approved by a recognized body, that provides the common and repeated use, rules, guidelines, or characteristics for activities for their results, aimed at achieving the optimum degree of order in a given context, in this case, coffee. The major aims of standardization are to achieve a maximum overall economy in terms of cost, human effort and conservation of essential materials, to ensure maximum convenience in use (simplification, rationalization, interchangeability of parts, increment of productivity and elimination of unnecessary wastes, and to adopt the best possible solution to recurring problems consistent with the above recommendations/ points. In line with the notion stated earlier, Coffee Quality Control and Auction Center was established with a key objective of coffee quality control which in turn strongly facilitates the coffee marketing system and the long coffee supply chain system of Ethiopia. The Centers main activities are concerned with standardization/grading based on the nations standard on which all stakeholders agreed and comply with and the coffee grading and standardization systems of Ethiopia are briefly discussed in this paper.

3. A Review of Coffee Processing and Quality Research in Ethiopia

Behilu W/Senbet, Abrar Sualeh, Negussie Mokonen, Solomon Endries
Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia
(*Corresponding author: behaws@yahoo.com)

Coffee is the most important crop in the national economy of Ethiopia and still the leading export commodity. In recent years, different coffee producing countries have tremendously expanded their production and their export volume. In this regard new emerging coffee producing countries have become strongly competent in the world market. Making effort to overcome challenges and threats only through expansion of production does not seem feasible for countries like Ethiopia. Thus providing good quality coffee is the only way out, viable option to get in to the world market and to remain competitive. Ethiopia has favorable conditions for the production of quality Arabica coffee, and coffee types with unique flavor and taste. However, this potential is affected by the improper processing practices employed by some producers. The need for proper processing of coffee should therefore, be taken seriously. For about forty

years now, coffee processing and quality research division has been engaged in coffee processing and quality research. The long-term research activity was concentrated on quality characterization, fermentation trial, the drying and storage of parchment coffee with a view to producing a product of the highest quality and thus not only ensuring that farmers will get the best possible price from his crop, but also that the reputation of Ethiopian coffee remains high in discriminating consumer countries. The fact that the results of research have been of immense economic value to the coffee industry in Ethiopia demonstrated from the many recommendations that have ensured and accepted by the coffee producers as standard practice for processing high quality Ethiopian coffee. This review paper discusses some of the most important aspects of previous work in Ethiopia on coffee processing with a view to identifying major areas of future research gap on which further significant developments must now depend. And some important pre- and post-harvest technologies to enhance coffee quality and the role played by every technical recommendation at every stage also identified as well as the respective impact with respect to quality improvement reviewed. The constraints facing the implementation of any of the recommendations also identified, discussed and a possible solution presented.

Key words: coffee arabica, coffee quality, post-harvest processing

4. Environmental Contamination from By-Products of Wet Coffee Processing in Southwestern Ethiopia: Current Status and Suggested Management Options

Solomon Endris[1*], Tesfu Kebede[1], Behailu W/Senbet[1], Worku Legesse[2], Yared Kassahun[1] and Tesfaye Yakob[1]

[1]Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia, [2]JimmaUniversity, School of Environmental Health (*Corresponding Author: solomonendris@yahoo.com)

Coffee effluents are the main source of organic pollution in environments where intensive coffee processing is practiced without appropriate by-product management systems. The rise in the quantity of wet processed coffee in southwestern Ethiopia has concurrently caused generation of huge amounts of coffee effluents and other byproducts that directly pollute rivers and the surrounding environment. Hence, the level of pollution in various rivers of Jimma zone as a result of coffee processing waste water was monitored from 2003 to 2005. In the study: physical, chemical and biological indices of water quality assessment were employed. Physico-chemical parameters of water quality were recorded both in-situ and ex-situ. Trace amount of NO_3-was found at upper course of most rivers, while as high as 17.2 mg/L and 17.8mg/L were recorded at downstream locations of *Temsa* and *Bore* Rivers. In addition, the average dissolved oxygen, at the different sampling sites of the rivers varied between 7.97 (at upper course of *Bore*) and 0 (at lower course of *Temsa*) which shows the deterioration of water quality in locations below effluent discharge points. Reduced pH values (as low as 2.1) were also recorded at downstream locations of most rivers. In general, results of the analysis on pH, EC, TDS, DO, BOD, NH_3, NO_3 and other parameters indicated a high level of pollution in almost all locations of the rivers below effluent discharge points. Analysis of overall stream quality was also accomplished on the basis of benthic-macroinvertebrate sampling. *EPT richness, a* commonly used biomonitoring index, was used to assess the level of water quality degradation in all rivers which confirmed existence of a similar pattern of pollution in most of the downstream locations. Substantial change in macroinvertebrate community structure was noticed which includes loss of pollution intolerant species in some downstream locations. Based on the data obtained in this study, during the main processing season, downstream locations of these rivers can not be used safely for household uses. Therefore, immediate intervention in the area of coffee factory water recirculation and other effluent management options should be dealt with top priority to avoid further contamination of water resources and

irreversible damage to the environment. In addition, a favorable policy environment should be created to control and enforce the use of available technologies that could reduce environmental contamination by coffee processing industries in the region. Finally this paper also includes various coffee waste water management options compiled from international sources, which are deemed relevant to the prevailing environmental and economic conditions of the region. Therefore, evaluating these coffee waste management options and selecting the most feasible ones is a matter of urgent attention.

Key words: benthic-macroinvertebrate; coffee effluent; environment; physico-chemical parameter; pollution

SESSION VII. COFFEE RESEARCH-EXTENSION AND SOCIOECONOMICS

1. Review of Research Center-Based Extension Interventions on Improved Coffee Technologies: Achievements and Challenges

Negussie Efa[1], Derese Teshome[2], Berhanu Megersa[2] and Getachew W/Michael[2]
[1]CABI, Africa, Addis Ababa; [2]Jimma Agricultural Research Center , P. O. Box 192, Jimma, Ethiopia

Coffee is a crop of considerable economic and social importance to Ethiopia. In view of its crucial importance and the immense potential for improvement, substantial efforts and resources have been committed to coffee research over the past four decades. As a result, remarkable achievements have been attained in developing improved coffee technologies/recommendations that would enhance the production, productivity and quality of the crop. Parallel to generating improved technologies, the Jima Agricultural Research Centre (JARC) has made various attempts to introduce and accelerate dissemination of improved coffee technologies. Especially, lack of strong extension service on coffee and absence of commercial coffee seed multiplying agency necessitated JARC's active involvement in production and distribution of seeds of improved varieties and other related technologies. A variety of approaches and mechanisms were employed by the Research-Extension division of JARC to trigger of dissemination and diffusion of improved coffee technologies. These include among others: on-farm and on-station demonstrations, hands-on training, workshops and conferences, field/open days and visits, written extension materials, exhibitions and displays, video, seed and seedling dissemination. Accordingly, demonstrations were conducted at 174 sites on various coffee technologies/recommendations, 1276 quintals of seed and 49145 seedlings were dispatched to users, 27 training programs were organized and 1142 extension staff and farmers were trained, and 24 field and open days were organized and attended by over 5300 stakeholders. Complementary extension researches and other studies were also conducted to support the technology generation and dissemination efforts. The paper thus discusses efforts made by JARC to foster links with stakeholders and in promoting introduction and dissemination of coffee technologies. Major challenges, constraints and directions for future interventions are also highlighted.

2. Adoption of Coffee Production Technologies in Ethiopia: Benchmarking to the Frontier

Admasu Shibru and Zekarias Shumeta
Ethiopian Institute of Agricultural Research, P.O. Box 2003, Addis Ababa, Ethiopia

After thousands of years of experience in coffee sector, only little change is observed in the system of coffee production and marketing in Ethiopia. In view of the global competitive production and marketing trend, it is not only necessary but also is a must to transform the traditional ways of doing business in the

sector. To this end, Jimma Agricultural Research Center has generated a number of technologies which are disseminated to the users. These coffee technologies include varieties, agronomic, and protection and harvesting, In this regard, there are questions like how strategic is the system in exploiting the potential gains from the utilization of the available technology, knowledge and information, in general, and queries on the content of the production technology package, the scale of extending/promoting the technologies and the linkages among different institutions, in particular. Based on coffee technology adoption studies, there exist gaps between the available levels of knowledge, information and technology, and the existing system of coffee production. The paper critically explains the need to benchmark the frontier and make the production systems so competitive, by improving the contents of the coffee production package, the supply of the technologies, services like the credit, extension and infrastructure. Moreover, cooperative development, intensive farmers' training and demonstration field trials, and scaling up of the technologies are identified to be important.

3. The National Production Effect of 30 Years Investment in the Coffee Berry Disease (CBD) Resistant Selections in Ethiopia: Impact of Coffee Research Technologies

Admasu Shibru[1] and Klaus Frohberg[2]

Ethiopian Institute of Agricultural Research, P. O. Box 2003 Addis Ababa, Ethiopia: Center for Development Research, University of Bonn, Germany

As it has been benefiting to about 25 million smallholder coffee producing households in about 80 developing countries in the world, coffee has significant role in the social and economic sectors in Ethiopia. Although a number of programs and projects have been launched for the development of the coffee sector, no significant transformation is made onto the production or the marketing sub-sectors of the commodity in the country. Different diseases, like the coffee berry disease and coffee wilt disease have been constraining the coffee production sector, among other things. Despite the continuous research support programs for the development of the sector, special emphasis has been given for research intervention in the area of developing CBD resistant varieties. As the intervention program on the coffee varietal research took more than three decades of investment, it is important to evaluate the returns of such long years' investment. The contribution of 15 cultivars that are identified to be resistant to the CBD, which were planted on about 20% of the coffee acreage in Ethiopia in the first 29 years of investment, have helped to save a considerable amount of money against the loss due to the disease. The value due to the marginal yield effects of these cultivars is much higher than the costs associated with the collection of the wild germplasm, selection and dissemination of the improved cultivars to the farmers. Specifically, in the first 29 years of the intervention, a compound value of about Birr 2,297.7 million is estimated to be obtained due to the increase in yield as a result of the use of improved cultivars. The result explains the benefit of investing in such critical diseases like CBD on such valuable crops like coffee.

SESSION VIII. COFFEE DEVELOPMENT AND MARKETING

1. Status of Coffee Production and Marketing in Oromia Regional State

Damenu Tulu, Samuel Assefa, Abebe Dirba
Oromiya Agriculture and Rural Development Bureau, Addis Ababa, Ethiopia

Coffee is the major cash crop for some hundred thousand farmers of Oromia regional state and chief foreign exchange earner of the country. Further more, it is the basis for the livelihood of those farmers and their families in the region. In Oromia coffee grows in all of 17 Zones of which seven are major coffee producers while four are medium and the rest six are minor producer. From 250 districts of the region around 113 districts are known as coffee growers. Those districts in major and medium coffee producers are supplying their products to the central market while those minor growing districts are mainly restricted to local consumption. The status of coffee production and productivity constraints and marketing potential in the Oromia Regional State is briefly outlined in this paper.

2. Status of Coffee Production and Marketing in Southern Nations, Nationalities and Peoples Regional State

Simayehu Tafesse, Sindu Abate, Simachew Chekol
Bureau of Agriculture & Rural Development, P.O.Box 80, Awassa, Ethiopia

Ethiopia is the home of coffee Arabic and center of its origin and diversity. The Southern Region is the 2nd largest producer and supplier of Arabica coffee in the country. It is the most important export crop of the region which shares 45% of the national market. There are about 50 *weredas* potentially producing high quality coffee and about 235,000 ha covered by coffee. The annual production ranged between 120,000 and 140,000 tons, of which 70,000 to100, 000 tons are supplied to central market. Coffee delivered to central market is 46% washed and 54% unwashed; which accounts to 70% Ethiopian coffee export. In the Region there are about 4 coffee production systems (garden 65%, forest 10%, Semi forest 23% and modern plantation 2%). Currently the area under coffee production and the average annual production is dramatically increasing from year to year. Coffees from the region mainly Yirgacheffee and Sidama are the best quality in the world. Since about 70% of the total coffee trees are old, the rejuvenation activities are under way and others management activities such as intercropping, composting, and mulching have been practiced in different coffee growing areas. Extension is now carried out and funded by the regional council and there is no coffee specific service; the regional government has recently made a major effort to train and put in place three DA'S in each *kebele*, each specializing in crops, livestock, and natural resource management. The distraction of forests affecting both flora and fauna including coffee trees that resulted in coffee genetic erosion particularly in the south western part of the region. Coffee wilt disease is one of important disease after coffee berry disease attacking all types of coffee cultivars including those released CBD resistant cultivars unless otherwise this disease is controlled on time, it will devastate the whole coffee farm. The other major problems relate to marketing systems mainly poor infrastructure, poor post–harvest handling, and price fluctuations.

Key words: - Arabica coffee, cultivars, extension, conservation, processing, marketing

3. Status of Coffee Production and Marketing in the Amhara Regional State

Sintayehu Miskir
Crop production and Protection Department, Bureau of Agriculture and Rural Development

The Amhara Region has the total surface area of 179,152 square kilometer, being located in the north central and north western parts of Ethiopia inhabiting about 17.8 Million populations (BoFED, 2004). The region comprises 10 major agro-ecological zones and 18 subagroecological zones having different physiographic units. It has a wide-range of topography with 63% lying between 1500 and 3000 meters above see level and the remaining 35% is between 500 and 1500 m asl. It receives mean annual rainfall

ranging from 200 to1600mm and its mean annual temperature ranges from 10^{0}C to25^{0}C. Generally the soil type consists of 32% black, 31% red, 25% brown and 12% others. Most of the soil is suitable to grow different crops and easily manageable for agricultural practices (BoARD). The major crops grown in the region are cereals (tef, maize, barley, wheat, finger millet etc.), pulse crops (faba bean and chickpea), horticultural crops (onion, tomato, pepper and garlic) and spices (cumin and fenugreeks). The region also known to have a potential for coffee production, and the status of its production and constraints are highlighted in this paper.

4. Coffee Development and Marketing Improvement Plan (CDMIP): A Review

Alemayehu Teshome, Esayas Kebede, Kassu Kebede

Ministry of Agriculture and Rural Development; Department of Coffee, Tea and Spice; P. O. Box 27572, Addis Ababa, Ethiopia (corresponding author: alemayehutg1@yahoo.co.uk)

In Ethiopia, Coffee has been playing a paramount socio economic role especially as the main stay of external trade, at least since at the start of this century. The country has immense natural resources that offer the greatest opportunity to produce very large volume of Coffee of different types that satisfy the various preferences of consumers. In recognition of its comparative advantage Coffee has received priority of development in Agricultural Led Industrialization and PASDEP. Thus tremendous efforts have been going on to implement Coffee Development and Marketing Improvement Plan (CDMIP) since its launching in 2003/04 (1996 E.C.). Being a component of the general frame work of the efforts of poverty alleviation, the goal of CDMIP can be explained as realizing maximum use of the comparative advantage of coffee sub sector in terms of economic and social benefits, mainly the forex earning of the country by optimizing its development the major objective of CDMIP are increasing annual coffee production of the country by nearly four folds or to about 900,000 ton by increasing both area coverage and productivity of existing Coffee by two folds; increasing volume, type and quality standard of exportable Coffee modernizing marketing systems; generating and utilizing improved technologies such as superior coffee cultivars, and conserving our genetic wealth. The CDMIP is intended to be implemented in coffee growing districts of Oromiya, SNNP and Gambella regional states. Achievements of the last four years are encouraging though much short comings encountered in implementation process have to be improved. Planting of coffee seedlings can be said the highest achievement of CDMIP so far about 542 million seedlings have been raised and most of them planted on new land area (126400 ha) and about 30 % are used either for infilling to optimizing plant density or replace uprooted old coffee. With regard to rejuvenation about 33,083 ha of old coffee have been stumped so far. How ever both planted and rejuvenated coffee have no significance effect on total production volume yet, as obviously known coffee starts bearing; 3 – 4 years after planting and 2 – 3 years after stumping. The numbers of coffee processing industries have shown a significant increment from 600 – 730 pulperies and from 390to 600 in cases of hulleres. Absence of the use of inputs such as chemical fertilizers , fungicide for control of CBD; pruning shears and bow saw and coffee drying materials can be taken as the short comings that demand due emphasis to improve.

Key word: CDMIP, coffee, rejuvenation, productivity, seedling planting, acreage

5. Technology Transfer and Adoption by Coffee Plantation Development Enterprise

Baye Mekonnen, Fesseha T/Selassie, Teferi Gedlu and Yazew Tezera

Coffee Plantation Development Enterprise, P.O.Box 4363, Addis Ababa, Ethiopia

Coffee Plantation Development Enterprise manages three big coffee plantations located in three National Regional States with diverse altitude and rainfall has endowed it with variations of ecosystems, which has the potential to produce coffee that meets the preference of consumers. It is established to produce washed coffee (majority) with sustainable yield. It further serves as demonstration site for intensified coffee plantation and disseminates advanced technology to the vicinities. In its intensification program 21,000 ha of land is planted with coffee berry disease (CBD) resistant cultivars with application of improved production technologies. However, productivity remained low almost equivalent to national average owing to poor yield performance of the cultivars planted in low altitude zones, fall in population of coffee trees, harvest loss, poor achievement of agronomic practices, less attention to crop protection practices and delayed delivery of inputs. Regarding the processing, modern technologies such as artificial dryers, demucilagers, ecological wet milling and gravity separator have been introduced and effectively operational at present. The enterprise is engaged in directly exporting coffee and the volume increase from 14,670 *Quintals* in 2002 to 37,590 Q in 2005. Efforts have also been made to diversify the coffee to the extent of supplying specialty coffee. In today's global economy sustainability in production and quality has become important variable and this entails coordination of producers and researchers.

Key words: CBD resistant cultivars, coffee market, production constraints, linkage, technology adoption

6. Coffee Marketing in Ethiopia: A Review of Performance, Structure, Its Contribution, Reforms, Impacts and Future Prospects

Kassahun Hirutu[1], Getnet Geremew[2]
[1]Bagersh, P.O. Box 1269 Addis Ababa, Ethiopia; [2]Ministry of Agriculture and Rural Development
(email: getnetgeremew@yahoo.com)

Coffee is indigenous to Africa, with Arabica coffee originating from Ethiopia and robusta from the Atlantic coast, around Angola and the great lakes region. Coffee is produced in more than 50 developing countries providing income for approximately 25 million small holder producers and employing an estimated 100 million people. The bulk of the world's coffee, however, is produced in Latin America. The three years average (2004 to 2006) that 52% of world production is accounted by the three coffee producers, namely, Brazil, Colombia, and Viet Nam. Brazil is the world's largest grower and seller of coffee. Viet Nam, which increased its production rapidly through out the 1990s, now holds the second position, bringing Colombia into third place and Indonesia into fourth. About 65% of the world supply of coffee is Arabica, while Robusta currently makes up around 35% compared to 25% before some 10 years ago. World consumption in 2006 is estimated at around 117 million bags of 60 kg. Coffee consumption in producing countries is close to 30 million bags and is constrained by low incomes. Consumption in Africa is negligible with the exception of Ethiopia, where there is a long and well established tradition of coffee drinking. Latin America coffee producing countries consume about 72%, Asia and Pacific 18% and Africa consumes about 10% of the total. Importing countries consumption in the period 2004 to 2006 is totaled 86,143 million bags. Of which 24% were consumed by the USA, 46% by Western Europe, 8% by Eastern Europe and Asia accounts about 14%. Although the top five consumers are the USA, Brazil, Germany, Japan and France, while the Nordic countries have the world's highest coffee consumption per capita. Prices of Agricultural commodities show a high degree of volatility in general, but coffee shows the most volatile price in particular. In 2002, coffee prices on world market reached their lowest point in real terms for a century. The fall in prices since 1997 has been dramatic with prices in some cases insufficient to cover production costs. In 2002, Oxfam noted that some farming households dependents on coffee were pulling their children out of school, they could no longer afford basic medicines and were cutting back on food consumption. Some coffee traders

were going out of business while many seasonal workers among the poorest and most vulnerable participants in the coffee chain lost their jobs. More over, government funds in producer countries were being squeezed, putting pressure on health and education provision and forcing governments further in to debt.

SESSION IX. COFFEE DIVERSIFICATIONS

1. Research Achievements on Major Spices in Coffee-based Farming Systems of Southwestern Ethiopia: A Review

Girma H/michael[1], Digafe Tilahun[1], Wondyfraw Tefera[2] and Belay Y/birhan[2]
[1]Teppi Agricultural Research Sub-center, P.O.Box 34; Teppi
[2]Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia,
(Corresponding author: girmah2003@yahoo.com)

Spices are very valuable cash crops for farmers especially in southwestern Ethiopia. Research on spices has been started since long time, but not organized enough in manpower and facility. Even if with very limited capacity, significant numbers of research achievements were recorded in spices research. Germplasm enhancement by collection and/or introduction, adaptation, evaluation and selection of best performing ones, study on agronomic requirements, harvesting stages with respect to quality, processing methods to produce full production package were given a due attention in the research. From low land spices black pepper, ginger, turmeric and cardamom were given high attention in the research. In that, performances of most of these spices were proved very promising in yield, quality and disease resistance. From more year evaluation results; five promising black pepper, three ginger, two turmeric and one cardamom varieties were selected and recommended for the suitable agro ecologies. Dry black pepper yield 1,970-2,850 kg/ha, fresh ginger rhizome 15,000-24,100 kg/ha, fresh turmeric 31,000 kg/ha and dry cardamom capsule 180 kg/ha were recorded from the selected spices. Quality was also promising except in turmeric and cardamom that required further studies to attain standard quality products. The study included the very important production packages like appropriate planting time, propagation methods, nursery and field management practices and harvesting time and processing techniques. Moreover, indigenous spices like korarima and long pepper have been given a due attention of research, and also recently introduced spices such as vanilla are under good adaptation. For the recommended varieties of black pepper, ginger, turmeric and cardamom spices there has been multiplication and distribution of planting materials for users.
Key words: Spices, quality, essential oil, propagation, maturity, harvesting

2. Achievements, Challenges and Future prospects in Producing and Commercializing Fruits as a Diversification Crops in Coffee-based Crop Systems of Ethiopia

Wondyifraw Tefera, Haileab Atsbeha, Tadesse Eshetu, Dawit Ashenafi and Belay Yemanebirhan
Jimma Agricultural Research Center, P.O. Box 192, Jimma, Ethiopia
(* Corresponding author: dorobl@yahoo.com)

South western part of Ethiopia is one of the potential areas for producing a number of tropical, subtropical and temperate fruits. To improve the quality and productivity of fruits at the farmers level and to diversify coffees

with fruit crops in the coffee based cropping system of south western Ethiopia, Jimma Agricultural Research Centre has done quite a number of research activities on some fruit crops. A lot of tropical and sup tropical fruit crops were maintained at the main (Melko) and sub centres (Teppi and Metu) for further study. An internationally well known variety of pineapple, smooth cayenne, was introduced from Kenya and recommended for production/dissimination after undertaking an adaptation trial. Further agronomic studies were also done on this variety and appropriate plant density, type and size of planting materials, optimum number of slips and suckers to be left on the plant as well as best method of weed control had already been determined under Gojab and Jimma areas. To develop avocado varieties, a characterization trial was done on seedling trees of avocado and some promising lines had so far been identified on the bases of their yield performance and fruit quality. Similarly, to increase the productivity and fruit quality of banana production in the region, some outstanding dessert and cooking bananas were recommended for dissemination. The attempt made to control leaf and fruit spot disease of citrus revealed that the use of fungicide (chlorothalonil 75% w.p.) resulted higher amount of total and marketable fruit yields of sweet orange. Despite these success stories, a wider research gap on fruit research is remaining unfilled. Root rot disease of avocado and fruit and leaf spots of citrus are still be the devastating problems that are causing the decline in the production of theses crops in south western part of the country. Similarly, cigar end rot and wilt dieses of banana, mango anthracnose, fruit flies of guava are the major problems that need dew attention. More over, proper agronomic practices and improved post harvest technologies are lacking for each fruit crops. Thus, in the forth coming, the research should be directed towards the development of efficient and cost effective means of disease control in avocado, citrus and other fruit crops. Suitable agronomic practices and post harvest technologies for each fruit crop should also be developed.

Key words: Avocado, Banana, Citrus, Pineapple, South west

3. Production and Marketing of Tea in Ethiopia: A Review

Melaku Addisu
Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia,
(e-mail: melaku1530@hotmail.com)

Tea (*Camellia sinensis)*, a crop belonging to the family *Theacea*, is originated in South-west Asia. The plant grows under a wide range of climatic conditions. However, for economic yield and good quality, its commercial production in the world is largely confined to the sub-tropics and the mountainous regions of the equator. Worldwide production, export and consumption of tea have increased steadily during the past four to five decades. This reveals the increasing importance of tea, as a cash crop, globally. Today, tea is the most widely consumed stimulant beverage followed by coffee and accounts for 46 % of the world's beverage market. Tea in Ethiopia, introduced for the first time in the early 19th century, has a very recent venture of production. Even then, it has already started not only to satisfy the ever increasing local needs but also to contribute to the national export earnings. Recently, as coffee diversification program, tea has a lion share in export promotion and foreign exchange earnings in the country. Ethiopian tea is thus, fast emerging as a competitive product in the European market. There are ample opportunities in the country that would facilitate the positive development of the industry. The existing potential, however, has not been utilized yet. Very few, less than 0.05%, of the total suitable tea area (about 6 million ha) in the country has been put under production till recently. Besides, there is a multitude of challenges facing the industry. The present paper, therefore, gives a brief review of the tea industry in Ethiopia and outlines the future support needs and suggestions for its positive development.

Key Words: *Camellia sinensis*, challenges, opportunities, production

4. Review of Major Cereals Breeding Research with Reference to Coffee Growing Regions of Ethiopia

Leta Tulu, Habte Jifar and Abush Tesfaye
Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia
(Corresponding author e-mail: letatb@yahoo.com)

In Ethiopia the major coffee growing regions have favorable environment for cereal production. This has created a linkage among the two crops and has intern enhanced the role of cereals in coffee diversification program. Maize, sorghum and tef are the major cereal crops grown in the regions as food and cash crops to meet household food and cash requirements supporting coffee growers when coffee price declines. Currently western part of Amhara, western, southern and south-eastern parts of Oromia and Southern Nations, Nationalities and Peoples Region are the major coffee growing regions having tremendous potential for cereals contributing to 93.8, 90.4 and 81.5 % of the national maize, tef and sorghum production, respectively. The main objective of breeding cereals with reference to these regions is to develop well adapted and high yielding improved varieties that increase productivity and enable coffee farmers to secure food self sufficiency and provide options that support and strengthen sustainable and broad based coffee economy. So far high yielding maize and sorghum varieties have been released for different agroecologies and made available for commercial cultivation. Popularization and demonstration of such varieties has shown that production and productivity of maize and sorghum can be significantly improved in coffee based agroecologies provided that improved varieties are utilized in combination with their recommended packages. Lack of variety resistant to diseases is the major problem in tef production. This paper reviews research efforts made to develop improved maize, tef and sorghum varieties fitting the major coffee growing agroecologies and suggests research and development strategies that will lead to their promotion as commercial and export oriented crops.
Key words: coffee diversification program, improved varieties, maize, sorghum, tef

5. Agronomic Research Efforts for Resource Use Optimization in Maize-Coffee Based Farming Systems

Tesfa Bogale and Yared Kassahun
Jimma Agricultural Research Center, P. O. Box, 192, Jimma, Ethiopia

Coffee and maize share the same agro-ecological niches both under natural and agricultural systems of Western and Southwestern regions of Ethiopia. Heavy and torrential rains that stay longer from 6-9 months characterize these regions. Besides, soils in the regions are highly fragile in nature and thus, restrained by severe losses of plant nutrients via erosion and leaching. These have been exacerbated by human acts that arise from lack of knows how to wisely manage and optimize uses of natural resources. To properly, manage and utilize all available resources, different agronomic research efforts that included various cropping systems, reduced tilling methods and soil fertility management systems have been carried out since late-eighties. Each system was composed of varying research protocols with different experimental designs that executed both on stations and on farms in coffee-maize systems of Melko, Gera and Metu. Subsequently, trials on double cropping of maize and other food crops gave extra net return over ETB 2000 per annum. While, intercropping trials of maize-common beans resulted in increase of land productivity index up to 1.60. In reducing soil disturbance in maize fields, crop residues retained in no-till plots were found to check eroded soils from upper slopes, decomposed soon and improved soil nutrient content. As compared to conventional till plots, 20-25% increases in grain yield were recorded from conserved plots.

For soil fertility management, various legume types were introduced for adaptability, higher biomass and better N-accumulation. Three green manure and one grain legumes were selected and used in sole and intercropped rational maize-legume systems. Thus, N from green manure legumes was found to offset whole N-requirements of the following maize, which was estimated to be more than 70kg urea-N ha^{-1}.
Key words: Resource management, cropping system, reduced till, maize-coffee system, soil fertility.

PART II:

POSTER SESSIONS

COFFEE BREEDING, GENETICS AND BIOTECHNOLOGY

PB1. Coffee (*Coffea arabica* L.) Germplasm Collections Maintained at Jimma/Melko

Fekadu Tefera, Bayetta Bellachew and Behailu Atero
Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia
(* Corresponding author, feka_tefera2@yahoo.com)

Ethiopia is the primary center of origin and genetic diversity of coffee (*Coffea Arabica* L.). Arabica coffee grows under very diverse environments including altitude (550 – 2600m), annual rainfall (1000 – 2000mm), temperature (min. 8 – 15 °C, maximum 24 – 31°C) and soil type. This has probably contributed a lot to the high genetic diversity within Arabica coffee population in this country. To effectively utilize these genetic resources, three long-term coffee germplasm collection programs namely national, CBD resistant mother tree selection, and regional collection were launched at different times by Jimma Agricultural Research Center (JARC) as the major part of coffee improvement program. In most cases, 'pointed' or 'targeted' collection method and single tree sampling were employed in order to collect as many desirable traits as possible for use in variety development program. Random collection was also done but to a limited extent since the Institute of Biodiversity Conservation (IBC) is responsible for it. The most important desirable traits considered during collection include yield, pest resistance, stress tolerance and several other morphological characteristics. Altogether, about 5630 accessions have been collected with complete passport data through the three collection programs, national (1185 accessions), CBD resistant selection (1041) and regional program (3404). Complete data base of these accessions have been developed to facilitate easy access. The collected accessions were maintained in seven field gene banks (Melko, Agaro, Gera, Haru, Awada, Tepi and Mechara) of JARC. The regional collection program which currently focused on five major coffee growing areas, viz., Harerge, Sidamo, Wollega, Limmu/Gera and lowland areas – Tepi and Bebeka, was designed to complement the local landrace variety development program. On the other hand, IBC has maintained about 5000 accessions at Chochie but most are duplicates of JARC collections. In general, the collections made so far by no means are comprehensive relative to the genetic potential of coffee available in the country and the collection program should continue in a more systematic manner. The collection strategy to be followed and its implication in the conservation of Ethiopian coffee genetic resources have been discussed.
Key words: *Coffea Arabica*, germplasm collection, accessions, genetic diversity

PB2. Heterosis and combining ability for yield and yield related traits in arabica coffee (*Coffea arabica*)

Wassu Mohammed, Bayetta Belachew and Harjit-Singh
[1]Department of Plant Science, Haramaya University, P.O. Box 291, Haramaya Ethiopia. [2]Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia

In view of limited work on heterosis and combining ability in coffee breeding programs of the world, the present study was conducted on five distinct *Coffea arabica* L. lines and 10 hybrids produced from there in half diallel fashion. The hybrids and their parents were planted in 1997, in randomized complete block design and evaluated for fresh cherry and clean coffee yields for four consecutive years from 2001 to 2004, and for yield related traits in 2004. Five hybrids exhibited positive and significant heterosis relative

to mid parent and better parent up to 116.4% and 115.9% for fresh cherry yield, and 121.7% and 98.2% for clean coffee yield, respectively. The between region crosses had significant average yield advantage of 88.72%, 55.98% and 52.30% over Sidamo x Sidamo hybrids, the three Southwestern released cultivars and the five parents, respectively. All hybrids that exhibited highest level of heterosis also gave highest yield that was not observed in coffee hybrid experiments else where. The study indicated the importance of both additive and non-additive gene actions in determining the expression of 9 out of 12 traits but variance component ratio, being less than one, indicated relative significance of non-additive gene actions. The observations indicated importance of continuing coffee hybrid programs considering parents diverse geographical origin to obtain maximum yield and exploitable heterosis.
Key words: heterosis, combining ability, hybrid, yield

PB3. Review of Multivariate Analyses of Phenotypic Diversity in the South and Southeast Ethiopian Coffees (*Coffea arabica* L.)

Mesfin Kebede
Awada Agricultural Research Sub-center **P**. O. Box 205, Yirgalem, Ethiopia

Since Ethiopia is the primary center of origin and genetic diversity for *C. arabica*, there is high genetic variability for yield and yield components, disease and pest resistance, and other traits. Systematic studies conducted on genetic diversity analysis of Ethiopian coffee germpiasms using morphological characters confirmed the prevalence of enormous variation for economically important traits. Cluster and principal component analyses conducted on 100 Hararge coffee germplasm accessions collected from 16 districts of East and West Hararge Administrative Zones with 4 standard checks using 14 quantitative characters produced 6 clusters. The number of accessions per cluster ranged from 5 in cluster VI to 44 in cluster III. Moreover, the first four principal components explained 78.5% of the total variation prevalent within the germplasm accessions out of which 38.5% was explained by the first principal component. Similarly, a field experiment conducted on evaluation of 41 south Ethiopian coffee accessions with 2 standard checks of the southwest Ethiopian origin using 7 morphological agronomic characters, average of three years data on severity of CBD and CLR infestations and clean coffee produced 9 clusters. The number of accessions per cluster ranged from 1 in cluster IX to 13 in cluster II. Further, the first four principal components explained 82.6% of the total variation prevalent within the germplasm accessions out of which 32.5% was explained by the first principal component. The clustering pattern of the accessions revealed the prevalence of genetic diversity in the south and Southeast Ethiopian coffees for the characters considered. The study highlighted the possibility of using accessions of the distant clusters as potential candidates for the genetic improvement of both coffee types through crossing and selection. However, these reports shall be further confirmed through molecular techniques of genetic diversity analysis using the same material or germpiasms.
Key Words: *Coffea arabica* L, cluster analysis, genetic diversity, quantitative traits

COFFEE ECOLOGY, AGRONOMY AND PHYSIOLOGY

PA 1. The potential of deficit irrigation for coffee (*Coffea arabica* L.) production in Ethiopia

Tesfaye Shimber and M.R. Ismail
Jimma Agricultural Research Center, P.O. Box 192, Jimma, Ethiopia.
(E-mail: tesfayeshimber@yahoo.com)

Erratic distribution of the seasonal rain fall and recurrent droughts are the major problems encountering coffee production in Ethiopia. Besides, shortage of water resources for irrigation during the dry spells makes the situation more difficult. In order to address the problem, three irrigation regimes (partial root zone drying, PRD, normal deficit irrigation, NDI and full irrigation or well watering, WW) were evaluated in a field using a widely adaptable and high yielding coffee (*Coffea arabica* L.) cultivar (cv. F-59) at Jimma Agricultural Research Center. WW resulted in considerably higher crop yield. However, the difference between WW and PRD was not significant, and yet PRD and NDI significantly improved the quality of coffee beans. In addition, PRD saved 50% of the irrigation water required for WW and resulted in significantly higher irrigation water use efficiency (IWUE). On the other hand, in a separate experiment with two supplemental irrigation practices (supplemental full irrigation, SFI and supplemental deficit irrigation, SDI) and a rain-fed culture during the dry season, it was observed that SFI resulted in significantly higher crop yield, though the difference between SFI and SDI was not significant. Besides yield advantage, overall quality of the crop was substantially improved and the amount of irrigation water applied was considerably reduced by SDI compared to the SFI practice. Hence, it was concluded that PRD and SDI seem effective deficit irrigation strategies that could save water, increase IWUE and improve crop quality without a significant reduction in crop yield in areas where water is scarce for irrigation and the dry spells are prolonged.

Keywords: *Coffea arabica*; deficit irrigation; IWUE; NDI; PRD; RF; SFI; SDI; WW.

PA2. Review of research achievements on coffee intercropping with other crops in the south and southwest of Ethiopia

Taye Kufa, Anteneh Nestere, Tesfaye Shimber, Endale Taye and Alemseged Yilma
Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia

In Ethiopia, the size of farmland owned by small-holding coffee growers is very limited, hardly exceeding half a hectare. Hence, intercropping is one of the traditional cropping systems used to diversify and increase crop production per unit area and/or per year. In this line, various investigations on coffee intercropping with other crops have been conducted with the objectives to evaluate the agronomic and economic benefits of the practice at Melko-Jimma and its sub-centers. At Melko-Jimma, coffee cultivars were intercropped with *enset*, potato, sweet orange and avocado, while studies on coffee intercropping with spices (ginger and turmeric) and *enset* were undertaken at Tepi and Wenago, respectively. The results depict that intercropping did not significantly affect growth and development of coffee trees when planted in proper combinations. Among the coffee cultivars, the compact types were more suitable for intercropping to sustain increased crop yields over crop years. Moreover, higher crop yield advantages were found from intercropped plots as compared with sole stands. This was particularly noticed for the annual crops at the early stages and with decreased coffee populations. Similarly, the gross money field benefits were greater due to the coffee intercropping with potato and spices than the sole coffee plots. As a whole, the research findings reveal that coffee intercropping with locally dominant cash and food crops was found to be agronomically and economically beneficial under experimental conditions in the south and southwest of Ethiopia. Therefore, depending on the suitability of the area and the priority of the farmers, coffee intercropping with other compatible crops can be practiced as an important remedy to increase crop production and economic returns, particularly in the garden coffee production system of the country.

Key words: Coffee intercropping, economic benefit, land equivalent ratio, relative yield.

PA3. Effects of genotype and fruit maturity stage on caffeine and other bio-chemical contents of arabica coffee

Endale Taye, Behailu Welde-Senbet, Bayetta Belachew and Fabrice Davrieux
Jimma Agricultural Research Center P. O. Box 192.
(Corresponding author: endaletw@yahoo.com)

In an attempt to investigate the impact of genotypes and fruit maturity stages on caffeine content and other important bio-chemical (chlorogenic acids, trigonelline, fat and sucrose) constituents of Arabica coffee, two set of laboratory experiments were conducted in 2005 in Coffee and Cacao Research Lab of CIRAD. In the first experiment high performance liquid chromatography techniques were used for quantification of caffeine content of green coffee beans. Where as in the second experiment near infra-red spectroscopy (NIRs) finger print was employed for the rapid prediction of caffeine, chlorogenic acids, trigonelline, fat and sucrose content of green coffee beans. Six Arabica coffee genotypes *viz.* 74208, 75227, 74143, 7334, 74159 and 74148 which were harvested at three fruit maturity stages (un-ripe, fully-ripe, and over-ripe) were used for both experiments. The results revealed that significant ($P < 0.01$) variation in caffeine content was detected among coffee genotypes in each experiment. Highest and lowest percent caffeine contents were detected in 75227 and 74208 coffee genotypes, respectively. Likewise, significant ($P < 0.05$) variation in caffeine content was also noted in response to stage of fruit ripeness for the conventional analysis. In these cases, lowest caffeine content was detected in un-ripe coffee beans. Though variation in caffeine content between fully-ripen and over-ripen beans were non-significant, inferior result was obtained in over-ripen beans. Results obtained with near infra-red spectroscopy showed significant ($P < 0.05$) differences in chlorogenic acids, trigonelline, fat and sucrose in response to genotypic difference. However, stage of ripeness did not affect the biochemical constituents except for sucrose content. Further research on diverse Arabica coffee genetic resource of the country should continue with the prime objective to identify genetically decaffeinated or genotppes with low caffeine content.
Key words: Genotypes, stage of fruit ripeness, caffeine, chlorogenic acids, trigonelline

PA4. Investigations in to major physiological disorders of coffee in southwestern Ethiopia: A review

Tesfaye Shimber, Taye Kufa, Endale Taye, Anteneh Nestere and Alemseged Yilma
Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia.

There are some physiological disorders in coffee plants induced by different factors, such as poor management and seasonal variability in climatic factors, such as rainfall, and temperature fluctuations. Crinkle leaf, leaf rolling and branch die-back are among the major physiological disorders affecting coffee production in most parts of Ethiopia. Crinkle leaf incidence (score: 1 – 5 scale) was found to be highest in spring season (1.96), at higher altitudes (2.09), in unshaded fields (2.80) and on compact coffee types (1.65). On the other hand, leaf rolling, which is primarily induced by higher evaporative demand, was observed to be affected by soil moisture gradient, coffee type (cultivar), spacing and leaf position with in a canopy. Similarly, the novel coffee branch die-back was found to be a series problem causing considerable yield reduction in poorly managed coffee fields. Its intensity was as high as 33.53 % in open stands, 40.00 % in weed infested fields and more severe in winter season. Therefore, results of some previous research works reveal that the major physiological disorders in coffee can be controlled or at least significantly minimized by applying such improved agronomic practices as timely control of noxious weeds, soil and moisture conservation practices, provision of moderate shade level, mulching and adequate soil

fertilization. In addition to this, planting adaptable coffee cultivars in recommended agro-ecological zones can also alleviate the problems.

Keywords: Branch die-back, crinkle leaf, leaf rolling, physiological disorder.

PA5. Field Management Research on Arabica Coffee in Ethiopia: II. A Review of Forest Coffee Management

Anteneh Netsere, Endale Taye, Taye Kufa, Tesfaye Shimber
Jimma Agricultural Research Center, P. 0. Box 192, Jimma, Ethiopia

Rejuvenation practices, *viz.* topping, agobiado and eskeletamento increase yield of forest coffee by 43.2, 40.4 and 38.0 and 12.5, 8.4 and 4.7% over conventional clean stumping and control (not rejuvenated trees), respectively. Earlier stumping immediately after harvesting tends to promote yield. Coffee trees stumped at 50 cm height had slightly higher coffee yield than the 30 cm stump. Tied ridge gave respective yield advantage of 19.0 and 23.6% over untied ridge and traditional flat land planting. Maintaining 3-4 numbers of bearing heads per tree or stump and adjusting population to the respective optimum densities of 4000-5000, 5000-6000 and 7000-8000 trees ha^{-1} at Tepi, Jima, and Metu and Agaro had maximized productivity of forest coffee. Forest coffee stands; however, had not respond to mineral fertilizer and weed management.

Key words: Bearing heads, forest coffee, population density, rejuvenation

PA6. Fruit Phenology and Factors Affecting Bean Size in Arabica Coffee: It's Implication to Crop Quality

Tesfaye Shimber, Alemseged Yilma, Anteneh Netsere, Endale Taye and Taye Kufa
Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia.

Bean size is among the most important attributes determining coffee quality. It can be affected by several factors including agronomic practices, as the normal fruit growth and development rithum can be modified by such factors as availability of soil moisture. In line with this, series of experiments have been carried out at Jimma Agricultural Research Center with the objective of determining the different growth stages (phenology) of coffee fruits and the impact of various factors on ultimate size of coffee beans. Results of these experiments showed that coffee fruit phenology assumed a sigmoid growth curve, which was common for all parameters (fruit length, breadth, depth, volume and fresh and dry weights). The pin head stage (the first eight weeks after anthesis) and the endosperm growth stage (16 – 26 weeks) were characterized by a slow, static and very minimum or no increment in size and weight, while a rapid growth rate (active fruit expansion phase) was observed between 9 – 15 weeks in both open and compact coffee types. The endosperm hardening and ripening phases were found to be between 25 and 32, and 33 and 37 weeks, respectively, after anthesis. However, these fruit growth stages were observed to be affected (enhanced or retarded) by soil moisture regime (application of full or deficit irrigation). Besides varietal differences, it was observed that bean size (length, breadth, depth and volume) was significantly affected by number of bearing heads per tree (multiple stems), fruit position on branch nodes and type of the branch (primary, secondary or tertiary).

Key words: Anthesis, Arabica coffee, bean size, fruit phenology, crop quality

COFFEE SOILS, NUTRITION, SOIL ANA WATER MANAGEMENT

PS1. Soil and Water Conservation under Coffee Based Cropping System in Southwestern Ethiopia

Tesfaye Yaekob, Tesfu Kebede, Solomon Endris
Jimma Agricultural Research Center, P.O. Box 192, Jimma, Ethiopia
(Corresponding Author: tesfayeyt@yahoo.com)

This paper reviews the erosion, soil and water conservation research activities conducted under coffee based cropping system in Southwest Ethiopia. The effect of canopy cover of different crops on runoff and soil loss was evaluated at Melko for three cropping seasons (1996-1998). The soil loss (15.5 and 15.7 ton ha^{-1}) measured in coffee plot was above the acceptable soil loss rate in first and second seasons since the canopy was not good enough to protect the soil from direct rainfall impact. Since the canopy cover improved in the third season, the soil loss (2.9 ton ha^{-1}) was in the acceptable range. The study showed that there is a need of integration of cover crops with coffee seedlings to improve the ground cover in the early seasons to sustain the production system. Another experiment was conducted to evaluate different techniques (soil-bund, vetivar-hedgerow, and bench-terrace) under un-shaded coffee plantation at Melko for three cropping seasons (2001-2003). In the second and third cropping seasons, the farmer's practice was effective in reducing soil loss (0.1 and 0.03 ton ha^{-1}) since the ground cover was good enough to protect the soil. Vetiver-hedgerow (3.66 ton ha^{-1}) and bench-terrace (4.59 ton ha^{-1}) were only effective in the third season. Soil-bund was not effective at all. It was found that biological measures were better than the physical one in controlling soil erosion. The farming system considerably contributes not only to the hard currency of the country but also to resource conservation of the region. Therefore, research should be strengthened to tackle the challenges.
Key words: canopy cover, erosion controlling techniques, runoff, soil loss, un-shaded coffee

PLANT PROTECTION (Pathology)

PP1. Dynamics and Importance of Minor Diseases of Coffee in Ethiopia: A Review

Demelash Teferi, Girma Adugna, Chala Jefuka, Arega Zeru, Sisay Tesfaye, Mesfin Seyoum
Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia
(Corresponding author: demelashteferi@yahoo.com)

Assessment of minor diseases of Coffee was conducted since 1968 with the establishment of crop protection unit at Jimma Agricultural Research Center far 12 minor Coffee diseases were identified and found with varying intensities in different coffee producing localities. Coffee leaf rust, Fusarium bark disease and bean discoloration are potentially important disease. Coffee varieties should be strictly tested for their level of resistance to minor diseases before their release.
Key words: *Coffea arabica*, Ethiopia, importance, minor coffee diseases,

PP2. Occurrence of Major Coffee Diseases in Afromontane Rainforest Coffee of Ethiopia

Arega Zeru [1*]; Fassil Assefa [2]; Girma Adugna [1]; Holger Hindorf [3]
[1] Jimma Agricultural Research Centre, P.O.Box 192, Jimma, Ethiopia
[2] Biology Department, Addis Ababa University, P.O.Box 1176, Addis Ababa, Ethiopia.
[3] Institut für Pflanzenkrankheiten, Nussallee, D-53115 Bonn
(*Corresponding author: aregazeru@yahoo.com)

Coffee berry disease (*Colletotrichum kahawae*), coffee wilt disease (*Gibberella xylarioides*) and coffee leaf rust (*Hemileia vastatrix*) were assessed from July to September 2005 in afromontane rainforest coffee areas of Ethiopia to estimate their occurrence. The diseases were prevalent in all surveyed forest coffee areas of Ethiopia: Harenna, Bonga, Berhan-Kontir and Yayu. Depending on the forest coffee area the mean percent incidence and severity of coffee berry disease (CBD) ranged from 6.0 to 40.0% and from 2.0 to 17.9% at Berhan-Kontir and Bonga, respectively. The mean incidence of coffee wilt disease (CWD) varied from 2.4% at Berihan-Kontir to 16.9% at Yayu forest coffee areas. The mean incidence of coffee leaf rust (CLR) also varied from 32.2% at Berihan-Kontir to 96% at Harenna forest coffee areas. The results have depicted that integrated management of major coffee diseases should be given attention for sustainable conservation and wise use of forest coffee in afromontane rainforest of Ethiopia.
Key words: afromontane rainforest coffee, disease occurrence, incidence, severity

COFFEE DIVERSIFICATIONS

PD1. A Review of Root and Tuber crops research achievements, challenges and future prospects in Southwestern Ethiopia:

Belay Yemanebirhan[1], Wondyifraw Tefera[1], Haileab Asebeha [1]and Abate Guangul[1]
Jimma Agricultural Research Center, P.O.Box 192, Jimma Ethiopia.
(*Corresponding author: belyemane@yahoo.com)

Root and tuber crops are parts of the traditional food system for millions of peoples in Ethiopia. Especially, they are the main components in the feeding habits of the people in the southern, southwestern and western parts of the country. They give greater yield per unit area than the major grain crops widely produced in the area. They can also support higher density of populations than other food crops when produced on small plots of lands. Research on root and tubers crops at Jimma Agricultural Research Center (JARC) was started as part of the coffee diversification program for the southwestern region. The major areas of research given attention since the inception of the program were germplasm collection and/or introduction, maintenance, variety screening for adaptation and high yield and identification of agronomic and compatible management practices for the promising cultivars. Therefore, some accomplishments have so far been made with regard to the afore stated areas of research. Accordingly, 110 taro, 45 cassava, 15 sweet potato,73 tannia, 33 yam, 47 aerial yam, 36 "Ethiopia dinich" and 22 enset accessions had been collected/or introduced so far from different sources and are maintained at the horticultural field of JARC. Most of these accessions were also characterized, evaluated, and are currently ready for further improvement programs. Consequently, fulfilling the entire criterion desired for release, two taro varieties (Kiyaq and Denu) were officially released by the National Variety Release Committee for South Western Ethiopia. From a similar effort two potato varieties that were found well adapted and

suitable in this part of the country (Guassa and Jallenie) are widely spreading in the area at the moment. Framers organized in farmers' research group(FRG) have started to produce and supply seed potato and generate lucrative incomes, beside averting the critical shortage of seed potato in these areas. On top of these, three cassava, one sweet potato and three yam cultivars were also selected and recommended as high yielding and adaptable to this same region. All these materials had been and still are multiplied and distributed to the local farmers through governmental and non-governmental organizations involved in rural development programs. Furthermore, for some of these crops, improved cultural practices such as appropriate spacing/ plant population, and best types of planting material were also identified and recommended. This review tries to exhibit the successful integration of root and tuber crops in the food system of the people in the major coffee growing regions of southwestern region of the Ethiopia. Therefore, in order to successfully utilize and exploit the food and income generating potential of these crops effectively, stakeholders, research partners, development workers and other institutions should give peculiar attention and hence assist the current efforts regarding the development of appropriate technologies for the improvement, production and processing of these crops.

Key words: Agronomic recommendation, Ethiopia, food security, root and tuber crops, variety

PD2. Lowland Pulses Breeding and Experiences in Soybean Scaling Up In Coffee Based Farming System

Leta Tulu, Tesfa Bogale and Abush Tesfaye
Jimma Agricultural Research Centre, P. O. Box 192, Jimma, Ethiopia
(Corresponding author: letatb@yahoo.com)

Haricot bean and soybean are the two major lowland pulses grown in association with coffee and cereals in coffee based farming system. Grown as intercrops they play significant role in supporting coffee producers meet their food and cash requirements compensating for the absence of income from young and stumped coffee. The main objective of pulse breeding is to develop well adapted and high yielding improved varieties that enable coffee farmers to secure food self sufficiency and provide options that support and strengthen sustainable and broad based coffee economy. Efforts made in this line have resulted in the release of high yielding varieties of food and export types. Similar work done to demonstrate and popularize these improved varieties has, however, failed to succeed in transferring the technologies. Lack of know how on processing and utilization of soy bean at small scale farmers level was, among others, the major barrier. A new approach was started in 2000/2001 to demonstrate and popularize packages of technologies and food preparation method in soy bean in collaboration with food science department in the Agriculture and Rural Development Bureau of Jimma and Illubabor zones. This was further supported and accelerated by wider scaling up of the technologies launched in 2004 with the participation of different stakeholders. The approaches created more awareness on the utilization aspect and promoted dissemination of the technologies. More than 400 and 3, 000 hectares of land were planted to soy bean in Jimma and Illubabor zones, respectively, in 2006. Production of soybean was estimated at 57, 000 quintals in Illubabor zone alone. Lack of market as a result of information gap between producers and consumers was observed as the major constraint to further scaling up of the technologies. This paper reviews efforts made in developing improved varieties of haricot bean and soybean and experiences in scaling up of soybean technologies in coffee based farming system of Ethiopia.

Key words: Coffee based farming system, improved varieties, low land pulses, technology scaling up