

# **3<sup>rd</sup> International Conference of Agricultural Sciences Sabaragamuwa University of Sri Lanka**



***Power of Research : Force for Tomorrow's Agricultural Development***

**8<sup>th</sup> & 9<sup>th</sup> December, 2016**

## **Extended Abstracts**



**AgInsight 2016, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka, PO Box 02,  
Belihuloya, Sri Lanka. 70140**

## **Proceedings of the 3<sup>rd</sup> International Conference of Agricultural Sciences 2016**

Responsibility of the content of extended abstracts included in this publication remains with the respective authors. Views and opinions expressed in the extended abstracts are of the respective authors' not Sabaragamuwa University of Sri Lanka's.

### **Published by:**

Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka,  
P. O. Box 02,  
Belihuloya,  
70140.  
Sri Lanka,

<b>Editor-in-chief</b>	: Professor Rohana P. Mahaliyanaarachchi
<b>Website</b>	: <a href="http://www.agit.sab.ac.lk/">http://www.agit.sab.ac.lk/</a>
<b>Email</b>	: <a href="mailto:agit@agri.sab.ac.lk">agit@agri.sab.ac.lk</a>
<b>Telephone</b>	: + 94 45 22 800 75
<b>Fax</b>	: + 94 45 22 800 41
<b>ISBN</b>	: ISBN 978-955-644-053-9



# **3<sup>rd</sup> International Conference of Agricultural Sciences**

**8<sup>th</sup> -9<sup>th</sup> December 2016**

***“Power of research: force for tomorrow’s agricultural development”***

## **Extended Abstracts**

### **Thematic Areas**

Agribusiness and Agricultural Economics

Agricultural and Agri-Environment

Livestock and Aquaculture

**Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka,**

**P.O. Box 02,  
Belihuloya, 70140.  
Sri Lanka.**



## CONFERENCE SECRETARIAT

<b>Chairman</b>	: Professor Rohana P. Mahaliyanaarachchi
<b>Coordinator</b>	: Dr. GDK Kumara
<b>Deputy Coordinator</b>	: Dr. PKGSS Bandara
<b>Secretary</b>	: Dr. RK Mutucumarana
<b>Assistant Secretary</b>	: Ms. BCH Madhuwanthi Ms. MS Elapata
<b>Secretarial Assistance</b>	: Ms. WGI Lakmali Ms. HGCL Gamage

## EDITORIAL BOARD

Prof. LP Vidhana Arachchi (Chair)  
Prof. Rohana P. Mahaliyanaarachchi  
Prof. AAY Amarasinghe  
Prof. DMA Guraratne  
Prof. M.Esham  
Prof. DAM De Silva  
Prof. PMAS Karunarathne  
Prof. PI Yapa  
Mr. Harsha Peiris (Copy Editor)  
Mr. JS Senadheera (Copy Editor)

Cover page and Layout : Prasad C. Iddamalgoda



3<sup>rd</sup> International Conference of Agricultural Sciences - 2016,  
Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka.

*"Power of Research: Force for Tomorrow's Agricultural Development"*

## Contents

Agribusiness And Agricultural Economics - Professional Forum	1
Invited Presentation	
The Strategy of Beautiful Village and the Sustainable Development of Rural Tourism in China: Based on the empirical study of Villagers' Perceptions	
<i>Cheng Li</i>	2
Invited Presentation	
A Formula for Sugarcane Pricing Policy for Sri Lanka	
<i>AP Keerthipala</i>	3
Knowledge and Training need of Women for Dairying in Tribal Hill blocks of Uttarakhand State, India	
<i>S. C. Tripathi, Pratibha Singh and Avadhesh Kumar</i>	4
Supply Chain Study of Eight Agricultural Crops In India's One of the Most Backward Tribal Regions	
<i>M. V. Durga Prasad and Shriprakashsingh Rajput</i>	7
The Evolution of Agri-Tourism Practices In India: Some Success Stories	
<i>Soumi Chatterjee and M. V. Durga Prasad</i>	9
Capital Bases Influencing Livelihood Strategies among Smallholder Farmers in Sri Lanka	
<i>H.M.U.N. Herath, T. Parfitt, P.O. Reilly and A.S. Karunaratne</i>	11
Institutional Landscape and its Role in Underutilized Crops (UUCs) Cultivation in Uva Province, Sri Lanka	
<i>Arosh Bandula, Achini De Silva, Asha Karunaratne and Patrick Oreiley</i>	14
Drivers and Barriers of Agro-tourism: Revisiting the Potentials of Agriculture amidst Intensifying Socio-Economic Mobilities in Sri Lanka	
<i>Ruwan Ranasinghe and Li Cheng</i>	18
Livelihood Analysis: A Case of Underutilized Crops Farmers in Moneragala District	
<i>Champika Jayaweera and Achini De Silva, Partick Oreiley and Asha S. Karunaratne</i>	20
Creating Brand Equity: A Study on Rice Based Value Added Products	
<i>Mohamed Ismail Mujahid Hilal</i>	26
Potentials of Jalapeno ( <i>Capsicum annuum</i> ) cultivation: Case Study of Udayarkattu and Vishwamadu Grama Niladhari Divisions (GN divisions) in Mullativu district	
<i>Arosh Bandula, Achini De Silva</i>	30
Human Health Effects of Agricultural Pollution: A Review	
<i>Ranmalee Bandara and P.I. Yapa</i>	33
Agriculture and Agri-Environment - Professional Forum	
Toward the Genetic Improvements of Grain Quantity and Quality in Rice	35
<i>U.I.P. Perera and Naoki Hirotsu</i>	36

# Agriculture and Food Post Production Systems in Asia-and the Pacific in the Next Quarter of the Century: Emerging Trends, Challenges, Opportunities, and Way Forward

<i>Prof. Keerthi Palipane</i>	37
Culture Filtrates of <i>Alternaria</i> spp. as Natural Herbicides for Management of parthenium Weed	
<i>Arshad Javaid, Tahira Mubeen and Uzma Bashir</i>	39
Evaluation of Field Efficacy of Selected Insecticides against Brinjal shoot and Fruit Borer, <i>Leucinodes orbonalis</i> Guenee	
<i>Niranjana R.F. Devi M and Philip Sridhar R</i>	42
Anthraxnose Resistance of Chilli Accessions Available in Sri Lanka	
<i>K.A.S.I. Kumari , D.M.J.B. Senanayake, C.M. Nanayakkara, A. Balasuriya, W.A.R. Dammika, W.M.K. Fernando, W.M.S.B.K. Wijerathne, P.J.K. Dasanayake</i>	45
Evaluation of Different Weed Management Practices in Machine Transplanted Rice Cultivation	
<i>R.M.U.S. Bandara, A.S.K. Abeysekara, W.M.U.B. Wickrama, H.M.M.K.K.H. Dissanayaka, A.N. Siriwardana, N.M.D.P. Nawarathna and Y.M.S.H.I.U De Silva</i>	48
Distribution of Myrothecium Leaf Spot of Bitter Gourd in Different Agro-ecological Zones of Punjab	
<i>Salik Nawas Khan, Sumera Naz and Shumaila Farooq</i>	51
Eco-geographic Distribution of Proso Millet ( <i>Panicum miliaceum</i> L.) in Sri Lanka	
<i>L.M.H.R. Alwis, Sean Mayes , Ho Wai Kuan, A.S. Karunaratne</i>	54
Rainfall Trends over Proso millet ( <i>Panicum miliaceum</i> L.) Growing Regions in Sri Lanka	
<i>Eranga M. Wimalasiri, M.J. Ashfold, Sue Walker and Asha S. Karunaratne</i>	57
Estimation of Combining Ability, Additive and non-additive Genetic Effects of Yield and some Yield Contributing Traits in Chilli ( <i>Capsicum annuum</i> L.) Inbred Lines	
<i>H.M.S.N. Herath, W.M.W. Weerakoon, A.M. Perera, H.M.S. Bandara</i>	60
Agribusiness And Agricultural Economics - Student Forum	63
Impactful Research – Everyone's Priority	
<i>Ajith de Alwis</i>	64
Farmers' Perception on the Gender of the Agriculture Instructors for Effective Technology Transferring in Paddy Farming Systems in Anuradhapura District, Sri Lanka	
<i>D.M.K. Dulanja, G.A.S. Ginigaddara, N. Somarathna, S.M.C.B. Karalliyadda and S.P. Dissanayaka</i>	66
Low Profitability in Tea Industry: A Case in Upcountry Cluster - 1 of Elpitiya Plantation	
<i>A.I.Y. Lankapura, Y.M. Wickramasinghe and A.M.K.R. Bandara</i>	69
Evaluation of Issues and Challenges of Tea Smallholders in Kegalle District in Sri Lanka	
<i>A.A.C.H. Dharmasena, A.G.L. Dilhani S.U. Pinnagoda, H.M.P. Madushani, R.M.J.C. Rathnayake, S.H.P. Malkanthi</i>	71
Flower Retailing: A Case of Flower Vendors Based In Religious Institutions	
<i>N.U.M. Perera, P.E. Kaliyadasa, A.M.C. Amarakoon, J.K.M.D. Chandrasiri and S.M.P.C. Padmini</i>	74

Improving Crop Yields And Economic Returns of Coconut by Intercropping with <i>Gliricidia</i>	
<i>H.M.D.E.H. Mudalige and H.S.R. Rosairo</i>	78
Impact of Provision of Food Safety Information Overtime on Consumer Demand	
<i>K.D.T.M. Gunawardana and U.K. Jayasinghe-Mudalige</i>	80
An Assessment of Cultural Services of Urban Coastal Ecosystems: Value of View as Recreation and Tourism Service	
<i>T.P.S.R. Guruge, L.P.P.S.G. Senarathne, U.K. Jayasinghe-Mudalige and Devaka Weerakon</i>	82
Banana Value Delivery Network; Study on Recognizing What Cause the Imperfection in Value Delivery Network Present in Embilipitiya–Ratnapura District	
<i>W.M.T.B. Weddagala, B.M.R.L. Basnayake, H.M.L. Wijesekara</i>	
<i>N.R.D.S. Dharmathilaka, K.K.A. Kiriveldeniya and D.A.M. De Silva</i>	85
Urban Consumers' Demand for Fruit Attributes using Grapes, Sweet orange, Pear and Pomegranate: A Conjoint Analysis	
<i>R.G.S.M. Ranasinghe, J.C. Edirisinghe and R.H.M.K. Rathnayake</i>	89
Mobile Market Decision Support System and its Application in Agricultural Marketing in Sri Lanka	
<i>W.M.T.B. Weddagala, B.M.R.L. Basnayake, H.M.L. Wijesekara and</i>	
<i>N.R.D.S. Dharmathilaka, K.K.A. Kiriveldeniya and D.A.M. De Silva</i>	92
Factors Affecting the Occupational Health and Safety Performance: A Case Study in a Fruit and Vegetable Processing Factory in Sri Lanka	
<i>M.S. Elapata, R.P. Mahaliyanaarachchi</i>	95
Major Drawbacks on the Perception of Fishermen for Culturing of Carp Species in Inland Freshwater Reserviores in Galenbindunuwewa Area	
<i>B.R. Jayathilaka, R.H.G.R. Wathsala and A.P.S. Fernando</i>	98
Agriculture and Agri Environment - Student Forum	100
Effect of Biofilmed Biofertilizers on the Development of Leaf Rot and Powdery Mildew Diseases of <i>Gerbera jamesonii</i>	
<i>M.T.N. Wickramage, K.A.C.N. Seneviratne and P.K. Dissanayake</i>	101
Effect of Oyster Mushroom ( <i>Pleurotus</i> Spp.) and Spent Mushroom Substrate (SMS) Onroot Knot Nematodes ( <i>Meloidogyne</i> Spp.)	
<i>V.N.M. Wickramasinghe, M.L.M.C. Dissanayake, K.M.D.W.P. Nishantha and Ingra Eriyagama</i>	104
Common Diseases of Orchid Grown in Western and Sabaragamuwa Provinces: Identification, Pathogenicity and Molecular Detection Techniques	
<i>H.S.D.E.H. Weerasinghe, M.L.M.C. Dissanayake and B.M.V.S. Bassnayake</i>	107
Isolation and Characterization of Rhizobia from Leguminous Plants and Determining their Plant Growth Promoting (PGPR) Traits	
<i>S.H. Wijesundera, A.P. Halmillawewa</i>	110
Development of Local Detection Kit for Banana Bunchy Top Virus	
<i>H.S.B. Piyasiri, C. Ranasinghe, R.T Ekanayake and M.G. Thammitiyagodage</i>	113

Effect of Anti-transpirant In Sustaining Rubber Leaf Physiology Under Dry Climatic Conditions	
<i>P.S.V. Rupasinghe, E. Munasinghe, N.S. Withanage</i>	116
Over Dominance of <i>Alstonia macrophylla</i> Walla. ex G. Don in Pine Plantations at Lower Hantana, Sri Lanka	
<i>Jayamini Jayawardhane, A.M.T.A. Gunaratne</i>	120
Development of Bg 94-1 Transgenic Rice Containing OSDREB2A Gene	
<i>D.I.M. Yahampath, and G.A.U. Jayasekara</i>	124
Microscopic Observation and Study of Commercially Available Bee Honey Samples for the Chemical Properties as per Sri Lankan Standard Specification (SLS 464: 1979)	
<i>K.G.R. Prathibha, T.D.M.C.K. Wijayasiriwardana and P.K. Dissanayake</i>	127
Aloe Vera Gel Coating to Extend the Shelf Life of Mango ( <i>Mangifera indica</i> ) Var. Willard	
<i>D.M.A.E.I. Dewagedara, S.A.E.C. Wijesinghe and R.H.M.K. Ratnayake</i>	129
Small Holder Farming System Productivity Model for a hypothetical farm at Monaragala District in Sri Lanka	
<i>Helitha H. Nilmalgoda, A.S. Karunaratne, S. Walker and P. O'reilly</i>	131
Identification of the Groundwater Potential Zones in Vavuniya District Using GIS	
<i>R. Ramya, A. Nanthakumaran and I.P. Senanayake</i>	135
Spatial Variability Studies of Selected Soil Properties for Crops Land Management in Ellapamaruthankulam	
<i>D. Kulendran and P. Loganathan</i>	138
Study on Bio Mass Energy Potential of the Kandyan Home Garden (KHG) System	
<i>Dulanja Abeysinghe, Sue Walker and Asha S. Karunarathne</i>	141
Efficiency of Biochar in Immobilizing Lead and Cadmium in Municipal Solid Waste Compost: Will the Raw Materials and the Pyrolysis Temperature Have an Impact on Immobilization Potential?	
<i>P.M.K.T. Kaushalya, P.I. Yapa and W.M.J. Weeraratne</i>	144
Effect of Soil Moisture on the Dry Matter Production and Partitioning in Two Black Pepper ( <i>Piper nigrum</i> L.) Cultivars (Panniyur-1 and Gampaha Selection) at the Early Vegetative Growth Stage	
<i>S.K.S.N. Siriwardhana, K.G.A.P.K. Amarasinghe and D.C. Abeysinghe</i>	149
Compost as a Phosphate Fertilizer	
<i>B.M.A.V. Gunarathne, L.P. Vidhana Arachchi and P. Weerasinghe</i>	151
Livestock and Aquaculture - Student Forum	153
Microbial Safety of Oysters ( <i>Crassostrea madrasensis</i> ) Harvested from Kalpitiya Lagoon in Sri Lanka	
<i>G.L.A. Subashini, K.W.S. Ariyawansa, P.H. Ginigaddarage, K.S. Hettiarachchi and C.N. Walpita</i>	154
Effect of Hydrothermally Processed <i>Citrullus lanatus</i> (Water Melon) Seed Meal on Growth Performance of <i>Cirrhinus mrigala</i> Fry.	
<i>Pavithra Attanayake and T.V. Sundarabarathy</i>	156



Analysis of Nutritional Value and Study of Post Harvest Techniques of Malabar Sprat ( <i>Ehirava fluviatilis</i> )	
<i>Maduwanthi Weerasekara and T.V. Sundarabarathy</i>	159
Effect of Different Heat Treatment Methods on the Nutritional Value and Microbiological Safety of Rice Bran Incorporated Poultry Feed	
<i>K.I.S. Senadheera and P.N. Yapa</i>	162
Development of a Probiotic Cereal Bar using Fermented Rice Bran with <i>Lactobacillus</i> <i>delbrueckii</i> subsp. <i>bulgaricus</i>	
<i>P.A.H.N. Wijesinghe and P.N. Yapa</i>	164

## PANEL OF REVIEWERS

Prof. A.A.Y. Amarasinghe  
Prof. N.S.B.M. Attapattu  
Prof. (Mrs.) Devika Malkanthi De Costa  
Prof. D.A.M. De Silva  
Prof. Mangala De Zoysa  
Prof. U. Edirisinghe  
Prof. M. Esham  
Prof. D.M. Anil Gunaratne  
Prof. L.H.P. Gunaratne  
Prof. Udith K. Jayasinghe-Mudalige  
Prof. P.M.A.S. Karunarathna  
Prof. (Ms) N.S. Kottearachchi  
Prof. K.L. Wasantha Kumara  
Prof. R.P. Mahaliyanaarachchi  
Prof. M.M.M. Najim  
Prof. H.H.D.N.P. Opatha  
Prof. Sriyani Pieris  
Prof. Bruce Prideaux  
Prof. S. Subasinghe  
Prof. Lal P. Vidhana Arachchi  
Prof. W.A.D.P. Wanigasundera  
Prof. Sudas D. Wanniarachchi  
Prof. Mahinda Wijeratne  
Prof. P.I. Yapa  
Dr. (Mrs.) N.R. Abeynayake  
Dr. E.D.N.S. Abeyrathna  
Dr. (Mrs.) L.M.H.R. Alwis  
Dr. P.L.A.G. Alwis  
Dr. A.D. Ampitiyawatta  
Dr. (Ms.) N.S. Aratchchige  
Dr. K.W.S. Ariyawansa  
Dr. Aruna Shantha  
Dr. P.K.G.S.S. Bandara  
Dr. C.K. Beneragama  
Dr. W.S. Botheju  
Dr. (Mrs.) W.A. Harinda Champa  
Dr. Dileepa De Croos

Dr. Vilasini W. De Silva  
Dr. (Mrs.) M.L.M.C. Dissanayake  
Dr. P.K. Dissanayake  
Dr. Jagath C. Edirisinghe  
Dr. E.M.U.W. Jayalath B. Ekanayake  
Dr. (Mrs.) G.A.S. Ginigaddara  
Dr. (Ms.) Sunethra K. Gunathilake  
Dr. K.S. Hemachandra  
Dr. H.M.L.K. Herath  
Dr. H.M.S.K. Herath  
Dr. Venura Herath  
Dr. (Ms.) N.Y. Hirimuthugoda  
Dr. Barana C. Jayawardene  
Dr. (Ms.) J.M.C.K. Jayawardhana  
Dr. T.S.P. Jayaweera  
Dr. M.G. Kularathna  
Dr. Ruvini K. Mutucumarana  
Dr. A.A.F.L.K. Perera  
Dr. G.A.S. Premakumara  
Dr. B.V.R. Punyawardhane  
Dr. (Ms.) C.S. Ranasinghe  
Dr. (Ms.) Nalika S. Ranatunge  
Dr. Laxman Rodrigo  
Dr. W.S.M. Seneviratne  
Dr. H.A. Sumanasena  
Dr. L.D.B. Suriyagoda  
Dr. E.P.N. Udayakumara  
Dr. (Mrs.) V.R.M. Vidhana Arachchi  
Dr. C.N. Walpita  
Dr. Heshan V.A. Wickramasuriya  
Dr. H.T.R. Wijesekara  
Dr. (Mrs.) L.L.W. Chandi Yalegama  
Mr. L. Amaralal  
Mr. B.P.A. Jayaweera  
Mr. J.B.D. Aruna P. Kumara  
Mr. G. Weerakody



**Message from the Chief Guest**  
*Professor (Dr.) Yang Gaung-fu*

It is with great pleasure to be associated with the 3<sup>rd</sup> International Conference of Agricultural Sciences, organized by the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka.

It is gratifying to note that the theme of the 3<sup>rd</sup> International Conference of Agricultural Sciences “Power of Research: Force for Tomorrow’s Agricultural Development” explores one of the key areas contributing to the survival of mankind.

This conference offers an ideal platform for the scientists to present their novel research findings in three thematic areas; Agriculture and Agri-environment, Agribusiness and Agricultural Economics and Livestock and Aquaculture. I wish this conference broadly collaborate global research work to overcome the current issues in agriculture sector.

Sri Lanka and China has a strong historical relationship for culture, religion and economy. I wish this conference confers an opportunity to make an everlasting relationship between the Sabaragamuwa University and Central China Normal University-China.

I congratulate the Chairman of the 3<sup>rd</sup> International Conference of Agricultural Sciences, Prof. RP. Mahaliyanaarachchi and his team for the untiring effort offered to make this event a grand success.

Professor (Dr.) Yang Gaung-fu  
Vice President  
Central China Normal University  
Wuhan  
China



## Message from the Vice Chancellor Sabaragamuwa University of Sri Lanka

*Professor Chandana P. Udawatte*

It is with utmost pleasure that I issue this message for the proceedings of the 3rd International Conference of Agricultural Sciences, 2016 and on behalf of the Sabaragamuwa University of Sri Lanka, I would like to extend my warmest welcome to all the participants at the conference.

Sabaragamuwa University of Sri Lanka, being still at its young ages of development, has taken many strides towards fulfilling its mission of searching for and disseminating knowledge, promoting learning, research and training to empower the nation with high caliber graduates. Thus this 3rd International Conference of the Faculty of Agricultural Sciences will be another milestone of the Faculty.

This international scientific forum, will make an opportunity for the undergraduates, academics and researchers to disseminate their latest research findings in Agricultural Sciences. It offers a unique opportunity for scientists to present their research finding and discuss latest research in three thematic areas: Agribusiness and Agricultural Economics, Agriculture and Agri-Environment and Livestock and Aquaculture.

During the sessions, key findings of local as well as international research groups will be presented while eminent scholars from the selected streams will be enlightening the gathering with their findings via plenary talks. Thus, the conference will be an ideal venue to extract knowledge with regard to recent research trends in Agriculture to our academics and undergraduates.

I sincerely hope that the initiative taken by the Faculty of Agricultural Sciences in organizing AgInsight-2016 will motivate many researchers at the national level and international level thereby encouraging them to undertake more interdisciplinary research in future since the current symposium will lay the a solid foundation for such aspects.

Finally I would like to extend a warm sense of gratitude to all those who contributed to AgInsight 2016 with their research findings and to the organizing committee for their untiring efforts to make the conference a successful one.

Professor Chandana P. Udawatte  
Vice Chancellor



3<sup>rd</sup> International Conference of Agricultural Sciences - 2016,  
Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka.

*"Power of Research: Force for Tomorrow's Agricultural Development"*



## Message from the Dean Faculty of Agricultural Sciences

*Dr. HSR Rosairo*

The Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka is proud to announce its third International Conference of Agricultural Sciences (AgInsight 2016) which will be held on 8<sup>th</sup> and 9<sup>th</sup> December 2016 at the premises of the Faculty of Agricultural Sciences in Belihuloya, Sri Lanka. This year's conference endures the theme "Power of Research: Force for Tomorrow's Agricultural Development".

The objective of the conference is to create a centre of attention of delegates with different backgrounds in agricultural research to foster links between different research fields, to create a dialogue and to present their research results and outcomes of development activities in agricultural sciences. Also, this conference offers the opportunity for academics and researchers to present their latest research findings to a wider audience. As such, top agricultural speakers, academics, researchers and industry leaders across Sri Lanka and scholars from overseas will share their views, research findings and innovations. This conference provides opportunity for the delegates to exchange new ideas, applications and experiences face to face, to establish business or research relationships and to find global partnerships for future collaborations.

Sabaragamuwa University of Sri Lanka and industry leaders support this event. Organizing an international event such as this conference is a challenging task. The conference had few hiccups; our keynote speaker from the United Kingdom selected at the beginning fell ill and our chief guest from Japan met with an accident very close to the conference. However, our conference had astounding recoveries thanks to the organizing committee. I congratulate Professor Rohana P. Mahaliyanaarachchi; the chairman, Dr. GD Kapila Kumara; the coordinator, and Dr. Ruvini Mutucumarana; the secretary of the conference and their team for their hard work, attitude and commitment which was the recipe for success of the conference.

Dr. HSR Rosairo  
Dean – Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka.



## Message from Conference Chair

*Professor Rohana P. Mahaliyanaarachchi*

Agriculture research is the most important process in the modern agricultural development and it plays a significant role in improving agricultural production in the rural farming sector. Subsequently it helps to uplift the quality and standard of life of farming communities in rural economies. Further agricultural research can be foreseen as a long term profitable investment for rural agricultural economies. However, it is a necessity that research findings of agricultural research in various sub disciplines to be filtered down to the end users, the farmers to obtain the benefits in terms of improving agricultural productivity and total production.

Modern agricultural information is mainly generated through scientific research. It is considered as an essential input to agricultural education, further research and development and for extension activities. It is a known fact that different types of information is required by different kinds of users for different purposes. The potential users of agricultural information both technological and marketing of agri products include government decision-makers, policy-makers, planners, researchers, farmers, teachers, students, program managers, field workers, wholesalers, retailers, traders, and many more. Therefore, findings of research in agriculture requires a mechanism to collect, process, and disseminate agricultural information to stakeholders. Agricultural conferences or symposia as AgInsight 2016 that open a forum to share research findings of both senior and junior researchers build strong mechanism for dissemination of agricultural information to the audience.

On behalf of the Committee for International Conference on Agriculture sciences- 2016, organized by the Faculty of Agricultural Sciences of Sabaragamuwa University of Sri Lanka I extend to all of colleagues a warm welcome to the International Conference on Agriculture sciences (AgInsight 2016) in the Sabaragamuwa province, Sri Lanka, December 8-9, 2016. AgInsight 2016 will provide an excellent opportunity to discuss and learn about the recent advances in agricultural sciences refers to sustainable farming. The conference will also provide an opportunity for participants to interact with others from different countries, establish contacts, and initiate collaboration among scientists from different parts of the world. I sincerely hope that the deliberations would assist in future policy directives, and planning and implementation of programs in relation to the theme of the conference.

As the conference Chair, I would like to express that the success of the conference depends ultimately on the many people who have worked with us in planning and organizing both the technical program and supporting social arrangements. In particular, I thank the Chief Guest, Guest of Honor, Special guests and Keynote & Guest speakers, all scientists, chairs and members of different committees, and entire team for their hard work to stage AgInsight 2016 and wish the Conference all success!

Professor Rohana P Mahaliyanaarachchi  
Conference Chair and Senior Professor - AgInsight 2016





## Keynote Address of the Inaugural Session

*Dr. Colin Hanbury*

### **Raising Science Publication Impacts, Some Recent Lessons**

#### **Abstract**

The dominance of English in science has led to problems for non-native English speakers in publishing research. Increasing the publication rate in high-ranking journals for agricultural scientists who are not native English-speakers has become an important topic.

Publication output from developed countries was found to be significantly related to both national spending on research and English scores ( $P < 0.05$ ). Appropriately, China linked promotion for scientists to publishing in high-ranked journals and, combined with funding increases, enormously increased publishing of agricultural science and science generally over the last 10–20 years. A small proportion of this funding goes to editing and improving manuscripts, which can require 3–5 hours for 5000 words – if well prepared and with initially reasonable English. This time can greatly increase if the English is very poor or arguments are not well structured. Such a high level of external input is impossible for many researchers in developing countries to access and paying for such services is too expensive for many institutions.

Using a model recently applied to a large cassava research project in Africa, a mentoring project is proposed for young agricultural scientists in Sri Lanka.

Dr. Colin Hanbury  
Assistant Research Professor  
University of Western Australia

# **AGRIBUSINESS AND AGRICULTURAL ECONOMICS**

**Professional Forum**

**8<sup>th</sup> December 2016**





## INVITED PRESENTATION

### **The Strategy of Beautiful Village and the Sustainable Development of Rural Tourism in China: Based on the Empirical Study of Villagers' Perceptions**

**Cheng Li**

*Tourism School, Sichuan University, P.R. China.*

*chengli@scu.edu.cn*

#### **Abstract**

This article analyses the development of Chinese villages and rural tourism. Along with the Beautiful Village strategy that has begun to be implemented since 2013 in China, empirical investigations were carried out in three villages of Southwest China; IPA model was applied to study on villagers' perception of the development of beautiful village and rural tourism to discover problems. The study will provide helpful reference to facilitate the comprehensive construction and mechanism innovation of rural tourism in China.

**Keywords:** *Beautiful village, Rural tourism, IPA model*

## INVITED PRESENTATION

### Agribusiness And Agricultural Economics

#### Afternoon Session

### A Formula for Sugarcane Pricing Policy for Sri Lanka

**AP Keerthipala**

*Sugarcane Research Institute, Uda Walawe, Sri Lanka.*

*apkeerthipala@yahoo.com*

#### Abstract

The existing sugarcane payment system adopted by the Sri Lankan sugar companies does not possess efficiency and equity considerations, the two most important requirements in cane pricing. It does not offer incentives for the sugarcane growers to produce high-quality cane and for the sugar companies to improve their processing efficiencies. Nor does it split proceeds from sugar and by-products between the grower and the miller in proportion to their economic contributions to the overall cane production and sugar manufacturing processes. The cane pricing system proposed in this paper satisfies both efficiency and equity criteria, and hence, its adoption will help the Sri Lanka sugar industry to increase sugar production with high level of efficiency, and hence, reduces the unit cost of sugar production and increases the profitability while ensuring the grower-miller equity criterion. In order to ensure grower-grower equity, measurement of the quality of individual farmer's cane supplies to the mill and making payment accordingly are required.

**Keywords:** *Cane payment, Efficiency, Equity, Pricing policy, Sugar, Sugarcane, Sri Lanka*

# Knowledge and Training need of Women for Dairying in Tribal Hill blocks of Uttarakhand State, India

S. C. Tripathi<sup>1\*</sup>, Pratibha Singh<sup>2</sup> and Avadhesh Kumar<sup>3</sup>

<sup>1,3</sup> Department of Veterinary & AH Extension Education College of Veterinary & Animal Sciences, GBPUA&T, Pantnagar-263145 Uttarakhand. India.

<sup>2</sup> Veterinary Officer, Almora Department of AH Uttarakhand. India.

\* Corresponding Author: [scet\\_111@rediffmail.com](mailto:scet_111@rediffmail.com)

## Introduction and Objectives

Poverty is invasive in developing world, where every 5<sup>th</sup> or 6<sup>th</sup> person still survives on less than \$ 1 a day. Majority of these live in rural areas and depend on farming for their living. Hill farming by and large is livestock based and accredited as a sustainable and employment generating activity for marginal and small farmers. The share of dairy sector to the State's GDP is estimated to be 7.5 percent. Product wise its value contribution is 77 percent by milk, 12.94 percent by dung, 6.33 percent by meat and rest by other products (2014-15). In Uttarakhand hills livestock is predominantly managed by the women. The Majority of farmers are rearing poor quality animals with low input and locally available feed stuffs, inadequate housing, health care and improper marketing and thus productivity is also low. In order to improve the production and productivity of livestock, there is a need to access the perceived needs of dairy producers and educate them in adopting new technologies, Durga Rani & Subhadra, (2009) and Pourouchottamane *et al.*, (2012). Thus the present work was under taken with an objective to identify and prioritize the training needs of tribal hill women of Uttarakhand.

## Research Methodology

For the study, two blocks of Deheradun district namely Kalsi and Chakarata were purposively selected. Information was obtained through available records, the pretested interview schedule, participatory rural appraisal and focus group discussion. Five villages were selected randomly for training needs assessment on objective parameters. From each village 30 tribal women engaged in dairying were randomly selected to make a sample size 150. Training needs were prioritized using the scale;

$$\text{Mean Score} = \frac{3X + 2Y + Z}{X + Y + X}$$

Where XYZ are the number of respondents perceived a particular constraint as; most important/ important/ not so important.

## Result and Discussion

Analysis of training needs on five selected parameters i.e. feeding management, breeding, housing, health care management, and livestock products marketing presented in table 01 revealed feeding and management as one of the most important areas of training for knowledge

whereas health care for skill development by obtaining 2.78 and 2.73 mean, training need score (MTNS), respectively. It may be because these are directly related with production performance of animals. By acquiring 2.64 score dairy product marketing was the next priority for knowledge and skill development. Knowledge

**Table 01: Broad training needs area for tribal women of Uttarakhand in dairy farming N- 150**

Sl. No.	Dairy Farm Operations	Knowledge		Skill	
		MTNS	Rank	MTNS	Rank
1	Feeding management	2.78	I	2.44	III
2	Breeding	2.48	III	2.21	IV
3	Housing	2.22	V	1.75	V
4	Health care management	2.31	IV	2.73	I
5	Livestock products marketing	2.64	II	2.64	II

and skill training need in product marketing were perhaps to strengthen entrepreneurial process. These findings are in accordance with Durga Rani & Subhadra (2009), Raj Kumar *et al.* (2013), and Saroj Kumari *et al.* (2015). Since health care management is a highly technical and life related job, hence, it was the priority for skill up-gradation. The selected five farm operations were further categorized into 4 sub- farm operations. Results of sub- farm operations indicated that knowledge of government programmes, cheap housing systems, veterinary health services, balanced feeding and repeat breeding were the most important training needs with a MTNS of 2.73, 2.68, 2.67, 2.41 and 2.13 respectively. However, on skill development priority needs were, livestock products marketing followed by deworming schedule, repeat breeding problem, calf rearing and balanced feeding with a MTNS of 2.89, 2.80, 2.75, 2.03 and 1.99 respectively. This priority sequence was perhaps due to progressive opinion of farm women towards technological benefits of each operation. Other farm operations viz. pasture grazing, mineral mixture feeding, cost of AI or natural service, knowledge of milch breeds, shed sanitation, common diseases, vaccination schedule, transportation services were ranked as 3<sup>rd</sup> and 4<sup>th</sup> in respective major farm operations.

## Conclusion

Tribal women are actively involved in various dairy farm operations that require a high level of knowledge and skill. The study concluded that feeding and management, health care, repeat breeding problems, calf rearing, product marketing and its irregular price system as important constraints in adopting dairying as entrepreneurship. There is need of regular and sound steps for identification and prioritization of training needs in these areas.

## References

- Durga Rani, V. and Subhdra, M. R. (2009) Training needs of farm women in dairy farming. *Veterinary World* 2 (6). 221-223.
- Pourouchottamane, R.; Venkatasubramanian, V.; Singha, A.K.; Mishra, A. and Pankaj, P. K. (2012). Training needs analysis of livestock farmers and rural youths of North Eastern India. *Veterinary Practitioner*. 13(2):374-379.

- Raj Kumar, N. Vimal; Jiji. R.S. and Rajkamal P. J. (2013). Training Needs of Dairy Farm Instructors in Fodder Production and Management. *Journal of Vet. Ani. Sci.*(44) 46-50
- Saroj Kumari; Sethi, Nishi; Malik, Joginder Singh,; and Yogi, Vikram (2015). Need Assessment of Women Dairy Farmers. *Advances in Social Research*. 1 (1), 35-42.

# Supply Chain Study of Eight Agricultural Crops In India's One of the Most Backward Tribal Regions

M. V. Durga Prasad<sup>1</sup> and Shriprakashsingh Rajput<sup>2</sup>

<sup>1</sup> Institute of Rural Management, Anand, Gujarat, India.

<sup>2</sup> Social Research & Development Anand-388001,(SR&D) cell,  
Shroff's Foundation Trust, Vadodara, Gujarat, India.

\* Corresponding Author: [dprasad@irma.ac.in](mailto:dprasad@irma.ac.in)

## Introduction and Objectives

To study the supply chain of 8 agricultural crops in India's one of the most backward tribal regions-Chhotaudepur located in eastern part of Gujarat. Livelihood of tribal farmers of this area mainly depends on rain fed agriculture on their small and marginal land holdings. The objective is to understand the existing interventions, identify the gaps and improvements necessary for maximizing the benefits to farmers and other stakeholders in the supply chain of 8 agricultural crops through integration. Crops which were chosen for study are paddy, maize, black gram, gram, pigeon pea, mango, brinjal and okra.

## Research Methods

Overall research design included preparation of case studies using farmer level survey through a common questionnaire, Focused Group Discussions and an in-depth review of literature and secondary data on all 8 supply chains in the district. Primary data were collected from the producers, processors, aggregators, and other service organizations in the supply chain. In order to capture farmers' perspectives, each of a set of selected five villages were sampled from two blocks of Chotaudepur and PaviJetpur by using purposive sampling. Certain crops will be produced only in some clusters of the villages and thus purposive sampling in village selection will become a better option. Qualitative and quantitative methods are employed in maximizing the benefits of stakeholders in the supply chain of 8 crops through interventions.

## Results and Discussions

Shroff Foundation Trust (SFT), a service provider, is found to be playing an important role of organizing and empowering farmers through training, exposure visits and constant handholding support at each stage of agricultural operations.

Village level *Farm Schools* and community level resource persons known as *Samajshilpis* have been nurtured right at village level for introduction of agriculture based technology, its validation and adoption to bring in positive changes in the agricultural economy of the region. SFT provides inputs and services which result in maximizing the benefits to multiple stakeholders in the supply chain of 8 crops.

However, market linkages are missing in the supply chain due to which the right organizations and the right approaches have not been identified and recommended for improvement in the supply chain.

## Conclusions

In paddy crop, a low cost processing technology has been developed at village level and proved to be beneficial to the supply chain stakeholders. However, there exists a dilemma towards sustainability part and it had been addressed in the form of its by product to be marketed back to the stakeholders who are the users of processing machine. A similar development had been done for the other crops. It was observed that empowerment of local tribal farmers can boost the local agricultural economy. This can lead to improved quality of life among the local tribal population boosting the overall economy of such backward areas.

# The Evolution of Agri-Tourism Practices In India: Some Success Stories

Soumi Chatterjee<sup>1</sup> and M. V. Durga Prasad<sup>2</sup>

<sup>1</sup> Quarter No C-27, IRMA Campus, Anand-388001, Gujarat, India.

<sup>2</sup> Institute of Rural Management, Anand, P.B. No. 60, Anand-388001, Gujarat, India.

\* Corresponding Author: [dprasad@irma.ac.in](mailto:dprasad@irma.ac.in)

## Introduction and Objective

Agriculture and its allied activities are on the brink of a change for both the farmers as well as consumers. A plethora of diversified activities amalgamated with scientific methods of cropping are paving a way for a mechanized and secure future for the farmers as well as new age consumers. Farmers are now enthusiastic to try newer methods away from the typified and orthodox patterns to build relations with the consumers directly and earn extra. Farm visits, farm stays and trail visits are gradually picking up amongst tourists to experience something different from clichéd sightseeing packages of a destination.

The paper also looks into the idea to comprehensively build upon a model for replication for areas of similar soil and climactic conditions as well as a synthesis of the theories and the indigenous practices available. Research limitations shall be the fact that all such farms cannot be visited owing to the difficult terrain as well as the time duration to cover all such farms.

## Research Methods

The methodology followed is exploratory and case based. A collection of some successful agri-tourism cases have been collated from the east, west, north, south and central zones of the country. The west, south and the north zone cases have been built upon primary, structured as well as unstructured interview based research while the central and the east zone cases are done on secondary research. This paper with its extensive primary research shall build upon concrete theoretical concepts and definitions. The paper aims to draw from the various indigenous practices from the country and also integrate them to analyze the potential of tourism in the farms. The paper shall delve deeper into the cases and the methodology adopted would be qualitative in nature.

## Results and Discussions

The results of this case based research paper if administered rightly can help to achieve many other success stories and lead as examples for other agriculture based economies. Agri-tourism practices with its baby steps and the talisman of research can definitely bring changes in the life of farmers, and consumers shall also reap the benefits of it. Agri-tourism could create awareness about rural life and knowledge about agriculture science among the urban school children. It provides a best alternative for school picnics which are urban based. It provides opportunity for hands on experience for urban students in Agriculture. It is a means for providing training to future farmers. It



would be effectively used as an educational and training tool to train agriculture and line department officers.

This provides a unique opportunity for education through recreation where learning is fun effective and easy. Seeing is believing, doing is learning and most importantly experiences are USP of Agri-tourism. (Kiran *et al.*,)

## Conclusion

Agri-tourism as a concept is not very new although its reach is limited to only some places in the country. The concept to date is considered as a supplementary to the primary source of income and caters to a niche market due to its exclusivity. The idea has a novelty attached to it in terms of nostalgia as well as village visits for consumers. The plate is full with offerings like dairy practices, bird watching, wine trails, hay making and local handicrafts to woo the consumers with the simplicity of villagers hooked to it in the background. There are options like doing on farm sales, roadside stands, agriculture related gift baskets, pick up and create own basket which are gradually gaining popularity among urban city dwellers. A special mention needs to be done for the kids and school going children who are being brought up in the cities sans the knowledge of natural agricultural processes and food production. With an idyllic setting nestled in the lap of nature and rooted practices children can adapt to basic farming courses and enjoy the detailing of their activities.

## References

Kiran, J.N., Lakshmi Prasad, V., Kavya, C. and Nagaraja, G.N. (2014). Investment opportunities in agri-tourism in India. Retrieved from [http://www.researchjournal.co.in/online/IJCBM/IJCBM%207\(2\)/7\\_400-405\\_A.pdf](http://www.researchjournal.co.in/online/IJCBM/IJCBM%207(2)/7_400-405_A.pdf) on 1/11/2016  
<http://www.agritourism.in/> retrieved on 1/11/2016

# Capital Bases Influencing Livelihood Strategies among Smallholder Farmers in Sri Lanka

H. M. U. N. Herath<sup>1\*</sup>, T. Parfitt<sup>1</sup>, P. O'Reilly<sup>1,2</sup>, A. S. Karunaratne<sup>2,3</sup>

<sup>1</sup> School of Politics & International Relations, University of Nottingham Malaysia Campus,  
Jalan Broga, Semenyih, Selangor Darul Ehsan, 43500, Malaysia.

<sup>2</sup> Crops For The Future Research Centre, University of Nottingham Malaysia Campus,  
Jalan Broga, Semenyih, Selangor Darul Ehsan, 43500, Malaysia.

<sup>3</sup> Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, PO Box 02,  
Belihuloya, 70140. Sri Lanka.

\* Corresponding Author: [nandaniherath22@gmail.com](mailto:nandaniherath22@gmail.com)

## Introduction and Objectives

A key feature of small holder systems in Sri Lanka is crop diversity within a wide range of agro-ecological regions. While paddy is the mainstay, home gardens and *chena cultivation* contribute significantly to assure food security in rural communities (Damayanathi & Gamage, 2011). While the practice of poly-culture remains dominant in small holder systems, crop combinations have changed markedly after economic liberalization in 1977. Subsequent to the policy change, subsistence farming was gradually pushed towards commercial farming, promoting more cash crops. High value cash crops including Chilli and Onions along with low value cereal crops are now dominant in smallholder systems. Moreover, widespread natural resource bases and varied climatic conditions within the island offer the farmers with the opportunity to adopt diverse crop combinations and agricultural practices for their livelihoods. This research therefore, investigates 'how resource availability influences the crop selection decisions and thereby livelihood strategies of smallholder farmers'.

## Research Methods

This study pursued the theoretical background of 'Sustainable Livelihood Approach' proposed by Robert Chambers which was considered central to rural development since then (Chambers 1995, Scoones, 2009). Literature suggests that the ability of smallholders to pursue different livelihood strategies, depends on the tangible and intangible assets in their possession, referred to as 'capital base' in the livelihood framework (Scoones, 2009). As such, a comprehensive analysis was carried out to investigate resource variations among segments including access to resources, influence of organizations and institutional support in selecting of livelihood strategies. Qualitative social research methodology was adopted and a number of data gathering tools encompassing baseline survey, in-depth interviews, focus group discussions, key informant analysis and participant observations were employed. Research was conducted in Anuradhapura District in the North Central Province of Sri Lanka. Farmers were selected from four divisions in the district based on the fertilizer subsidy recipients' list maintained by the Agrarian Services Centers. Agrarian Services Centers bear the responsibility of input distribution while the Provincial Department of

Agriculture conducts agriculture development programmes in the selected segments, namely Anuradhapura, Kahatagasdigiliya, Thirappane and Ipalogama. Ten farmer families from each segment participated in the survey and in-depth interviews were conducted with forty farmers using a detailed interview guide.

## Results and Discussion

Out of the four segments, paddy was cultivated everywhere as the traditional staple. In areas where water is a limiting resource for lowland paddy, farmers cultivated subsidiary food crops in paddy fields and *chenas* during Yala season. These farmers pertinently operate on smallholdings and 17.5% farmers in the sample own less than 1 ha. Average size of a land considered as small holding is 0.8 ha (Narayansuwami, C., 2000). While literature advocates that policies and institutions play an influential role in gaining access to livelihood resources (Ashely and Hussain, 2000), field survey revealed that farmers choose to cultivate paddy, motivated by the institutional support in terms of subsidies. However, variations exist in crop combinations with regard to subsidiary food crops and fruits & vegetables. Farmers in Kahatagasdigiliya adopted green gram cultivation in paddy lands between seasons, as a result of technology transfer through extension services. Similarly, in Thirappane Guava fruit was promoted by the extension services. Cattle management was a chosen livelihood in addition to traditional crops in Kallanchiya AI range in Anuradhapura where natural pasture lands were available.

**Table 01: Variations in Crop Combinations**

Segment	Village cluster	Crop combinations	
		Yala season	Maha season
Kahatagasdigiliya	Kanhindigama	Paddy & OFC ( Green gram)	Paddy & Maize
	Kiriibbewa	Paddy & OFC ( Sesame)	Paddy & Maize
	Ellewewa	Paddy & OFC ( Sesame)	Paddy & Maize
	Ranpathwila	Paddy & OFC (Sesame)	Paddy & Maize
Anuradhapura	Kallanchiya	Paddy & OFC (Sesame, Finger Millet )	Paddy & Maize
	Meemalwewa	OFC (Sesame, Finger Millet) & Home Gardens	Paddy & Home Gardens
	Rotawewa	OFC (Sesame)	Maize
	Kappriggama	Paddy & OFC (Sesame)	Paddy, Maize, Vegetables
Thirappane	Galkulama	Paddy & vegetables	Paddy, Maize, Vegetables
	Karuwalagawewa	Paddy & OFC (Sesame )	Paddy, Maize
	Wannammaduwa	Home Gardens, Guava	Paddy,OFC, Guava
	Uttimaduwa	OFC (Sesame) & Vegetables	Paddy & OFC
Ipalogama	Sembukulama	Home Gardens , Guava	Home gardens-Guava, Papaya, vegetables
	Ranorawa	Chena-Vegetables	Paddy & Chena
	Nochchiyagama	Chena-Vegetables	Paddy & Chena

Source: Field survey, 2015.

Livelihood analysis framework describes five capital bases namely natural, physical, financial, human & social capitals from which livelihoods are constructed (Scoones, 2009).

While above variations can be attributed to decisions based on natural and institutional resources, findings reveal the impact of human and social capitals. For example, farmers' ability to engage in off farm activities based on their skills and business orientation or entrepreneurial capabilities vary among the segments. Educated farmers in the sample have chosen farming as a livelihood, after retirement from government service. Moreover, differences were evident among segments, with regard to social affiliations with farmer organizations and extension services. For example, farmers in the Ipalogama segment who cultivate vegetables and subsidiary food crops in *chenas* for their livelihood, are in a deprived situation due to poor access to new knowledge. They are disadvantaged by poor relationship with the extension service which can be attributed to lack of social capital.

## Conclusions

Although little variation was observed in natural and physical capital bases, social and human capital bases show noticeable variations among the segments. Farmers who are benefited by institutional resources in terms of subsidies, new knowledge and technology adopt new crop combinations leading to better livelihood outcomes. Lack of social capital by way of linking with institutions and organizations deprive the farmers of the opportunity to access physical and financial capitals. Spatial variations with regard to access to capital bases, social and human capital bases in particular, have contributed to variations in cropping patterns and livelihood strategies adopted in the research area.

## References

- Ashley, C., Hussein. (2000). *Developing Methodologies for Livelihood Impact Assessment: Experience of the African Wildlife Foundation in East Africa*. Overseas Development Institute (ODI), Working Paper129, London, UK.
- Gamage,D., Damayanthi,N.(2011). *Transformation of Smallholder Agriculture Sector in Sri Lanka: An Annotated Compendium of Statistics. Research Report No: 141*. 1st ed.: Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI).
- Narayanasuwami,C.(2000). 'Capacity Building for Agricultural Development'. In: Samarasinghe, S.G. (ed), *Hector Kobbekaduwa Felicitation Volume* (1st ed.,pp. 73-106) Sri Lanka: Hector Kobbekaduwa Trust.
- Scoones, I., (2009). Livelihoods Perspective and Rural Development. *Journal of Peasant Studies*, 36 (1), pp.1-26

# **Institutional Landscape and its Role in Underutilized Crops (UUCs) Cultivation in Uva Province, Sri Lanka**

**Arosh Bandula<sup>1\*</sup>, Achini De Silva<sup>2</sup>, Asha Karunarathne<sup>2</sup>, Patrick Oreiley<sup>1</sup>**

<sup>1</sup> *Crops for the Future Research Centre, University of Nottingham Malaysia Campus, Malaysia.*

<sup>2</sup> *Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya. 70140. Sri Lanka.*

*\* Corresponding Author: aroshb@yahoo.com*

## **Introduction and Objectives**

Some traditional crops species which are not utilized at significant levels are generally called underutilized crops (UUCs). According to Engels *et al.*, (2001), the term commonly used to refer to crop species whose potential has not been fully utilized. Those crops are represented in rural small holder farming sector for a long time which are depicted as scattered farming units. (World Bank, 2003).

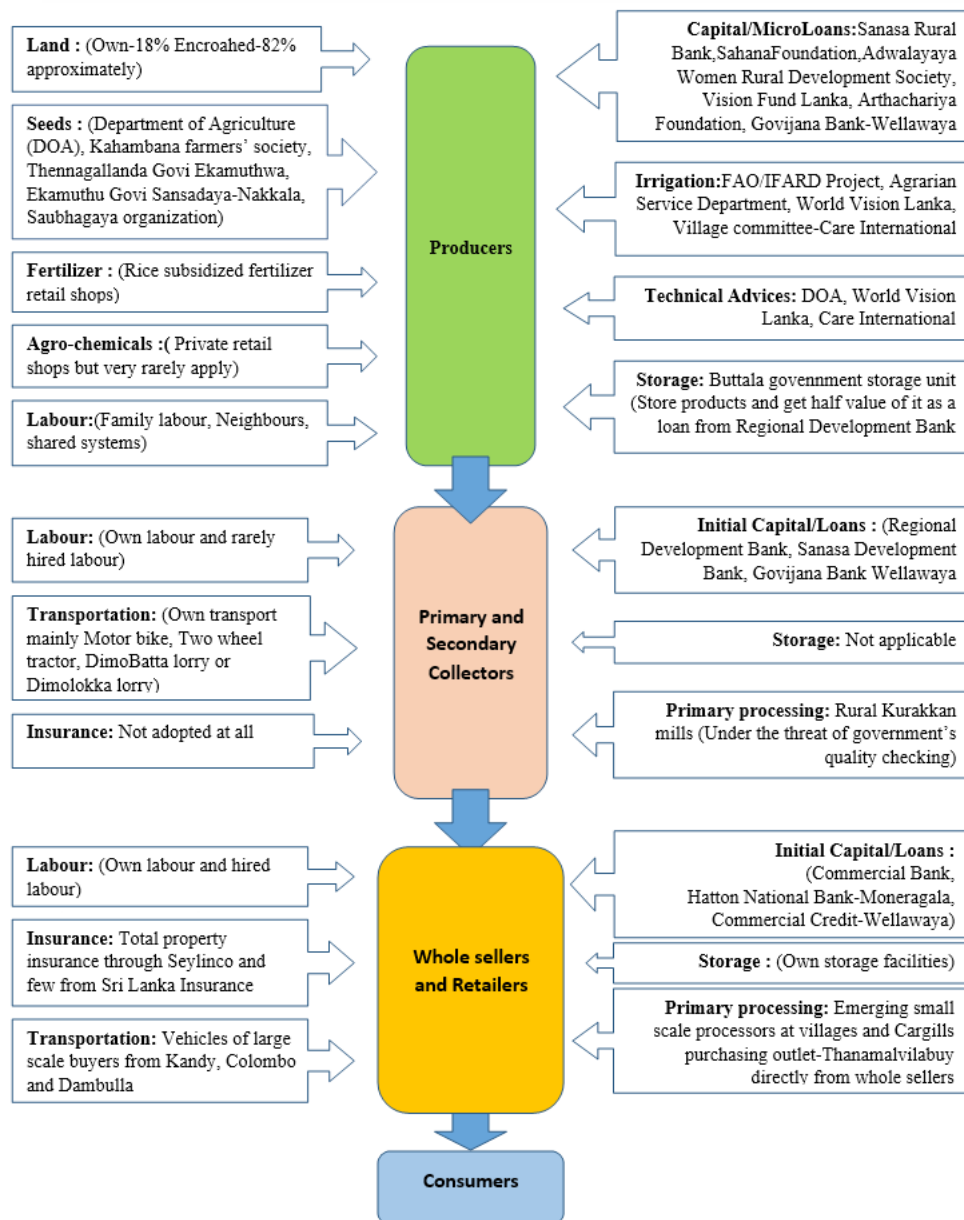
The role of underutilized crops (UUCs) for the rural development is an emerging research domain even though mankind still depends on a very limited number of crops to meet their food and economic needs. (Jaenicke, 2006) This over dependence has already alarmed the world by emphasizing the importance of sustainable management of underutilized crop species. Uva province in Sri Lanka has been recognized for a significant amount of available underutilized crop resources. However, in the process of improving the production and utilization of those resources, understanding of the institutional fabric of the operational environments of UUCs is heavily emphasized. Study objectives were to investigate how the structure of input provision and service delivery environments interact with key actors of the underutilized crop value chains in the existing context.

## **Research Methods**

The study selected Thanamalwila, Wellawaya and Moneragala Divisional Secretariat Divisions (DS Divisions). Three Grama Niladhari Divisions (GN Divisions) were selected purposively from each DS Division based on the availability of farmers who are engaged in underutilized crop cultivation. Few Focus Group Discussions (FGDs) with farmers groups and a series of key Informant Interviews (KIIs) were conducted at different levels from Lead Farmers (LF), Agricultural Instructors (AIs) and Deputy Director of Agriculture (DDA) levels. KIIs at three different levels ensure more precise and balance information from ground level to policy level. The data collection process was initiated with the consultation of DDA-Moneragala district and approaching to the respective AIs under his control. Then lead farmers were approached through AIs. The total sample covered 36 farmers, 9 Lead Farmers, 3 AIs and one DDA. Sets of open-ended guiding questions were developed to interview three levels of interviewees and farmer groups. The primarily developed guiding questions were field tested and fine-tuned before moving to the actual survey. AIs were interviewed by visiting their

Agrarian Service Centres by taking appointments with the consultation of DDA-Moneragala. Lead farmers were visited at their houses or farm lands by contacting them over the telephone with the support of respective AIs. All collected information underwent simple descriptive methods and simple content analysis.

## Results and Discussion



*Figure 01: Snapshot of institutional arrangement along the underutilized crops value chain*

Figure 01 explains the institutional involvement on the UUC value chain in the study area. The UUC cultivations have organized as scatter grown plants at their home

gardens and around 1-2 acre size encroached Chena (Shifting cultivation) land located 1 to 3 kilometers away from their houses. Significant extents of lands are recognized as encroached entities. Farmers get seeds of key underutilized crops such as Kaupea, Meneri and Gingerly from DOA at the beginning but later multiplication was managed by village based farmers' institutions. They apply fertilizer and agro chemicals rarely to their crop lands but take few from existing retail shops when required. Farmers get loans from different institutions. They have higher tendency to go for private credit providers due to their close relationship with them and less conditions apply even though high interest rates are charged. Irrigation needs are addressed by the Government, some non-governmental organizations and FAO funded projects which concluded recently. Farmers have fresh interest to use the Government storage unit in Buttala to store their products. They receive the opportunity to get a loan at a lower interest rate from the Regional Development Bank for the half value of the stored stock as they store at the Buttala unit.

Primary and secondary collectors use their own labour and transport facilities to cover-up their needs. They do not adapt to insurance and storage functions since they transfer their collections to whole sellers within a shorter time period. However, collectors use bank loans especially from government development bank institutions such as the Regional Development Bank, Sanasa Bank and Govijana Bank.

Whole sellers use both own and hired labour for their needs. They have reasonable storage facilities. They collect and store the products and when it reached ceiling contact level large scale buyers from Colombo, Kandy or Dambulla are called to sell their stocks. Large-scale buyers use their own lorries with higher capacities for the transportation. Whole sellers get loans mainly from private banks, initially based on their personal relationships. However, they approach state banks for some special loans. Whole sellers have insured their entire properties besides any specific crop product at both private and state insurance companies. Few emerging local processors directly buy from whole sellers with the intension of purchasing qualitative and uniformed products.

## Conclusions

In the characteristics of institutional engagement of underutilized crop value chain, actors have shown some differences in micro and macro institutional levels. All main categories of actors extensively use their own labour. Farmers have their own seed management mechanisms at village levels to handle their cultivations. Fertilizer and agro-chemicals are not a big need for farmers but irrigation is considered as a key area requirement that further support them. Non-government organizations play some impressive roles in this area but at household and just small community group levels. The storage facility established by the Ministry of Agriculture facilitates farmers to sell their products directly and get a loan for the half value of the stock. This strategy has controlled middlemen influence on farmers to a reasonable extent.

Collectors use their own transport facilities. They take bank loans mainly from development banks. The collectors have no interest on developing medium scale storage



facilities on insurance systems. They tend to collect products and immediately transfer to the hands of whole sellers. Whole sellers store the products at their own stores and sell to outstation buyers during peak price times. They use reasonable portions of bank loans and insure their properties as a whole mainly at private insurance companies.

Farmers propose a public-private partnership model to improve the existing institutional structure regarding underutilized crops. They expect that such a model in long-term will ensure more benefits for farmers while opening opportunities to send their products to international markets in large volumes.

## References

Engels, J.M.M *et al* (2001) London and Rome: CABI-IPGRI

Jaenicke, H. (2006). *Underutilized crops can play a crucial role in food and livelihoods security for the poor*. The International centre for underutilized crops, Colombo, Sri Lanka.

World Bank.(2003). *Reaching the Rural Poor: A New Strategy for Rural Development*. Washington, D.C.



# Drivers and Barriers of Agro-tourism: Revisiting the Potentials of Agriculture amidst Intensifying Socio-Economic Mobilities in Sri Lanka

Ruwan Ranasinghe<sup>1</sup>, Li Cheng<sup>2</sup>

<sup>1,2</sup> School of Tourism, Sichuan University, Chengdu, PRC.

\* Corresponding Author: ruwan@uwu.ac.lk

## Introduction and Objectives

Indisputably agriculture has been the core of Sri Lankan civilization. Historically, the sector uplifted the nation into the highest level of prosperity encapsulating the entire socio-economic, cultural as well as geopolitical representations around it. During the times of colonization, the sector was flourishing in the Island and the entire social system revolved around agriculture. However, amidst the intensifying mobilities of corporeal, technological, physical, communicative and image concerns in modern times, the role of agriculture seems misdirected or left behind. On the contrary, agricultural sector has to be the core of any economy on which industrial and service sectors are built. Similarly, local relations have entirely been replaced by global relations resulting local cultures becoming none-ingenuous. This paper examines the viability of agro-tourism sector in the context of Sri Lankan economy, amidst intensifying mobilities. We argue that the agricultural sector of the island economy should be revisited and diversified into novel areas such as tourism, harmonizing with the global mobilities.

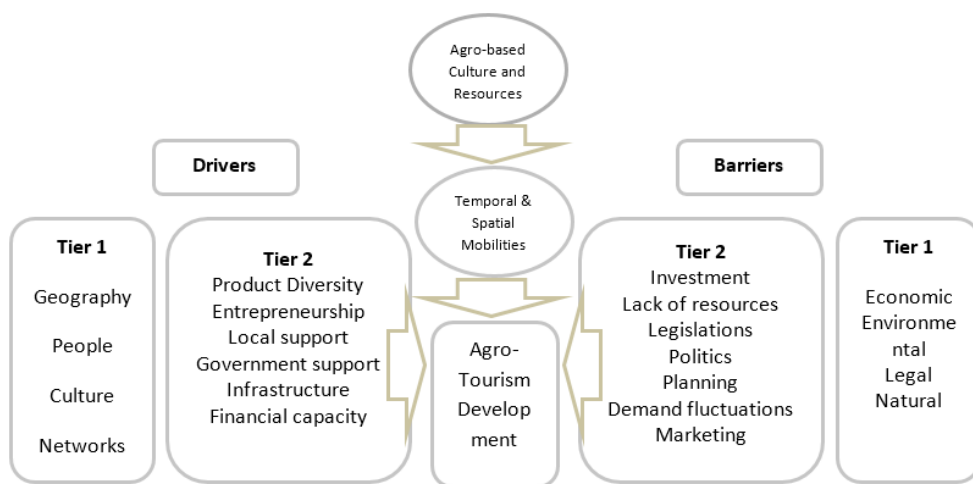
## Research Methods

The paper aims at elucidating novel approaches of diversifying the agro based culture of Sri Lanka adding value to address globally driven mobilities. This is a conceptual paper in nature and relevant literature was extensively reviewed to build up our arguments. We propose a conceptual model to explain the transformation of agricultural resources amidst socio-economic mobilities into tourism experiences. The paper mainly relies on a conceptual approach where the relevant theoretical contexts are examined in the light of existing literature.

## Results and Discussion

The notion of agro-tourism has become a panacea while the real agricultural and tourism stakeholders remain isolated. The rich agro based culture of the Island is under rapid transformation amidst the influence of socio-economic mobilities underpinned by technology, information and communication, transport and most importantly the image mobilities. In the process of global mobilities, tourism plays a significant role while the structural changes of tourist profiles are shaping and reshaping the industry character constantly. Such progressions have created opportunities for repositioning of agriculture into new frontiers. Linking primary agro productions with growing service sectors like tourism could undoubtedly enhance its value and is a timely move to sustain the highly welfare driven agro sector of Sri Lanka. To regain its glories, the sector has to be aligned to the global moves particularly, with the growing sectors which are economically viable. Tourism on the other hand, has shown a promising

growth in recent times all over the globe. However, increased mechanization and commercialization leading to cultural split-up from the sector draw attention in order to preserve its touristic values. Agriculture based folk songs, performances, festivals and celebrations need to be reproduced in real life. Such reproductions demand economic viability for which active involvement of authorities is prerequisite. In essence, proposed two-tier model explains drivers and barriers for agro-tourism development in Sri Lanka (Figure 01). The agricultural resources, mobilities as well as the drivers and barriers identified can transform the agro tourism experiences in the long run.



**Figure 01**

## Conclusions

We focused on the potentials of diversifying agriculture into growing service sectors such as tourism. It invariably has to be positioned amidst global mobilities addressing the changing demand patterns. The paper is built on the main argument that welfare driven agro sector should be diversified nourishing its cultural values to gain its glories. Policy planning, product development and marketing excises are proposed to handle through a central body. The links should be established among officials responsible for agriculture and tourism research, local development and community empowerment at national, regional and local level. Theoretically, the proposed conceptual model is significant in advancing agro tourism literature.

## References

- Sznajder, M., Przezborska, L., & Scrimgeour, F. (2009). *Agritourism*. Oxfordshire. CABI.
- Torres, R., & Momsen, J. (Eds.). (2011). *Tourism and agriculture: new geographies of consumption, production and rural restructuring*. Oxon. Rutledge.
- Ramsey, M., & Schaumleffel, N. A. (2006). Agritourism and rural economic development. *Indiana Business Review*, 81(3), 6.
- Malkanthi, S. H. P., & Routry, J. K. (2011). Potential for agritourism development: Evedance from Sri Lanka. *Journal of Agricultural Sciences*, 6(1).

# Livelihood Analysis: A Case of Underutilized Crops Farmers in Moneragala District

Champika Jayaweera<sup>1</sup>, Achini De Silva<sup>2</sup>, Patrick Oreiley<sup>3</sup>  
and Asha S. Karunarathne<sup>2</sup>

<sup>1</sup> Nottingham University Malaysia Campus, Malaysia.

<sup>2</sup> Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya. 70140. Sri Lanka.

<sup>3</sup> Crops for the Future Research Centre, University of Nottingham Malaysia Campus, Malaysia.

Corresponding Author: [champikajayaweera@yahoo.com](mailto:champikajayaweera@yahoo.com)

## Introduction

Human being mainly depends on a very limited number of major crops to meet their needs giving their less attention to minor crops (Dansi *et al.*, 2012). Those minor crop species are categorized as underutilized species (UUCs) in which potential to improve livelihoods, as well as food security and sovereignty is not being fully recognized (Dansi *et al.*, 2012). Many of the plant species across the world are remained as underutilized though they play a crucial role in the rural livelihoods (Dansi *et al.*, 2012).

A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living and it is considered as sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; where it contributes net benefits to other livelihoods at local and global levels and in the short term and long term (Chambers & Conway, 1992).

In general, people need five types of capitals in developing sustainable livelihood strategies, namely, physical, financial, natural, human and social (Chambers and Conway, 1992). This paper seeks to illustrate the livelihoods of underutilized crop (UUC) farmers to assess their accessibility to five types of livelihood capitals and their role of strengthening livelihood strategies to make their livelihoods more sustainable by improving livelihood outcomes & to find out the most economical crop in each division.

## Methodology

The mixed method approach which employed a combination of quantitative data assembled through sample survey and secondary analysis of socio-economic data were used in this study where data were generated through ethnographic and in-depth interviews. Data pertaining to such information were also derived from participative research.

The study was carried out in Moneragala district of Sri Lanka by interviewing 90 Household heads (HH). Moneragala, Thanamalwila & Wellawaya DS divisions were selected. Thenegallanda, Kahambana & Nakkala GNs from Moneragala DS, Kahakurullanpelessa, Mahawewa & Bodagama GNs from Thanamalwila DS & Andawelayaya, Nugayaya & Buduruwagala from Wellawaya DS were selected & 10 HHs in each were interviewed. Most economical crops were selected using five point scale mean values collected with farmers' perception on given different economic criteria under each crop.

## **Results & Discussion**

### ***Sustainable livelihood framework (SLA)***

Livelihood framework contains a 'core' in which assets are put into use through certain strategies and activities to produce certain livelihood outcomes (Chambers & Conway, 1992). This core exists in a context characterized by existing institutions and policies affecting people, from the extended family and local community to the larger context of the national state and beyond, and the vulnerability context which describes the set of external, social, economic and political forces and stresses which people are subjected (Chambers & Conway, 1992).

### ***Livelihood Assets***

All livelihood strategies depend upon access to assets of some kind or other, whether such access involves private ownership or other forms of access (Chambers & Conway, 1992). In the livelihoods framework, assets are conventionally divided into the financial, physical, natural, human & social capital.

### ***Human Capital***

Human capital provides labor for the various enterprises like income generation, subsistence farming and water collection engaged in, by households (Chambers & Conway, 1992). Human capital is partly related with household size & depends upon the level of education, experience, age and gender profiles, occupations and so on. In general, farming activities were strengthening with the family labor where spouse and kids play an important role but unrecognized in financial terms. Access to human capital is dependent on their skills, knowledge and good health & physical capability. In this study, special consideration is given to household composition, education, employment & their involvement in farming in order to assess their accessibility to human capital as a key factor for enhancing their farming strategy.

Percentages of female members were higher than male in all divisions, including 58.62% in Moneragala DS, 55.07% in Thanamalwila DS and 66.15% in Wellawaya DS. It is evident that percentages of members in Moneragala DS within the age groups of 20-30, 31-40, 41-50, 51-60, >60 and <20 were 34.48%, 13.79%, 13.79%, 15.52%, 13.79% and 8.62% respectively while in Thanamalwila DS they were 20.29%, 31.88%, 31.88%, 4.35%, 2.9% and 8.7% respectively. In Wellawaya DS, those categories were consisted of 23.08%, 30.77%, 23.08%, 16.92%, 3.08% and 3.08% members respectively.

Majority of members in Moneragala DS & Wellawaya DS have achieved education up to primary level which represented 67.24% and 56.52% while 61.54% have achieved education up to O/L at the highest in Thanamalwila DS.

The highest percentage in Moneragala DS falls within the farming as their employment category which represented at 74% and the lowest was in government & business categories representing the same 8%. The highest percentage in Thanamalwila DS falls within the farming as their employment category which represented at 66.07% and the lowest was in business since not a single member involved in business. 85.48% in Wellawaya DS was in farming while no one was in business.

Further household members' involvement in farming was analyzed in order to see the contribution of human capital for UUCs farming. There was a significant contribution from all the family members unless they are having any other employment. In Moneragala DS, percentage of farmers who are fully involved in farming was high which represented 43.1% followed by highly involved (36.21%), less involved (8.62%), not involved (8.62%) and involvement is neutral (3.45%). The higher percentage of farmers were involved in fully & highly involved levels within the Thanamalwila DS as represented at 39.13% and 31.88% respectively. In Wellawaya DS, a higher portion was observed in fully involved level category at 64.62%.

### ***Natural Capital***

Natural capital refers to the stock of natural resources that provides flows of valuable goods and services. Major types of natural capital related with UUC farming include lands, subsoil assets, forests and water (Scoones, 1997).

Soil quality reflects how well a soil performs the functions of maintaining biodiversity and productivity, supporting plants and other structures, and providing a slew of other non provisioning ecosystem services (Scoones, 1997). Based on topographical and climatic variation, a variety of soil types are identified in the district. According to the great soil groups of Sri Lanka, there are two soil groups in the district, namely Reddish Brown Earth (BE) and Red Yellow Podzolic (YP) soils. The RBEs are present in Dry and semi-dry Intermediate areas while RYP soils are found in wet and semi-wet intermediate areas. Within these two soil groups eight solid units are identified (DPA - CIDA study on lower Uva Regional Development Plan 1982).

The total rainfall in the district ranges 1328 - 1821 mm (50-72 in) a year. Over 84 percent of rain is received during the seven rainy months inclusive of October to January and March to May. There are also minor but significant regional differences in the amount and distribution of annual rainfall within the Dry Zone and there is thus a regional specification of plant growth. As a common factor in the Dry Zone the district is characterized not only by an uneven average spread of rain over the year but also by very high variability in each month's rainfall from year to year (DPA - CIDA study on lower Uva Regional Development Plan 1982). 27% of the sample is under rain-fed system only while 4.01% of the crops are irrigated by a common or private water source. 68.99% of the crops are being supplied with water by both systems as per the availability.

For almost all the cereal crops, they are willing to have their own seeds which are produced in the previous season. In this sample no any common storage facility is observed. They use several types of storage facilities at different levels such as poly bags (46.56%), gunny bags (10.69%), 'Atuwa'(7.63%), bottles (21.37%), buckets (1.53%), "dummassa"(8.4%) and "labukataya"(3.05%).

More than 50 acres of land in each division are utilized for UUC cultivation by smallholders collectively which represented at 66.5ac in Moneragala, 60.33ac in Thanamalwila and 73.83ac in Wellawaya.

Farming is also considered as a natural base in their livelihoods. Crop diversity is a main indicator for their accessibility to the natural capital. Based on the information gathered from the 90 interviewees, 38 crop species were listed as underutilized in Moneragala district. There were cereals, vegetables, fruits, spices, medicinal plants and tuber crops among them. For the five important species, *Vigna unguiculata*, *Vigna radiata*, *Arachis hypogaea*, *Eleusine coracana* and *Citrus aurantifolia* appear as the most widely grown species as they have been each listed by 65.56%, 45.56%, 43.33%, 34.44% and 26.67% of the interviewees respectively (Figure 1) while *Murraykoenigii*, *Musa sp.*, *Anacardium occidentale*, *Aegle marmelos (L) Correa*, *Senna auriculata*, *Brassica juncea*, *Alternanthera sessilis* were mentioned only by 1.11% of the interviewees making them the least important crops for cultivating.

### ***Social Capital***

Social capital relates to the formal and informal social resources that people draw upon in pursuit of their livelihoods. People develop these social resources by investing time, effort and other resources in membership of formal groups or organizations, informal social interactions in and outside the community, relationships of reciprocity, including produce exchange & mutual assistance.

Though it takes many forms of associations within Moneragala district, this study aimed at associations from which they have support to farming. Almost all in the district are member of at least one formal association while some are involving in more than one. Farmers' association, Samurdhi association, Maranaadhaara Samithiya and association of low country vegetable growers' were observed four community networks within the district. Respectively 100%, 37.78%, 24.44% and 10% of the farmers were member of each community.

Such investments help them to build trust and facilitate co-operation. They can increase access to information and reduce transaction costs. They allow people to make claims on other people's obligations to support them, and can help in the development of informal safety nets amongst the poor. Finally, they are able to increase people's power and influence.

### ***Physical Capital***

Physical capital which includes infrastructure (buildings, roads), production equipments (tools, vehicles, machinery) and technologies is another important factor within this UUC farming community so as to increase the productivity. In Moneragala district,



80.46% of farmers use their own machinery, tools and equipments while 19.54% hire them when they need. It means they have accessibility to physical assets at a comparatively higher level.

### ***Financial Capital***

It is useful to explore the accessibility to financial capital by HHs in terms of cash, credit/debt, savings, and other economic assets which are essential for the pursuit of any livelihood strategy. Assuming that HH has little savings, income and expenditure based on UUC farming were taken into consideration in this study. It was also difficult target, since HH members are understandably loathe to divulge details of their income and they are more than willing to set out their multitude of expenditures stressing they are suffering.

Access to formal sector savings facilities was also limited within the district, with banks operating branches only in the largest urban centers. Most households continue to use formal sector savings facilities. Given the distance and the cost of transport, there is an urgent need for improved informal sector savings alternatives. They use to have access to micro credit as well with group based banking.

Of the sample, 50% of them are getting an income in between LKR 10,001 & LKR 25,000. No single individual earns more than LKR 50,000. 42% of the sample earns in between LKR 25,001 and LKR 50,000 while remaining were in the category of below LKR 10,000.

Food expenses were analyzed as fractions of the total income. Accordingly, 1/2, 1/3, 1/4 & 1/6 of total income were spent on food expenses by 20%, 60%, 15.56% & 4.44% of HHs respectively.

With above capitals, they can involve in two major livelihood strategies. One is in agricultural production and the other is being a labourer. Finally, these strategies are resulted in livelihood outcomes like more income, increased well-being, reduced vulnerability, improved food security & more sustainable use of natural resource bases.

### ***Most Economical Crops***

The most economical crop was selected in each GN division by given score values under four major economical aspects including profit making, low post harvest losses, market accessibility & receiving of market information. Scores were given according to the five points scale where the contribution for each aspect is extremely high(5), high(4), neutral(3), low(2) and extremely low(1). The most economical crop was selected by the highest mean score value. In some villages, there was more than one crop having the same mean score value at the highest (Table 01).

**Table 01: Most economical crops in the Moneragala district**

DS division	GN division	Most economical crop		Mean score value
		Common name	Scientific name	
Moneragala	Nakkala	Lime	Citrus aurantifolia	15
	Thenagallanda	Gingerly	Sesamum indicum	15
	Kahambana	Lime	Citrus aurantifolia	15
	Kahakurullanpalassa	Cashew	Anacardium occidentale	17
Thanamalwila	Bodagama	Lime	Citrus aurantifolia	16
		Pomegranate	Punicagranatum	16
	Mahawewa	Finger millet	Eleusine coracana	12
		Lime	Citrus aurantifolia	12
Wellawayaya	Buduruwagala	Groundnut	Arachis hypogaea	14
		Groundnut	Arachis hypogaea	12.5
	Andawelayaya	Thumbakarivila	Momordica dioica	12.5
		Passion fruit	Passiflora edulis	13

## Conclusion

Access to human capital is dependent on their skills, knowledge and good health & physical capability. Within the Moneragala district, there was a variation in household composition in terms of age, education & employment. There was a significant contribution from almost all the family members for farming being the highest percentage involved in farming fully & highly categories. All the DS divisions have more than 50 acres under the UUCs farming among 30 HHs in each division. Almost all in the district are member of at least one formal association while some are involving in more than one, making their social capital more successful. In terms of physical capital, a larger portion of them are using their own machinery & equipments for farming. 50% of them are getting an income in between LKR 25,001 & LKR 50,000 by cultivating UUCs. *Citrus aurantifolia* appeared the most economical crop in four GN divisions among all nine.

## References

- Chambers, R and Conway, GR (1992). Sustainable rural livelihoods: Practical concepts for the 21<sup>st</sup> century. IDS Discussion Paper No. 296. IDS, Brighton.
- Dansi *et al.* (2012), Diversity of the Neglected and Underutilized Crop Species of Importance in Benin.
- DPA Consulting Limited, (1982). Lower Uwa Regional Development Plan, vol 2, Regional Analysis.
- Scoones, I. (1997), Sustainable Rural Livelihoods: A Framework for Analysis.



# Creating Brand Equity: A Study on Rice Based Value Added Products

**Mohamed Ismail Mujahid Hilal**

*Faculty of Management, South Eastern University of Sri Lanka.*

*Corresponding Author: mujahidh@seu.ac.lk*

## Introduction and Objectives

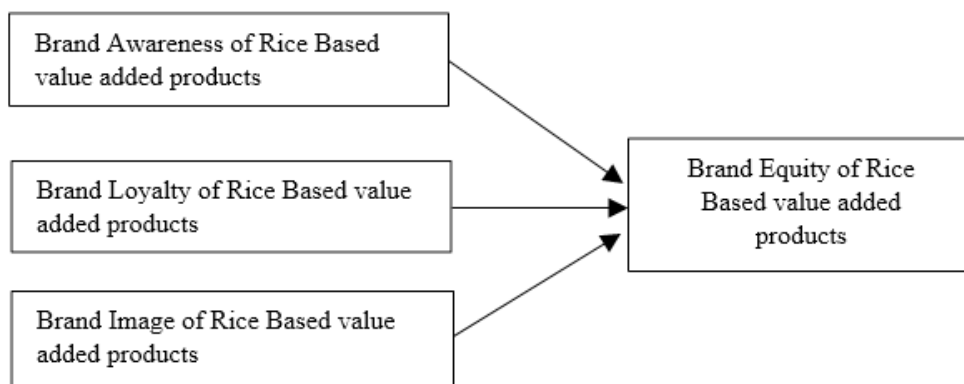
Brand equity is one of the important concepts among practitioners and academic today. A brand which has a higher equity receives substantial preferences among consumers and organizations is also getting advantages. Hence, it is vital for managers to evaluate the brand equity and how a brand equity is created and accordingly, managers formulate the marketing strategy to have a competitive advantage.

Paddy cultivation is a vital sector that contributes to the Sri Lankan economy significantly. Sri Lanka has achieved self-sufficiency in the paddy production and our country has produced 4,819,395 metric tons of paddy in 2015. At present, Sri Lanka is enjoying almost 11 per cent surplus of paddy in the country according to the Department of Census and Statistics. As alternative measures to arrest the situation, many researchers and scientists recommended manufacture of rice based products. Accordingly, many companies launched rice biscuits, noodles and flakes (Munchee's Rice Raisin Cookies, KOMA Rice Cracker with different flavours, Rice Vermicelli and Orient Flakes) as branded products. It is important for marketers to investigate their efforts on marketing of investment. Thus, the major objective of this study is to explore the key brand equity dimensions and its impact on the creation of brand equity.

## Research Methods

This study is quantitative in nature. Convenient sampling technique was adopted for this study since there are lots of consumers for these rice based value added products all over the island. The respondents were from Ampara and Batticaloa areas. The questionnaires were administered among these consumers in order to collect data. 114 duly filled questionnaires were taken for analysis. The questionnaire consisted of two parts. The first part included a demographical profile of the customers who consume rice based products and who know about rice based value added products.

The second part comprises 17 items including 5 items for brand awareness, 3 items for brand loyalty, 6 items for brand image and 3 items for brand equity. The respondents were from Ampara and Batticaloa regions. According to Keller (2013), brand awareness and brand image are the major dimensions of the brand equity and brand loyalty also contributes to the brand equity (Akar, 1991). Thus, Brand equity dimensions such as brand awareness, brand image and brand loyalty were the independent variables and overall brand equity is dependent variable in this study. The conceptual framework is shown in the following figure.



Source: Review of Literature

**Figure 01: Conceptual Framework**

Measurements were adopted from Severi & Ling (2013) for awareness, brand loyalty and overall brand equity from Yoo and Donthu (2001) and brand image from Sondoh *et al.* (2007) and Kim and Kim (2005). Respondents were asked to rate all statements in seven point likert scale. Collected data were fed into SPSS and were analyzed. Factor analysis was carried out with the principle component method. Since second in brand loyalty, forth item in the brand image and second item in the overall brand equity had communalities less than 0.5 and these items were removed and were re-factorized after the items with less than 0.5 were removed. Multivariate analysis was done using multiple regression technique. Reliability statistics were calculated and the Cronbach's Alpha value was 0.76 which was acceptable.

## Results and Discussion

Results show that all three variables such as brand awareness ( $p < 0.05$ ,  $t = 3.084$ ), brand loyalty ( $p < 0.05$ ,  $t = 4.610$ ) and brand image ( $p > 0.05$ ,  $t = 1.721$ ) are contributing to the overall brand equity of the rice based value added products. The results of the regression show that the model is a best fit (R-Square = 0.596, Adjusted R-Square = 0.585,  $F_{3, 110} = 52.12$ ,  $p < 0.05$ ). This means that 59.6 per cent of the variation in overall brand equity of the rice based products are explained by the brand awareness, brand loyalty and brand image at 5 per cent significant level. This is confirmed with the results of the following multiple regression equation.

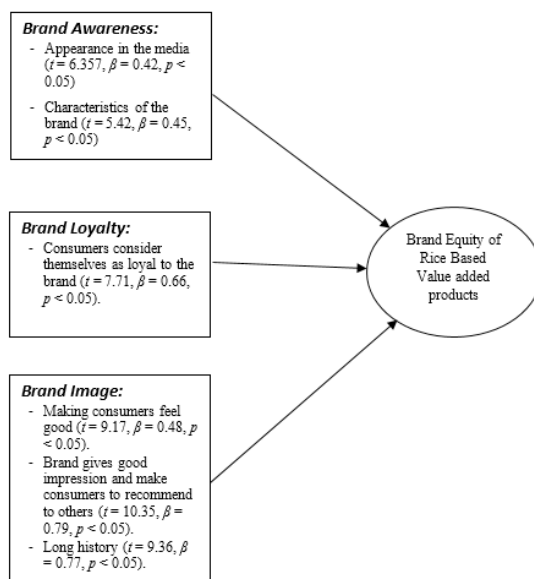
### *Brand Equity*

$$= -0.003 + 1.041 \text{ Brand Awareness} + 0.43 \text{ Brand Loyalty} \\ + 0.683 \text{ Brand Image}$$

Although the model is a best fit, all variables are significant except brand image for rice based products. The first factor, that is the most significant in creating brand equity for rice based value added product is brand loyalty and the second significant variable is brand awareness. Thus, marketers need to focus on the brand image and find ways to improve the brand image of rice based value added products in our country.

As far as brand image is concerned, marketers need to take special care of it since it is insignificant ( $p = 0.088$ ). Findings suggest that marketers should promote word of mouth by making sure that the brand offers what it has promised to give for consumers. Marketers should also have brand names for rice base products which could well be differentiated with similar and other competitive brands.

Researcher has looked at the individual influences of the three variables under study to the brand equity. This is given in the following Figure 02.



**Figure 02: Individual Attributes Influencing Brand Equity**

In the case of brand awareness, brand equity is created through media advertising and characteristics of the brand shown on the media. This is shown in the Figure 2. When brand loyalty exists and prevails, consumers' thoughts with regard to loyalty to the brand that they purchase contributes to the brand equity of the rice based value added products. Under the brand image elements, feeling of consumers with regard to brand, impression of the brand that persuade the consumers to recommend to others and long history of the brand, positively contribute to the brand equity of the rice based value added products.

## Conclusions

The objective of this study is to explore the key brand equity dimensions and their impact on the creation of brand equity. This objective has been achieved by looking at the contribution of brand awareness, brand image and brand loyalty in creating brand equity of rice based products. Marketers of rice based value added products need to focus on the brand image since it is with insignificant contribution to the creation of brand equity of rice based products. Brand image can be improved only by making aware of rice based value added products. This can be done through investing heavily on the promotion of rice based value added products with its health benefits. This study

also helps marketers to see whether their marketing efforts work well for the rice based value added products.

## References

- Aaker, D.A. (1991), *Managing Brand Equity*, Macmillan, New York, NY.
- Keller, K.L. (2013), *Strategic Brand Management: Building, Measuring, and Managing Brand Equity*, (4<sup>th</sup> ed.), Pearson, England.
- Kim, H. and Kim, W.G (2005), The Relationship between Brand Equity and Firms' Performance in Luxury Hotels and Restaurants, *Tourism Management*, Vol. 26, pp. 549-560.
- Severi E., and Ling K.W. (2013), The Mediating Effects of Brand Association, Brand Loyalty, Brand Image and Perceived Quality on Brand Equity, *Asian Social Science*; Vol. 9, No. 3, pp. 125 -137.
- Stephen L. Sondoh S. L, Omar M.W, Wahid N.A (2007), The Effect of Brand Image on Overall Satisfaction and Loyalty Intention in the Context of Color Cosmetic, *Asian Academy of Management Journal*, Vol. 12, No. 1, pp. 83–107
- Yoo B. and Donthu N. (2001), Developing and validating a multidimensional consumer-based brand equity scale, *Journal of Business Research*, Vol. 52, No.1, pp. 1-14.

# Potentials of Jalapeno (*Capsicum annum*) cultivation: Case Study of Udayarkattu and Vishwamadu Grama Niladhari Divisions (GN divisions) in Mullativu district

Arosh Bandula<sup>1\*</sup>, Achini De Silva<sup>2</sup>

<sup>1</sup> Crops for the Future Research Centre, University of Nottingham Malaysia Campus, Malaysia.

<sup>2</sup> Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O.Box 02, Belihuloya. 70140. Sri Lanka.

\* Corresponding Author: aroshb@yahoo.com

## Introduction and Objectives

Thirty years of civil war has ruined the lives of thousands of people. Rehabilitation of the ruined lives was a serious task of the post war scenario. Both Government and non-governmental organizations implemented various livelihood development programmes with higher expectations on the upliftment of the livelihoods. Both successful and unsuccessful programmes added remarks to the development agenda thus, programme evaluation provide a better direction for future work.

Jalapeno is one of the newly introduced crops to Sri Lanka where Heyleys (pvt) Ltd is the key exporter of Sri Lanka's Jalapeno produce to European International market. The product has a growing international market demand and significantly higher economic returns for the farmers. Under this favorable context, a pilot project was implemented following an out grower model to cultivate Jalapeno with selected farmers. Heyleys and Care International facilitate the project. The study objectives were to assess the success and failures of Jalapeno cultivation. In addition, reasons for the failures and identification of possible mitigation strategies were among the objectives of the study.

## Research Methods

The study purposively selected Udayarkattu and Vishwamadu Grama Niladhari divisions by considering availability of committed farmer networks and other required basic resources. These two Grama Niladhari divisions represent farming communities engaged in paddy and some traditional vegetable farming. They provide their productions to close suburb and regional markets.

This study conducted by covering full length of cultivation cycle of the crop with sixty six (66) selected farmers, represents 44 farmers from Udayarkattu and rest of the 22 from Vishwamadu. The plant counts in each farmer field were measured in initial nurseries and transplanted on permanent plant beds. The input costs and management cost were collected in terms of financial and standard labour hours and converted to monetary terms to assess the total cost. Yield data were collected in each harvesting cycle and the financial value of yield was recorded. Farmers were trained to measure and record basic data while researcher worked full time monitoring the progress of experiment. Series of farmer consultations were conducted by adopting

Focus Group Discussions (FGDs) to gather more qualitative information. Collected data were initially analysed using simple descriptive statistics. Data from community consultation underwent simple content analysis.

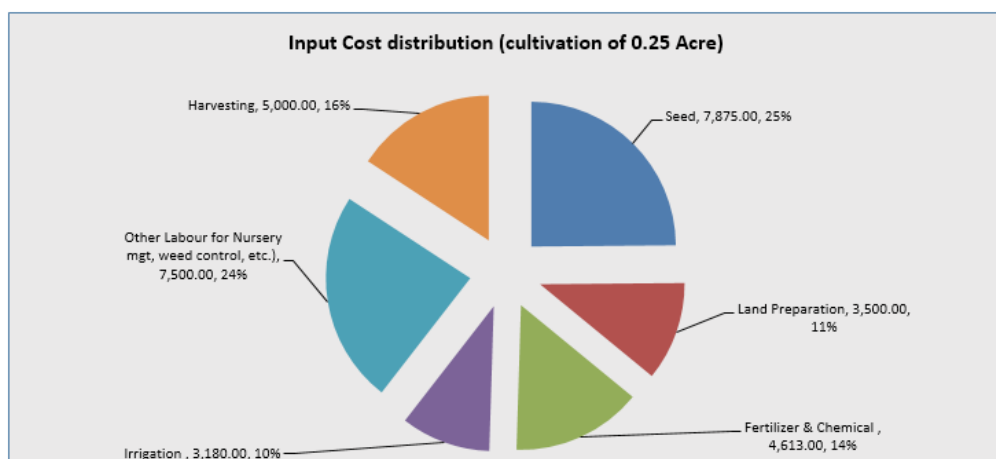
## Results and Discussion

The study found that twenty six percent (26%) of farmers abandoned their cultivation before reaching the harvesting phases of the crop. It contributes nine percent (9%) at nursery stage and rest of seventeen percent (17%) at permanent beds before reaching the harvesting phase. Only seventy four percent (74%) of farmers reached the harvesting phase.

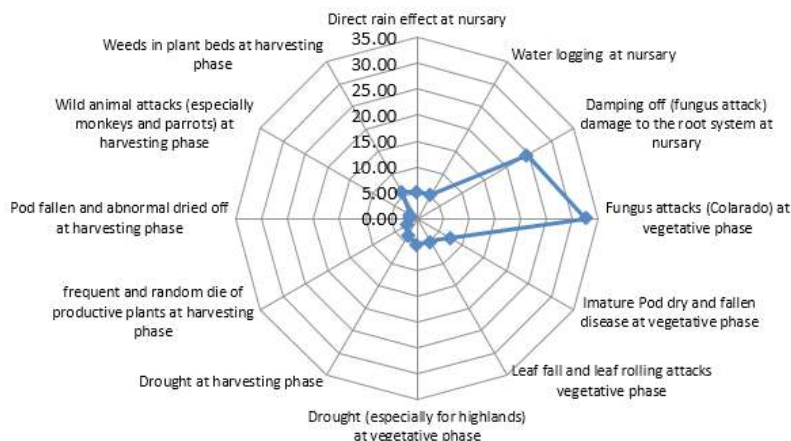
As shown in figure 1, cost for seeds contributes one fourth (25%) of the total cost followed by labour requirement for nursery and weed management (24%) and sixteen percent (16%) for harvesting practices. Those three practices collectively contribute sixty five (65%) of the total input cost.

As illustrated in figure 1, Poor yield performances are strongly contributed to the issues related to vegetative phases initially at nursery and then at permanent beds. Fifty one percent (51%) of the total yield loss contributed to issues faced at vegetative phase in permanent beds followed by 34% in nursery phase. Fungus attacks are the leading reason for the failures in both phases in addition to heavy rains, water logging and immature pod drops.

The expected average yield 0.25/Ac of Jelapano plot remained 237.5 Kg under field conditions. (Standard situation is 2500 plants 0.25/Ac bring 2500 Kg.). The low level yield contributed to low plant densities in fields is due to poor germination rates and significant death of plants before the production phase. The average yield per plant remained 165 grams in field condition though it is 1000 g /plant in favorable experimental condition.



### Factors contributing for reduced yield than expected



**Figure 01: Cost distributuion of Jalapeno cultivation and b. factors influencing poor yield**

### Conclusion

The cultivation of Jalapeno needs a greater amount of labour at different stages. Labour is the highest cost contributor for the cultivation. In this context, the crop can be recommended for farming families having a significant amount of excess family labour. Since seed is the highest individual cost contributor, emphasis on the importance of developing organized farmer groups is apparent as they involve in purchasing seed as a bulk under some discounted prices.

It is strongly recommended to maintain high quality nursery conditions and plant beds to manage death of plants at vegetative phases. Application of strategies to escape nurseries from direct rainfall and ensure good drainage in plant beds can minimize death of plants which has a direct influence on yield.

It is emphasized that the importance of improving traditional farming systems coincide with adopting new crops like jalapeno to manage risk of new crop failures and food security. It is highlighted that the importance of adopting crop insurance facility to manage the risk of failures of such crops is pivotal. Forward contracts with buy back vvreagreements with the buyer may be a good strategy to promote the crop among farmers.

### References

- Andrews, J. (1984). Peppers: The domesticated capsicum. Univ. of Texas Press, Austin. p. 49–58,102, 103.
- Bosland, P.W. (1992). Chiles: A diverse crop. Hort Technology 2:6–10.
- Heyleys annual report (2013). Heyleys Agriculture Private Limited, Sri Lanka.



# Human Health Effects of Agricultural Pollution: A Review

Ranmalee Bandara<sup>1\*</sup> and P. I. Yapa<sup>2</sup>

<sup>1</sup> Faculty of Geomatics, Sabaragamuwa University of Sri Lanka,  
PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka,  
PO Box 02, Belihuloya. 70140. Sri Lanka.

\* Corresponding Author: ranmalee@geo.sab.ac.lk

## Introduction and Objectives

In the past 50 years, farmers have become heavily dependent on intensive agriculture. It is fundamentally dependant on non-natural inputs (e.g., pesticides, herbicides and fertilizers), many of which generate residues that damage the environment and human health (Horrigan *et al.*, 2002). It uses large quantities of fossil fuels and degrades natural resources of the Earth. The farming system tends toward maximization of production while ignoring disastrous consequences such as health and environmental issues (Boody and DeVore, 2006 Reference). Under intensive agriculture, economic efficiency of farming is profoundly emphasized but the environmental costs on to society are disregarded. Protection of the environment and human health can be improved if more of our farms are transformed to eco-friendly systems of production (Brown *et al.*, 1998). Environmentally induced occupational diseases are increasing worldwide, especially in rural agricultural communities (Wimalawansa and Wimalawansa, 2016).

## Research Methods

In 1998, the world used 137 million metric tons of chemical fertilizers. Worldwide use of fertilizers increased with more than 10-fold overall and more than 4-fold per person (FAO, 1999). Common chemical fertilizers used in industrial agriculture are not used efficiently by the plants (Adesemoye and Kloepper, 2009). Tilman (1998) estimated that crops actually absorb only one-third to one-half of the nitrogen applied to farmland as fertilizer. Triple Super Phosphate (TSP), the popular synthetic Phosphorous fertilizer, is contaminated with toxic metals in particular (Dissanayake and Chandrajith, 2009).

Some of the increase in pesticide use can be attributed to mono-cropping practices, which make crops more vulnerable to pests, but the use of high-volume also reflects the imprecise nature of pesticide application (Pimentel *et al.*, 1991). Pesticides produce both short- and long-term effects on human health (Quijano *et al.*, 1993). The long-term effects of pesticides include elevated cancer risks and disruption of the body's reproductive, immune, endocrine, and nervous systems. Study by Baliga (1996) proved the effect of nonmedical use of antibiotics in intensive animal farming on weakening the effectiveness of antibiotics in treating human diseases due to the emergence of antibiotic-resistant bacteria.

Graciela *et al.* (2011) identified links between rising of both male and female infertility and frequently-used agrochemicals.



## Results and Discussion

Human health is the interactive result of several factors at the individual, family, community, national and international levels. Several sectors or disciplines have the capability to act on a wide range of conditions determining health. These include agriculture, trade, food technology and nutrition. At the outset, it is important to acknowledge that current agriculture systems have wide-ranging impacts on the quality of ecosystems and human health. The rapidly expanding human population has driven the need for greater quantities of inexpensive food through intensive farming. Pesticide-rich, fertilizer-driven, largely mechanized intensive agriculture has a significant impact on exposure of humans to toxic chemicals. Fertilizers and phosphates flow into rivers and lakes, contaminating waterways and encouraging water pollution.

Chemical food flavourings and colours are added to foods to encourage consumption (Khanna *et al.*, 1991). Pesticides remain as residues in food, and are subsequently ingested and metabolized by people. The nutritional attributes of food and food contaminants impact the consumer directly. The toll on human health that results from intensive agriculture includes considerable economic losses such as the cost of mortality, productive capacity loss due to premature death and morbidity resulting from hospitalization and health care services, both public and private (Hawkes and Ruel, 2006).

Agriculture provides opportunities to improve human health as well – e.g. ecological agriculture. It can be just as productive as intensive farming, but is better for the environment, the economy, and the human health (Bhat, 2008).

## Conclusions

Agriculture is supposed to produce enough food to feed the world population. Additionally, food that is being produced should maintain a healthy living. It is evident that current popular agriculture practices, i.e. chemical agriculture, have proven to be ineffective in supporting a healthy living. Over the quantity of food produced, quality in terms of nutrient composition and the presence of contaminants have become the key concern now, as a result of dramatic increase in health related issues. At present, there is sufficient evidence linking intensive agriculture and deteriorating human health. Thus, a complete change in agriculture system is a timely need.

## References

- FAO. Annual Fertilizer Yearbook 1998. Rome: Food and Agriculture Organization of the United Nations, 1999.
- Pimentel D, Greiner A, Bashore T. Economic and environmental costs of pesticide use. *Arch Environ Contam Toxicol* 21:84-90 (1991).
- Repetto R, Baliga SS. Pesticides and the Immune System: The Public Health Risks. Washington, DC: World Resources Institute, 1996.
- Pesticide Action Network North America (PANNA). 1999. Regional Center. Disrupting the Balance: Ecological Impacts of Pesticides in California. San Francisco: Autumn Press, 1999.

**AGRICULTURE AND AGRI-ENVIRONMENT**  
**Professional Forum**  
**8<sup>th</sup> December 2016**

## INVITED PRESENTATION

### Agriculture And Agri-Environment

#### Morning Session

### Toward the Genetic Improvements of Grain Quantity and Quality in Rice

**U.I.P. Perera and Naoki Hirotsu**

*Graduate School of Life Sciences, Toyo University, Japan*

*hirotsu@toyo.jp*

Increases in both the quantity and quality of rice, a staple crop for more than half of the global population, are imperative to support rapid population growth. To increase grain yield, we had cloned *TGW6* (*THOUSAND GRAIN WEIGHT 6*), a gene from the Indian landrace rice 'Kasalath'. *TGW6* encodes a novel protein with IAA-glucose hydrolase activity, and 1-bp deletion caused a frame shift and prevented the production of the mature protein due to a premature stop codon in 'Kasalath' allele. Through pleiotropic effects on source organs, 'Kasalath' allele *TGW6* enhances grain weight, leading to significant yield increases. We found the 'Kasalath'-type *TGW6* only in one *O. rufipogon* line and scattered across the genotypes of four cultivars from Indo-china. These suggest that *TGW6* might be a gene left behind in domestication that can be useful for further improvements in yield characters in modern cultivars. On the other hand, qualities of grain such as zinc and iron contents are supposed to be impaired by the future climate change. I will discuss about this issue and the strategy to improve grain quality in rice under climate change conditions.

## INVITED PRESENTATION

### Agriculture And Agri-Environment Evening Session

#### **Agriculture and Food Post Production Systems in Asia-and the Pacific in the Next Quarter of the Century: Emerging Trends, Challenges, Opportunities, and Way Forward**

**Prof. Keerthi Palipane** PhD New South Wales

#### **Abstract**

The major challenges in the food and agriculture sector in the future are ensuring food security and eliminating malnutrition for a continuously increasing human population under limited availability of arable land and water, continuing climate change and changes in the trends of food consumption namely, changes in commodity composition of consumed food, increased demand for organically produced and GM foods.

Population Projections indicate that the present population in the countries of Asia and the Pacific will increase from around 3.7 to 4.5 billion by the year 2050. Even though the prevalence of undernourishment in Asia and the Pacific sub region has decreased over the years, still 10 -15% of the people are undernourished. Projections of per capita food consumption show a continuous increase in the years to come from around 2500 to 3000 Kilocalories per person per day in the next few decades. On the other hand, of the total suitable crop land available for rain fed cultivation nearly 63 and 91% respectively have been already utilized in the countries of East Asia and South Asia. Further, the total water demand will increase by 462 and 243 km<sup>3</sup>/yr respectively in East and South Asia. Climate models predict temperature increases in the Asia-Pacific region of around 0.5-2.0°C by 2030 and greater rainfall concentration during the summer monsoon and decline in winter rainfall. Changes in the commodity composition of food consumption show that there is increased consumption of cereals, oil crops, meat and dairy products in the next few decades. The other emerging trends in the future are: growing interest in organic farming; and the demand for GM foods.

Since the annual crop production growth is predicted to remain at around 1.5% up to the year 2030, a viable approach to address the future challenges and trends in food production to ensure food security whilst eliminating malnutrition in developing countries is to improve the prevailing food post production systems to minimize the serious quantitative and qualitative losses occurring along the post harvest supply chain from farm to market. Some important technological needs for post-harvest loss reduction in food supply chains are: mechanization of post harvest operations; introducing scientifically designed storage facilities and systematic storage procedures;

introducing “integrated pest control” methods for control of storage pests in food crops and minimizing the use of hazardous pesticides; introducing multi-stage milling techniques for rice and other food grains; and use of improved packaging methods for handling and transportation of food crops.

Hence, adopting a “Systems Approach” to food post-harvest loss reduction by introducing “Good Practices” throughout the post harvest system will not only increase incomes of farmers and other stakeholders in the food supply chain but also assure “Food Security” in the countries of Asia and the Pacific.

# Culture Filtrates of *Alternaria* spp. as Natural Herbicides for Management of parthenium Weed

Arshad Javaid\*, Tahira Mubeen and Uzma Bashir

Institute of Agricultural Sciences, University of the Punjab, Lahore, Pakistan.

\* Corresponding Author: arshadjpk@yahoo.com

## Introduction and Objectives

Parthenium weed (*Parthenium hysterophorus* L.), family Asteraceae, inhabits in most parts of the world and is now considered as world's noxious weed due to its invasiveness, adaptability to variable environmental conditions, ability to grow and spread luxuriantly (Kumari, 2014). This weed poses serious biotic threats to plants due to its potential to alter above-ground vegetation, below-ground soil nutrients and to act as alternate host for pest and diseases of crops (Timsina *et al.*, 2011). Chemical herbicides such as glyphosate, atrazine and trifluralin are effective to control this weed. However, because of environmental concerns associated with the use of synthetic herbicides, substantial efforts have been made in search of alternative environmental friendly weed-management strategies (Teerarak *et al.*, 2010). Recent studies show that fungal metabolites can be used as potential alternatives to chemical herbicides for parthenium management (Javaid *et al.*, 2011). The current investigation was carried out to assess the Bio-herbicidal potential of culture filtrates of *Alternaria japonica* and *Alternaria longipes* prepared in different growth mediums against parthenium weed.

## Research Methods

Pure culture of *A. japonica* and *A. longipes* were obtained from Fungal Culture Bank of Pakistan, University of the Punjab, Lahore, Pakistan. Both the species were grown in malt extract broth and potato dextrose broth for 15 days. Culture filtrates were obtained by passing the materials through muslin cloth followed by filtration through filter paper and then through Millipore filter paper. In laboratory bioassays, the effect of original (X) and diluted ( $\frac{1}{2}$  X) filtrates was studied on seed germination, and shoot and root growth of parthenium. Twenty five surface sterilized seeds were placed on pre-sterilized glass Petri plates (9-cm diameter) lined with double layer of filter papers, moistened with 2.5 mL of each original and diluted concentrations of the fungal metabolites. In control treatment, sterilized distilled water was used instead of fungal culture filtrates. Each treatment was repeated four times. Data concerning seed germination and plant growth were recorded after 10 days. *In vivo* study was carried out by spraying culture filtrates of the two *Alternaria* species prepared in potato dextrose broth. In this experiment, pot grown 1-, 2- and 3-week old parthenium seedlings were sprayed 3 times with original (X) and concentrated (2X) fungal culture filtrates, with intervals of 4 days. Plants were harvested after 45 days growth and length, and fresh and dry weight of root and shoot were recorded.

## Results and Discussion

In laboratory bioassays, generally, culture filtrates of both the *Alternaria* spp. prepared

in either of the two growth mediums significantly reduced germination and seedling growth of parthenium. However, culture filtrates prepared in potato dextrose (PD) medium showed greater herbicidal activity than those prepared in malt extract (ME) broth. Original metabolites prepared in PD reduced germination, shoot biomass and root biomass of parthenium up to 80%, 93% and 81%, while those prepared in ME reduced these parameters by 51%, 80% and 78%, respectively, over control. Metabolites of *A. japonica* showed greater herbicidal activity than metabolites of *A. longipes*. Different herbicidal effects of fungal metabolites in the two growth mediums might be the result of formation of different types or quantities of herbicidal constituents in dissimilar growth mediums.

In foliar spray trials, herbicidal effect of the fungal metabolites was associated with concentration of the filtrates and the age of the host plant. In general, 1-week old parthenium seedlings were highly susceptible to foliar spray of metabolites of both the *Alternaria* species. Original and concentrated metabolites of *A. japonica* significantly reduced shoot length by 36% and 70% in 1-week, and 22% and 47% in 2-week old parthenium seedlings, respectively. The effect of metabolites on shoot length of 3-week old plants was insignificant. Similarly, original and concentrated metabolites of *A. longipes* significantly reduced shoot length by 60% and 71% in 1-week, and 39% and 47% in 2-week old parthenium seedlings, respectively (Table 1). Previous studies also showed that herbicidal activity of fungal metabolites is decreased with the age of the parthenium (Javaid *et al.*, 2011).

**Table 01: Effect of foliar spray with culture filtrates of two *Alternaria* spp. on growth of pot grown parthenium plants.**

Age of plant	Conc.	Culture filtrates of <i>A. japonica</i>				Culture filtrates of <i>A. longipes</i>			
		Shoot length (cm)	Shoot dry wt (g)	Root length (cm)	Root dry wt (g)	Shoot length (cm)	Shoot dry wt (g)	Root length (cm)	Root dry wt (g)
1-Week	Control	8.9 a	1.16 a	26.2	0.09 a	9.18 a	1.18 a	26.1 a	0.08 a
	X	5.7 c	0.70 bc	16.1	0.06 b	3.6 de	0.80 bc	15.4 bc	0.05 bc
	2X	2.7 e	0.61 c	13.0	0.05 bc	2.6 e	0.50 d	13.4 c	0.03 cd
2-Week	X	6.9 b	0.80 bc	19.3	0.05 bc	5.6 c	0.93 a	15.0 bc	0.06 ab
	2X	4.7 d	0.66 c	18.3	0.04 c	4.8 cd	0.54 d	13.2 c	0.02 d
3-Week	X	8.8 a	0.96 ab	21.4	0.06 b	8.3 ab	0.90 ab	17.1 b	0.08 a
	2X	8.2 a	0.71 bc	19.1	0.04 c	7.8 b	0.70 cd	15.0 bc	0.06 ab

Values with different letters in a column show significant difference ( $P \leq 0.05$ ) as determined by LSD Test.

## Conclusions

The present study concludes that culture filtrates of *A. japonica* and *A. longipes* contain potent herbicidal constituents for ecofriendly management of parthenium weed. Culture filtrates of both species prepared in potato dextrose broth showed higher herbicidal activity against parthenium weed than those prepared in malt extract broth.

## References

- Javaid, A., Javaid A., Akbar, M. (2011). Herbicidal potential of culture filtrates of *Drechslera* spp. against *Parthenium hysterophorus*. *Chilean Journal of Agricultural Research*, 71(4), 634-637.
- Kumari, M. (2014). *Parthenium hysterophorus* L.: A Noxious and Rapidly Spreading Weed of India. *Journal of Chemical, Biological and Physical Sciences*, 4(2), 1620-1628.
- Teeraraka, M., Laosinwattanaa, C., Charoenying, P. (2010). Evaluation of allelopathic, decomposition and cytogenetic activities of *Jasminum officinale* L. f. var. *grandiflorum* (L.) Kob. on bioassay plants. *Bioresource Technology*, 101(14), 5677-5684.
- Timsina, B., Shrestha, B.B., Rokaya, M.B., Munzbergova, Z. (2011). Impact of *Parthenium hysterophorus* L. invasion on plant species composition and soil properties of grassland communities in Nepal. *Flora - Morphology, Distribution, Functional Ecology of Plants*, 206(3), 233-240.



# Evaluation of Field Efficacy of Selected Insecticides against Brinjal shoot and Fruit Borer, *Leucinodes orbonalis* Guenee

R. F. Niranjana<sup>1\*</sup>, M. Devi<sup>2</sup> and R. Philip Sridhar<sup>2</sup>

<sup>1</sup> Department of Agricultural Biology, Faculty of Agriculture,  
Eastern University of Sri Lanka, Chenkalady, Sri Lanka.

<sup>2</sup> Department of Agricultural Entomology, Tamil Nadu Agricultural University,  
Coimbatore 641003, Tamil Nadu, India.

\* Corresponding Author: [nirurodney@gmail.com](mailto:nirurodney@gmail.com)

## Introduction and Objectives

The brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenée (Crambidae: Lepidoptera) is the most serious and destructive pest of brinjal throughout South Asian region with a yield loss up to 60-80% (Kaur *et al.*, 2010). As the larvae of *L. orbonalis* lies inside the fruit or shoot the management of this pest become too difficult (Alamet *et al.*, 2003). However, farmers rely exclusively on the application of insecticides to control *L. orbonalis*, to produce blemish-free brinjal fruit and to get maximum yield. Indiscriminate use of toxic, broad-spectrum pesticides threatens the health of farmers and consumers, through bioaccumulation and biomagnification of toxic residues; in addition, it causes environmental contamination and disturbance in ecological balance. Hence the present investigation was carried out to select new promising insecticides against brinjal shoot and fruit borer, *L. orbonalis*.

## Research Methods

The field experiments were carried out to evaluate the bioefficacy of ten synthetic insecticides against *L. orbonalis* on brinjal at Alandurai, Thondamuthur, Coimbatore, Tamil Nadu, India during the seasons *Rabi* 2014/15 (October 2014 to January 2015) and summer 2015 (February to May 2015). The experiments were conducted with four replicates in a randomized block design (RBD). All the recommended agricultural practices were followed while raising the crop. Pre-treatment observations on the infestation of *L. orbonalis* were taken before spraying and all infested shoots and fruits were removed manually while pre and post treatment observations were made in weekly interval. Two rounds of application were made (21 days interval) using hand-held, single-nozzle, atomizing (air-assist) sprayer: pneumatic knapsack sprayer. The spray nozzle was carried near ground level and directed at a right angle to the row. Each row was sprayed twice, once from each side with the spray volume of 400 litres per ha. All spray applications were made during early morning. The percent shoot damage and the number of natural enemies prevailed in each insecticide treated plot were counted at a weekly interval whereas fruit damage was recorded at the time of harvesting. In order to count the numbers of natural enemies, 10 brinjal plants were randomly selected from each plot and counted the numbers of natural enemies from various species. It was recorded as numbers of natural enemies per 10 plants.

## Results and Discussion

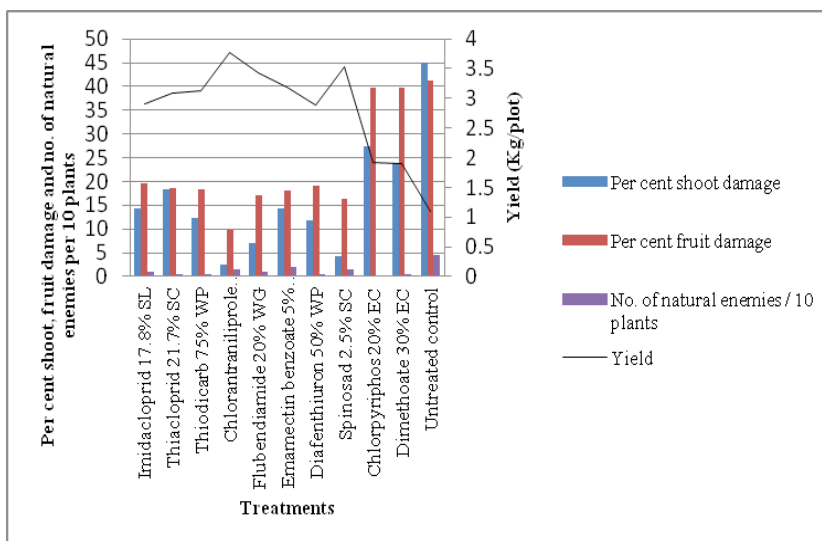
### *Effect of insecticides on shoot and fruit infestations and yield*

It was noticed that almost all insecticides reduced the shoot and fruit infestation and increased the yield substantially in 14 days after 2<sup>nd</sup> spray (Fig. 1); however, Chlorantraniliprole 18.5% SC was found to be the most effective insecticide in reducing shoot (15.4%) and fruit (9.9%) infestation with high yield (1,890 kg/ha) in brinjal cultivation. Next to that, Spinosad 2.5% SC and Flubendiamide 20 WG were proved their efficacy against *L. orbonalis*.

Misra (2011); Dattatrayet *al.*, (2012) studied the efficacy of Chlorantraniliprole against *L. orbonalis* at field level and stated its better in efficiency in producing maximum yield with least shoot and fruit infestation.

### *Effect of insecticides on natural enemies*

It was observed that almost all chemical insecticides comparatively reduced the activities of natural enemies (Figure 01), though Chlorpyrifos 20% EC (1.0 nos./10 plants at 14 days after 2<sup>nd</sup> spray) and Dimethoate 30% EC (0.5 nos./10 plants at 14 days after 2<sup>nd</sup> spray) drastically reduced the natural enemies. Emamectin benzoate 5 SG, Spinosad 2.5% SC and Chlorantraniliprole 18.5% SC fairly safe to natural enemies and 3 natural enemies/ 10 plants were observed in these treated plots which were equivalent to untreated control plot at 14 days after 2<sup>nd</sup> spray.



**Figure 01: Efficacy of chemical insecticides against of *L.orbonali***

In connection with the present study Misra (2011) also stated that Chlorantraniliprole at the dose 20-50 g a.i/ha was safe to natural enemies prevailed in brinjal fields.

## Conclusions

The study showed that almost all insecticides except Chlorpyrifos 20% EC and

Dimethoate 30% EC reduced the shoot and fruit infestation in brinjal substantially in 14 days after 2<sup>nd</sup> spray whereas Chlorantraniliprole 18.5% SC was found to be the most effective insecticides followed by Spinosad 2.5% SC and Flubendiamide 20 WG.

The study also revealed that approximately all chemical insecticides comparatively reduced the activities of natural enemies, though it was high in Chlorpyrifos 20% EC and Dimethoate 30% EC treated plots. Emamectin benzoate 5 SG, Spinosad 2.5% SC and Chlorantraniliprole 18.5% SC were fairly safe to natural enemies.

## References

- Alam, S. N., Rashid, M. A., Rouf, F. M. A., Jhala, R. C., Patel, J. R., Satpathy, S., Shivalingaswamy, T. M., Rai, S., Wahundeniya, I., Cork, A., Ammaranan, C. and Talekar, N. S.(2003). Development of an integrated pest management strategy for eggplant fruit and shoot borer in South Asia. Shanhua, Taiwan: AVRDC—the World Vegetable Center. *Technical Bulletin No. 28*. AVRDC Publication No. 03-548. 56 pp.
- Dattatray, S., Meena, P., Usha, Z. and Parimi, S.(2012). Newer Insecticides for the Management of Brinjal Fruit and Shoot Borer, *Leucinodes orbonalis*. *Indian Journal of Plant Protection*, 40(4): 273-275.
- Kaur, M., Dhatt, S., Ajmer, S., Sandhu, J. and GosalSatbir, S.(2010). Genetic transformation of Cry 1AC gene to counter fruit and shoot borer of brinjal (*Solanum melongena* L). *Crop Improvement*, 37(2), 200.
- Misra, H. P.(2011). Bioefficacy of Chlorantraniliprole against shoot and fruit borer of brinjal, *Leucinodes orbonalis* Guenee. *Journal of insect science*, 24(1): 60-64.

# Anthracnose Resistance of Chilli Accessions Available in Sri Lanka

K.A.S.I. Kumari<sup>1\*</sup>, D.M.J.B. Senanayake<sup>1</sup>, C.M. Nanayakkara<sup>2</sup>, A. Balasuriya<sup>3</sup>,  
W.A.R. Dhammika<sup>1</sup>, W.M.K Fernando<sup>1</sup>, W.M.S.B.K Wijerathne<sup>1</sup>,  
P.J.K Dasanayake<sup>1</sup>

<sup>1</sup> Field Crops Research and Development Institute, Mahaelluppallama.

<sup>2</sup> University of Colombo, Colombo.

<sup>3</sup> A. Balasuriya, Abaya, Kamburupitiya.

\* Corresponding Author: shanikaisuru@gmail.com

## Introduction and Objectives

Chilli (*Capsicum annum* L), one of the economically important field crops cultivated in Sri Lanka, is challenged by a number of pests and diseases. Chilli anthracnose caused by *Colletotrichum* spp. is a major disease problem, which affects healthy seed production and post-harvest quality of chilli during *Yala* and *Maha* seasons. Major symptoms of anthracnose include small circular spots on the skin of the fruit, which expand in the direction of long axis leading to premature fruit drop. The frequent application of fungicides for the controlling of the disease causes social and environmental problems. Therefore, a profitable and sustainable disease management method, such as the use of disease resistant varieties is essential. There are no anthracnose resistant chilli accessions in Sri Lanka. Therefore, this study was carried out to identify the reaction of locally available chilli accessions to anthracnose disease.

## Research Methods

Anthracnose affected chilli pods were collected from the research field of the Field Crops Research and Development Institute, Mahaelluppallama during 2015/16 *Maha* season. Suspected causal organisms were isolated from them on to potato dextrose agar media plates and the plates were incubated at 28-30 °C. Cultural tests, microscopic observations and Koch's Postulation procedure was followed to confirm the pathogen. Twenty one chilli accessions were selected for screening. Detached fruit inoculation was done. Healthy ripened pods obtained from each accession were surface sterilized with 70% ethanol followed by 2-3 washing with sterilized distilled water. Samples were injured softly with flame sterilized needles and inoculated with droplets of *Colletotrichum capsici* and *Colletotrichum gloeosporioides* spore suspensions (10<sup>5</sup> spores/ml), separately. The lesion developments were measured ten days post-inoculation, under *in-vitro* (28°C and RH-100%) conditions. Anthracnose symptoms were evaluated at the inoculation site, on the basis of the developed lesion size relative to the overall size of the pod. Data were analyzed using SAS software version 9.0 (two isolates x twenty one accessions) in a complete randomized design to test the main and the interaction effects. According to the method described by Montri (2009), disease severity was assessed on a scale of 0-9 as follows: 0=No infection; 1=1-2% of the pod showed necrotic lesion; 3= >2-5% of the pod showed necrotic lesion, acervuli may be present or water soaked lesion up to 5% of the pod's surface; 5= >5-15% of

the pod showed necrotic lesion with acervuli; 7= >15–25% of the fruit area showed necrotic lesion with acervuli; 9=>25% of pod showed necrosis, lesion often encircling the pod, abundant acervuli. Based on the above scale, accessions were grouped into six classes: no infection = highly resistant; score 1 = resistant; score 3 = moderately resistant; score 5 = moderately susceptible; score 7 = susceptible and score 9 = highly susceptible. Plants of twenty one accessions, with mature pods, were also inoculated with spore suspensions ( $1 \times 10^5$  spore  $\text{ml}^{-1}$ ) twice per day while maintaining 100% RH. The symptom variation was visually assessed up to the 14<sup>th</sup> date post inoculation.

## Results and Discussion

In the study, isolated chilli anthracnose causal organisms were identified as *C. capsici* and *C. gloeosporioides*. *C. capsici* cultures appeared on culture plate as irregular, fluffy mycelium, white to grey color, with a dark center and under side having dark concentric zones. Spores were hyaline with both ends curved and pointed as well as gradually tapering towards both ends. Upper side of *C. gloeosporioides* cultures initially showed white color, which turned light orange with time. The colony was with a thin mycelium and under side was dark in color, zonated, colonized, with abundant orange colour conidial masses near the center. Spores of *C. gloeosporioides* were cylindrical with rounded ends.

According to detached pod inoculation study results, it was observed that the lesion lengths developed with the two isolates, *C. capsici* and *C. gloeosporioides* on different chilli accessions were not significantly different ( $P=0.0001$ ) from each other.

Anthracnose severity that was evaluated with plant inoculation, according to the method described by Montri (2009), Jaffna local (34.95%) and Waraniya (25.84%) were highly susceptible to both the species while CAH36 (21.98%), ICPN (21.19%), MICH3 (16.89%) and PBC 380 (22.92%) were susceptible. The Galkiriyagama selection (10.78%), Hèn miris (13.23%), Kochchi-1 (9.68%), Kochchi-2 (13.11%), KA-02 (12.80%), MI-02 (13.08%), MI Green (13.39%), MICH3 (14.8%), Jaffna Selection (12.23%), Waraniya purple (9.68%), 987.3 (13.11%) and Chilli Thai (commercial variety)(13.85%) showed a moderately susceptible reaction. The susceptibility was the lowest *Arunalu* (8.59%) and MI Hot (8.23%). Visual observations under *in-vivo* conditions showed symptom variation among the accessions. Sunken concentric patches appeared on mature pods of ICPN within seven days after inoculation and the other accessions took more than 07 days for the same. Waraniya, Jaffna local and MI Hot showed sunken concentric patches on leaves. The study revealed that none of the tested accessions were totally resistant to anthracnose disease.

## Conclusions

Both *C. capsici* and *C. gloeosporioides* species equally damage the host. Jaffna local and Waraniya were highly susceptible against tested *Colletotrichum* species while CAH36, ICPN MICH3 and PBC 380 showed susceptible reaction. The Galkiriyagama selection, Hèn miris, Kochchi-1, Kochchi-2, KA-02, MI-02, MI Green, MICH3, Jaffna Selection, Waraniya purple, 987.3 and Chilli Thai (commercial variety) showed moderately susceptible reaction and are placed in moderate susceptibility group,

*Arunalu* and MI Hot showed the lowest susceptible reaction in susceptible range and these findings may be useful for developing anthracnose tolerant varieties.

## References

- Garg, R. (2012). Novel sources of resistance and differential reactions on chilli fruit infected by *Colletotrichum capsici*. *Australasian Plant Pathology Society*.41, 463-473
- Rajapakse, R.G.A.S (2002). Development of variety screening method for anthracnose disease of chilli (*Capsicum annuum* L.) under field conditions. *Topical Agriculture Research and Extension* 5(1&2)
- Montri, P. (2009). Pathotypes of *Colletotrichum capsici*, the causal agent of chili anthracnose, in Thailand. *Plant Dis.* 93,17-20

# Evaluation of Different Weed Management Practices in Machine Transplanted Rice Cultivation

R.M.U.S.Bandara<sup>1,2</sup>, A.S.K. Abeysekara<sup>1</sup>, W.M.U.B. Wickrama<sup>1</sup>,  
H.M.M.K.K.H. Dissanayaka<sup>1</sup>, A.N. Siriwardana<sup>2</sup>, N.M.D.P. Nawarathna<sup>2</sup>  
and Y.M.S.H.I.U. De Silva<sup>1,3</sup>

<sup>1</sup> Rice Research and Development Institute, Batalagoda, Ibbagamuwa, Sri Lanka.

<sup>2</sup> Post Graduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.

<sup>3</sup> Post Graduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.

\* Corresponding Author: [rmusbandara@gmail.com](mailto:rmusbandara@gmail.com)

## Introduction

The yield performance of lowland rice varieties depends on the method of crop establishment. However, yield of transplanted rice is generally believed to be higher than that of dry-seeded rice (Balasubramanian *et al.*, 2003). Broadcasting is the most widely practiced establishment method by Sri Lankan paddy farmers. Though it is easier to be practised it has several disadvantages such as high weed infestation, high insect pest infestation and lodging. Under the *Yaya II program*, farmers were introduced machine transplanting by the Department of Agriculture of Sri Lanka. Inter row spacing of the transplanting machine is a fixed value of 30cm. It allows a severe weed infestation in the field and finally resulting a significant yield loss. Thus, weed management is an essential practice in machine transplanting. Farmers are looking for a better weed management practice in machine transplanting. This study was conducted with the objective of finding out a better weed management practice in machine transplanting.

## Materials and Methods

A farmer's field demonstration experiment was conducted at Manapaha in Kurunegala District in 2015/2016 Maha Season in order to evaluate and show performances of different weed management practices in machine transplanted rice cultivation. The demonstration had 07 treatments [T1=Pretilachlor 300g/l+Pyribenzoxim 20g/l followed by weeding twice, T2= Pretilachlor 300g/l +Pyribenzoxim 20g/l, T3= Pretilachlor 300g/l EC, T4= Pretilachlor 300g/l EC followed by weeding twice, T5=Weeding twice (at 2 Weeks After Transplanting (2WATP) and 4Weeks After Transplanting (4WATP), T6=Hand-weeding and T7=No-weeding].

Each Treatment plot was 18 square meters in size. Crop establishment was done using machine-transplanter. Fertilizer application was done according to the recommendation of the Department of Agriculture, Sri Lanka. Weed dry weights were taken in each treatment at 06 weeks after transplanting. Final grain yields were measured in 03 crop cuts in each plot as three replicates. Data was analysed employing a ANOVA using SAS software.



## Results and Discussion

Treatment	Weed Dry Weight (g/m <sup>2</sup> )	WCE %	Grain Yield (mt/ha)
Pretilachlor 300g/l + Pyribenzoxim 20g/l followed by Weeding twice	1.63 c	98.5	6.63 b
Pretilachlor 300g/l + Pyribenzoxim 20g/l	1.50 c	98.7	6.70 b
Pretilachlor 300g/l EC	1.43 c	98.7	7.84 a
Pretilachlor 300g/l EC followed by Weeding twice	1.50 c	98.7	6.63 b
Weeding twice (at 2 WATP and 4WATP)	33.96 b	69.8	6.63 b
Hand-weeding (Control)	0 c	100.0	6.85 a
No-weeding (Control)	112.38 a	---	3.50 c

\*\* Means with the same letter are not significantly different ( $\alpha=0.05$ ).

**Table 01: Weed dry weight, Weed Control Efficacy (WCE), Plant height and Grain yield of different treatments**

Weed dry weights of all treatments were significantly different from *no-weeded control*. Weed dry weights of all herbicide treatments were comparable with *hand-weeded control*. Weed dry weights of treatment 05 (*weeding twice*) was significantly different from *no-weeded control*. Herbicide treatments showed a lower weed dry weight than *Weeding twice* treatment. It is because herbicide treatments could kill weeds emerged from inter rows and within rows whereas weeding could only kill weeds emerged from inter rows. *Mechanical weeding* could enhance the growth of weeds which are vegetatively propagated through stem cuttings and therefore, *weeding twice* treatment showed a higher weed dry weight than that of herbicide treatments. *Pretilachlor 300g/l EC* and hand-weeded control showed comparably higher grain yields. Their yields were the highest among all other treatments. Although only *weeding* treatment showed a higher weed dry weight, its yield was comparable with treatments *T1*, *T2* and *T3* because it was still capable of managing weed population below the economic threshold. Although *weeding* loosen and aerate the soil, there were no yield increment shown in such treatments. That may be due to rice crop is well adopted to submerged condition and therefore, there exists no any special response for loosening and aeration of the soil by *weeding* practice.

## Conclusion

All treatments ultimately gave a significantly higher yield than no-weeded control. It is clear that weed control is essential in machine transplanted rice cultivation. Only *Weeding* was also effective in managing weed population below the economic threshold in machine transplanted rice cultivation. *Pretilachlor 300g/l EC* was well performed among all herbicide treatments in machine transplanted rice cultivation.



## References:

- Abeysekera, A.S.K., K. Jayawardana, L. Ranasingha and A. Senevirathna (2000). Effect of novel herbicides on control of weeds in rice fields in Sri Lanka. Proc of the Third International weed science Congress, Fozdo, Igussu, Brazil pp249-251
- Abeysekera, A.S.K., Jhonson D, Herath H.M.S and U.B. Wicrama (2006) Diversity of Weed Flora in Wet Seeded Rice in Sri Lanka. International Rice Congress 2006. New Delhi India 9<sup>th</sup> -13<sup>th</sup> October 2006.
- Balasubramanian, V., J.K. Ladha, R.K. Gupta, R.K. Naresh, R.S. Mehla, B. Singh and Y. Singh. (2003). Technology options for rice in the rice-wheat system in south Asia. In: Improving the Productivity and Sustainability of Rice-Wheat Systems: Issues and Impacts. ASA Special publication 65.
- Balasubramanian V., R. Rajendra, V. Ravi, N. Chellaiah, E. Castro, B. Chandrasekaran, T. Jayraj and S. Ramanathan. 2006. Integrated Crop Management for Enhancing Yield in Transplanted Rice Systems in Kerala. International Symposium on Rice from Green Revolution to Gene Revolution. Directorate of Rice Research, Hyderabad, India, 4-6 October 2004.
- Department of Agriculture, Sri Lanka, Pest Management Recommendations (2015)

# Distribution of Myrothecium Leaf Spot of Bitter Gourd in Different Agro-ecological Zones of Punjab

Salik Nawaz Khan\*, SumeraNaz, Shumaila Farooq,

*Institute of Agricultural Sciences, Quaid-E-Azam Campus, University of the Punjab, Lahore.*

*\* Corresponding Author: salik\_nawaz@yahoo.com*

## Introduction

*Momordicacharantia* L. (Bitter gourd) locally known as “Karawila” is one of the most popular vegetables because of its medicinal and nutritional value. So far, more than 15 fungal, bacterial and viral plant pathogens have been reported to attack bitter gourd plant in Pakistan. The *Myrothecium* Leaf Spot (MLS) was first reported during 1988 at Faisalabad district of Punjab province and remained as a minor issue in certain pockets of the province. During 2007, it appeared as an alarming issue for bitter gourd cultivation. The disease is characterized by appearance of water soaked minute spots that are dark brown to black in color. These spots vary in shapes from round to irregular and may present anywhere on leaves. These spots coalesce on later stages of what to form blighted areas on the leaves (Belisario *et al.*, 1999). Irregularly shaped black sporodochia can form with a white fringe of mycelium. These spore structures appear in concentric rings within the necrotic areas and seen on the leaf undersides. Very little information is available on distribution pattern of *Myrothecium* Leaf Spot in the province. Therefore, the study was designed to investigate the disease distribution pattern in Punjab province during 2011-2013;

to classify different agro-ecological zones with respect to prevalence of MLS

to suggest new areas for cultivation of Bitter gourd where crop is naturally safe from diseases.

## Materials and methods

The surveys were conducted on from April 2011 to September 2013 at all growth stages of crop seedling, vegetative, flowering and fruiting. It was conducted on early spring (February-March) and late summer (mid-June – mid July) seasoned crops. Disease assessment was made on disease prevalence, incidence, and severity and percent disease index. Formulae used for the calculations are given below. Prevalence percentage of the disease was calculated on the basis of the number of locations showing disease in an area; whereas, Percent disease incidence was noted on leaves/plant infected from five spots in a field. Data for severity of disease was recorded on a 0-5 visual severity rating scale. In Pakistan, considering vegetables’ rectangular shape a land space of 0.25 hectares was considered as the basic sample unit. A total of 319 locations from 11 sub agro-ecological zones covering 24 districts and 117 fields comprising on 0.25 hectares from farmers’ fields, demonstration plots of Extension Wing of Punjab Agriculture Department were included.

## Results

Disease was widely distributed and none of the area or cultivar was found disease free in canal irrigated plains and Barani areas. The disease was observed at every growth stage of the plant and cumulative description of the surveys conducted during 2011, 2012 & 2013 revealed the highest prevalence, disease incidence and severity and disease index for *Myrothecium leaf spot* (MLS) disease in mixed cropping zone of Punjab. Mean prevalence of MLS disease was consecutively recorded 100 % for the surveyed years in mixed cropping zone whereas in rice zone, 36, 32 and 42% for the year 2011, 2012 and 2013 respectively were recorded. Barani and zone showed prevalence range of 14 to 17% and the highest 17% was recorded during 2013 whereas cotton zone exhibited a range of 14 to 22% and the highest 22% was recorded during 2012. The least prevalence recorded in DG Khan Zone was 11, 19 and 14 % during the years 2011, 2012 and 2013 respectively (Table 01).

**Table 01: Geographical distribution of *Myrothecium roridum* during 2011-13 in districts of mixed cropping zone of the Punjab, Pakistan**

District	PDI $\pm$ SE	DSR (0-5)	PDIn $\pm$ SE
Lahore	59.07 $\pm$ 0.23	1-4	31.43 $\pm$ 0.19
Kasur	44.56 $\pm$ 0.11	1-3	27.04 $\pm$ 0.07
Faisalabad	33.17 $\pm$ 0.28	1-3	23.14 $\pm$ 0.20
Sargodha	48.22 $\pm$ 0.29	1-4	31.05 $\pm$ 0.25
Jhang	28.73 $\pm$ 0.13	0-3	10.27 $\pm$ 0.17

PDI= Percent disease incidence; DSR= Disease severity range; PDIn= Percent disease index; SE= standard error

## Discussions

The cumulative assessment of surveys conducted during 2011, 2012 and 2013 exhibited highest disease index of 29, 25 and 30% respectively in the mixed cropping zone whereas the least disease index of 3.27, 4.13 and 3.23 % during 2011, 2012 and 2013 respectively was recorded in DG Khan Zone. Disease severity was ranged 1-4 on visual severity rating scale (VSRS) for mixed cropping zone while in DG Khan irrigated, ranged from 0-2 during the surveyed years. The mixed cropping zone consists of Lahore, Faisalabad, Kasur, Gujranwala and Jhang districts. Significant variation prevails for meteorological conditions, production technology, market approach investment trends and crop protection strategies. In mixed cropping zone, soil is fertile and intensive cultivation culture prevails in general. Cultivation of vegetables in tunnels makes it more susceptible because fungal inoculums and availability of favorable environmental conditions make situation worst (Powell *et al.*, 2013). In these areas no strong background for cultivation of vegetables on commercial scale exists and a dry hot climate with sandy loam soils exists. On the west bank of DG Khan link canal, low rainfall and poor quality sandy loam soil is found generally. Keeping in view of disease statistics and analysis of field and market sociology, it is suggested

that these disease free or lower index areas should be promoted for vegetables and especially for bitter gourd cultivation.

## Conclusion

Present investigation helped to identify new areas in southern regions comprising with DG Khan and its adjacent districts of Punjab for bitter gourd cultivation. General discussion with state governed and private stake holders revealed that the reason for low disease is being newly introduced and cultivation on lesser areas, because of poor market facilities and network for major cities of the countries. Therefore, the Government should introduce an improved production technology and a market network system so that farmers of underdeveloped areas should get better economic return.

## References

- Belisario A, Forti E, Corazza L and van Kestsren HA. (1999). First report of *Myrotheciumverrucaria* from muskmelon seeds. *Plant Pathol.*,83: 589.
- Hoagland RE, Weaver MA and Boyette CD. (2007). *Myrotheciumverrucaria* fungus; Abioherbicide and strategies to reduce its non-target risks. *Allelopathy J.*, 19(1):179-192.
- Powell M, Cowan J, Miles C and Inglis DA. (2013). Effect of a high tunnel, organic cropping system on lettuce diseases in western Washington. *Plant Health Prog.* Onlinepublication.doi, 10.1094/PHP-2013-0922-01-RS.
- Robinson RW and Decker-Walters DS. (1999). Cucurbits, CAB International, Oxon (GB) pp 226.

# Eco-geographic Distribution of Proso Millet (*Panicum miliaceum* L.) in Sri Lanka

L.M.H.R. Alwis<sup>1\*</sup>, Sean Mayes<sup>2</sup>, Ho Wai Kuan<sup>3</sup>, A.S. Karunaratne<sup>4</sup>

<sup>1</sup> Faculty of Animal Science and Export Agriculture, Uva Wellassa University.

<sup>2</sup> School of Biosciences, University of Nottingham, Sutton Bonington Campus, UK.

<sup>3</sup> Crops For the Future, Semenyih, Selangor, Malaysia.

<sup>4</sup> Faculty of Agricultural Sciences, Sabaragamuwa University, Belihuloya, Sri Lanka.

\* Corresponding Author: mangalee@uwu.ac.lk

## Introduction and Objectives

Proso millet (*Panicum miliaceum* L.) is an underutilized cereal food crop grown in subsistence farming systems in Sri Lanka for human consumption and bird seed purposes (Karunaratne, 2015). It is a hardy crop that can be grown well in dry environments requiring less water. Proso millet has an excellent food value as its seeds are rich in fiber content, non-starchy polysaccharides with some unique proteins and are also rich in minerals and trace elements like iron, zinc, copper and magnesium (James *et al.*, 2011). With short duration conditions, high adaptability to drought, hardiness and delayed monsoon conditions with poor soil nutrients, proso millets are successful in cultivation in semi-arid regions under marginal lands (Hunt *et al.*, 2011), however, it has been neglected in the main stream of crop improvement. Identifying genetic diversity available in proso millet germplasm is a prerequisite for their efficient use in crop improvement, since broad spectrum of genetic diversity is required for improving newer and improved traits to meet the consumers need, global food security and increased vulnerability to climate change. Hence this study was planned to evaluate the eco-geographic distribution of proso millet in Sri Lanka.

## Research Methods

Based on the grey literature and informal discussions with the Department of Agriculture (DOA), the study areas were selected. Germplasm was collected from Monaragala and Hambantota Districts representing diverse agro-ecological conditions and different agricultural practices during *Yala* (May to September) season in 2015. Within the unit of collection, full range of variation was represented by collecting common types through random collection and rare types through biased collection. One square meter quadrant was used to select three locations in the farmers' fields. Materials were collected as seeds from composite harvests and seeds from one plant in farmers' fields, considered as one genotype or an accession. An Eco-geographical survey was undertaken to determine the distribution of particular species in specific regions and ecosystems to establish frequency of variants and associated ecological conditions. Data were collected on plant density, land extent, type of land, seed source, grain yield per plant, irrigation and fertilization at the farmers' fields. At each location in the farmers' fields, data on latitude and longitude were collected using Global Positioning Systems.

## Results and Discussion

The collecting of plant genetic resources primarily aims at tapping germplasm variability in different agro-ecological zones and assessment of the diversity in germplasm collections which are essential for the systematic management and utilization of germplasm in breeding programmes (Salini *et al.*, 2010). Also, the identification of geographical distribution in composite collections as mini-core collection is to play an important role in exploration efforts before these valuable resources are lost due to climate change or neglect. Accordingly, to estimate the eco-geographic distribution of proso millet population in Sri Lanka, seeds of a total of 1025 plants of proso millet as accessions were collected from various agro ecological areas around nine villages in Monaragala and two villages in Hambantota districts from 41 farmers, in order to assess the phenotypic and geographical pattern of diversity of proso millet germplasm including landraces and growing lines. Proso millet showed the adaptation to local climates such as rainfall, relative humidity and temperature as well as soils in these areas. As seeds source, 68% of farmers obtained their seeds by purchasing from other growers while 32% of farmers kept their own seeds for next season growing. Growing extent is ranged from 0.5 to 5 acres and 51% of farmers grow proso millet in one to two acres of lands under rain fed and no fertilization. Plant density was ranged from 55/m<sup>2</sup> to 711/m<sup>2</sup> while average grain yield per plant was ranged from 0.1 to 1.7 g. It revealed that plant density highly affects the grain yield at farmers' fields. Understanding the patterns of distribution of plant genetic resources, especially the extent and contextual bases of distributions, may be critical in setting appropriate targets for future predictions. Estimation of the diversity and distribution of proso millet germplasm are important for providing genetic resources for plant breeding, aiding in conservation, and broadening the genetic base which is vital in decline in genetic diversity which leads to ensure agricultural sustainability and food security.

## Conclusions

Proso millet is eco-geographically distributed in Monaragala and Hambantota areas in Sri Lanka well adapted to their climates and soils. There are 1025 proso millet accessions as a seed bank for future studies in assessing the genetic diversity and climate resilience through predictive modeling approaches.

## References

- Hunt, H.V., Campana, M.G., Lawes, M.C., Park, Y., Bower, M.A., Howe, C.J. and Jones, M.K. (2011). Genetic diversity and phylogeography of broomcorn millet (*Panicum miliaceum* L.) across Eurasia. *Molecular Ecology*. 20, 4756–4771.
- James, T.K., Rahman, A., McGill, C.R. and Trivedi, P.D. (2011). Biology and survival of broom corn millet (*Panicum miliaceum*) seed. *New Zealand Plant Protection* 64: 142-148 (2011). Available at [www.nzpps.org](http://www.nzpps.org).
- Karunaratne, A.S. (2015) (eds) Proso millet (*Panicum miliaceum* L.)-Agronomy, Botany, Ecophysiology and Nutrition. Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, 70140, Belihuloya Sri Lanka.

Salini, K., Nirmalakumari, A., Muthiah, A.R. and Senthil, N. (2010.). Evaluation of proso millet (*Panicum miliaceum* L.) germplasm collections. Electronic Journal of Plant Breeding, 1(4): 489-499.

# Rainfall Trends over Proso millet (*Panicum miliaceum* L.) Growing Regions in Sri Lanka

Eranga M. Wimalasiri<sup>1</sup>, M.J. Ashfold<sup>1</sup>, Sue Walker<sup>1,2</sup>, Asha S. Karunaratne<sup>3</sup>

<sup>1</sup> Faculty of Sciences, University of Nottingham Malaysia Campus,  
Jalan Broga, 43500 Semenyih, Selangor, Malaysia.

<sup>2</sup> Department of Soil, Crop and Climate Sciences, University of Free State,  
P O Box 339, Bloemfontein, 9300, South Africa.

<sup>3</sup> Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka,  
PO Box 02, Belihuloya. 70140. Sri Lanka.

\* Corresponding Author: [khyx5gem@nottingham.edu.my](mailto:khyx5gem@nottingham.edu.my)

## Introduction and Objectives

Rainfall is the key determinant of agriculture in many parts of Sri Lanka. Proso millet (*Panicum miliaceum* L.), one of the underutilized minor millets, is mainly grown under shifting cultivation, principally in the southern plains as a rain-fed crop. It is the main crop in some parts of the low country dry zone (LCDZ) during *Yala* season (March to September) where the area receives a lesser amount of rainfall. Past studies on the long-term trends of rainfall in Sri Lanka have shown both positive and negative trends, especially and temporally (Wickramagamage, 2015). Being the main crop during *Yala* season, any change in rainfall pattern affects the food security of poor subsistence farmers in the area. Growing concern about the impact of global warming and climate change on food and water security has drawn attention on the studies on long term rainfall trends. As economy and lifestyles of people in the area solely depend on agriculture, understanding rainfall trend is important to enhance the agricultural productivity of these regions. Therefore, this study was designed to analyze rainfall trends over Proso millet growing regions in Sri Lanka.

## Research Methods

Daily rainfall data over the past 30 years (1986-2015) were collected from five meteorological stations located in Proso millet growing area of LCDZ, namely, Udawalawa (6.408°N80.841°E mean rainfall 1533 mm), Sewanagala (6.396°N80.913°E mean rainfall 1439 mm), Pelwatta (6.723°N81.204°E mean rainfall 1623 mm), Thanamalwila (6.440°N81.133°E mean rainfall 1213 mm) and Kuda Oya (6.621°N81.231°E mean rainfall 1180 mm). Sri Lanka receives rainfall from four monsoons and they can be separated into FIM from March to May, SWM from June to September, Second Inter-Monsoon (SIM) during October and November and North East Monsoon (NEM) from December to February (Suppiah, 1996). *Maha*, the major growing season is from October to February that includes SIM and NEM, while the minor season, *Yala*, is from March to September and receives rains from FIM and SWM. The monotonic trends in precipitation were detected using the Mann-Kendall non-parametric statistical test (Mann, 1945; Kendall, 1975).



The Mann- Kendall test statistic is given as following;

$$Z_{mk} = \begin{cases} \frac{S - 1}{\sqrt{\text{var}(S)}} & S > 0 \\ 0 & S = 0 \\ \frac{S + 1}{\sqrt{\text{var}(S)}} & S < 0 \end{cases}$$

in which,

$$S = \sum_{i=1}^{n-1} \sum_{k=i+1}^n \text{sgn}(x_k - x_i)$$

$$\text{var}(S) = \frac{n(n-1)(2n+5) - \sum_i e_i(e_i-1)(2e_i+5)}{18}$$

Where  $Z_{mk}$ , is the Mann-Kendall statistics,  $x_k$ ,  $x_i$  are the sequential data values and  $n$  is the length of the data set. If  $\Theta$  is greater than, equal to, or less than zero,  $\text{sgn}(x_k - x_i)$  is equal to 1, 0, -1 respectively. The extent of any given tie is  $e_i$  and  $\sum$  stands for summation over all ties. If the computed p-value is greater than the significance level ( $\alpha=0.05$ ), the null hypothesis  $H_0$ , of no trend in the series is accepted.

## Results and Discussion

Trend analysis revealed that total annual rainfall of the Proso millet growing region has increasing trend, but it was only significant ( $p<0.05$ ) in Sewanagala, Pelwatta and Kuda Oya. The FIM showed increasing trend throughout the study area, but a significantly ( $p>0.05$ ) increasing trend was only recorded from Thanamalwila and Kuda Oya, the driest stations in the study area. Generally, rainfall during SWM showed a negative trend, but it was only significant ( $p<0.05$ ) in Udawalawa. This will further magnify the already existing water deficit in the area during the late phase of *Yala* season. Rainfall during SIM and NEM monsoon increased at all stations where Pelwatta, the wettest station in the study area showed a significantly increasing ( $p<0.05$ ) trend for both *Yala* and *Maha* seasons. Rainfall during SIM and NEM also showed a significantly positive trend in Sewanagala and Thanamalwila respectively. Even though SWM was decreasing, the increment of FIM at the beginning of *Yala* season increased the total rainfall amount during that season. Rainfall throughout the *Yala* season increased at all stations except Udawalawa, but none of them were significant ( $p>0.05$ ). *Maha* rain increased throughout the study area but was only significant ( $p<0.05$ ) in three out of five stations studied.

Earlier studies have shown that rainfall from SWM is decreasing and NEM was increasing over the country while total rainfall in dry zone was increasing

(Muthuwaththa and Liyanage,2013; Wickramagamage,2015). These results provide confirmatory evidence that the total annual rainfall over Proso millet growing area showed an increasing trend. *Yala* is the subsidiary growing season in the area and many drought tolerant crops are being cultivated due to water scarcity. Several other crops such as cowpea, gingerly, finger millet, groundnut and mung bean that are cultivated during high rainfall season (*Maha*) in the area as rain-fed crops will generate additional income to poor farmers if they can grow them during *Yala* season with apparent increased rainfall regime under a changing climate.

## Conclusions

In line with the results of this study, it seems fair to suggest that total annual rainfall over Proso millet growing area was increasing. Even though SWM was decreasing, the increment of FIM rains increased total rainfall during *Yala* season, where farmers cultivate Proso millet. In general, rainfall data from five stations in Proso millet growing region in Sri Lanka showed a similar trend with variable magnitudes. With the present increasing trend, several other crops that are being cultivated in *Maha* season can be cultivated during *Yala* season. The important information revealed by the study will assist in long-term agricultural planning in the low country dry zone of Sri Lanka.

## References

- Kendall, M.G. (1975). *Rank Correlation methods*. 4<sup>th</sup> edition. Charles Griffin, London.
- Mann, H.B. (1945). Non parametric test against trend. *Econometrica*, 13: 245-259.
- Muthuwaththa, L.P. &Liyanage, P.K.N.C. (2013). Impact of rainfall change on the agro-ecological regions of Sri Lanka, In Gunasena, H.M.P.,Gunathilake, H.A.J., Everard, J.M.D.T., Ranasinghe, C. S. &Nainanayake, A.D. (Eds). *Proceedings of the international conference on climate change impacts and adaptations for food and environment security sustaining agriculture under changing climate*, 59-66.
- Suppiah R (1996) Spatial and temporal variations in the relationships between the southern oscillation phenomenon and the rainfall of Sri Lanka, *Int J Climatol* 16:1391–1407
- Wickramagamage, P. (2015). Spatial and temporal variation of rainfall trends of Sri Lanka.*Theoretical and applied Climatology, Online Publication. 1-12* <http://doi.org/10.1007/s00704-015-1492-0>

# Estimation of Combining Ability, Additive and non-additive Genetic Effects of Yield and some Yield Contributing Traits in Chilli (*Capsicum annuum* L.) Inbred Lines

H.M.S.N. Herath, W.M.W. Weerakoon, A.M. Perera, H.M.S. Bandara

*Field Crops Research and Development Institute, Mahailuppallama, Sri Lanka.*

*\* Corresponding Author: shalikaahmasn@gmail.com*

## Introduction and Objectives

Chilli is one of the most important cash crops grown in Sri Lanka. During the year 2014, chilli production within the country was 71,767 mt. In the same year, 46,422 mt of dry chilli was imported with the value of RS.7578 million (DOA. 2014). Therefore, increasing the productivity of chilli cultivation is very important to minimize the importation of dry chilli. Development of high yielding chilli hybrid is one of the major approaches to increase the productivity. The diallel analysis provides information on genetic properties of parents and their crosses (Hasanuzzaman *et al.*, 2012). It is an important tool for the preliminary evaluation of genetic stocks in hybridization program with the objective of identification of good general- as well as specific-combiners (Bhutia *et al.*, 2012). The aim of this study is to estimate the combining ability, additive and non-additive genetic effects using yield and six yield related agronomic characters and identification of good combiner parent lines for hybrid development.

## Research Methods

This experiment was conducted during *yala* 2015 and *maha* 2015/16 at the Field Crop Research and Development Institute (FCRDI), Mahailuppallama (08°06'40.54" N and 80°28'14.70E) belonging to DL1b agro-ecological region in Sri Lanka. Eight inbred lines namely, MICH PL 28, MICH PL 47, MICH PL 9, MICH PL 65, MICH PL 83, MICH PL 70, MICH PL 20, MICH PL 13, MICH PL 4 and MICH PL 8 were selected for this study. Thirty day old seedlings of these parental lines were planted in clay pots during *yala* 2015. Eight pots from each parent were maintained inside the insect proof net house. At flowering, crosses were made according to half-diallel design. Ripened pods were harvested and hybrid seeds were extracted separately. Hybrids' parents were planted in the field during *maha* 2015/16. Each plot (6.0 m x 1.8 m) consisted 50 plants at the spacing of 60 cm x 45 cm and 1 plant per hill. Randomized complete block design with two replicates was adopted. Data were collected on days to 50% flowering, fresh green chilli yield, pod diameter, pericarp thickness, plant height and canopy width. Estimation of combining ability variances and effect for yield and yield related agronomic characters were done using the method 2 and model II of Griffing.

## Results and Discussion

Analysis of variance for yield and yield contributing traits of parents had indicated that there are genotype differences among the hybrids and their parents. General Combining Ability (GCA) variances were significant for all the tested characters

whereas significant Specific Combining Ability (SCA) variances were observed for all the characters other than pod length, pod diameter and days to 50% flowering. This indicates that both additive and non-additive gene actions play an important role in the inheritance of tested traits. Predominance of additive gene actions exhibited in the inheritance of all the traits with high GCA variances. According to Patelet *et al.*, (1998) plant height, no. of pods/ plant, pod length, pod diameter, pod weight and green fruit yield/plant are predominantly controlled by additive gene effect. According to the general combining ability of ten parent lines, none of the parents was a good general combiner for all tested characters. The inbred line, MICH PL 47 exhibited significant positive general combining ability for all the characters except days to 50% flowering. Two inbred lines MICH PL 47 and MICH PL 8 showed high positive GCA effect for yield. In addition to yield, these inbred lines were good general combiners for pod length, pod diameter, plant height and canopy width. Even though, the SCA effect for most of the tested traits was significant, none of the crosses exhibited a significant SCA effect for all the traits. The highest SCA effect for yield in hybrids was observed in the cross of MICH PL 9 x MICH PL 20. Among the different hybrids, the cross combinations, MICH PL 65 x MICH PL 20, MICH PL 65 x MICH PL 4 and MICH PL 28 x MICH PL 65 that exhibited high positive SCA for yield were also a good specific combiner for pod diameter. Most of the cross combinations showed high negative SCA effect on pericarp thickness.

## Conclusions

GCA variances were significant for all the characters, yield, pod length, pod diameter, pericarp thickness, plant height, canopy width and days to 50% flowering indicating that additive gene action play an important role in the inheritance of tested agronomic characters. Significant SCA variances for all the characters other than pod length, pod diameter and days to 50% flowering indicated the presence of non-additive gene action and the possibility of exploiting hybrid vigor. Even though, the SCA effect for most of the tested traits was significant, none of the crosses was significant for all the traits. The inbred lines, MICH PL 47 and MICH PL 8 can be selected as good combiners for the development of chilli hybrids.

## References

- Bhutiaa, N. D., T. Setha, V. D. Shendeb, A. Chattopadhyay. 2015. Estimation of Heterosis, dominance effect and genetic control of fresh fruit yield, quality and leaf curl disease severity traits of chilli pepper (*Capsicum annum* L.) *Scientia Horticulturae* 182 (2015) 47–55
- Hasanuzzaman, M., M. A. Hakim, J. Fersdous, M. M. Islam, L. Rahman. 2012. Combining ability and heritability analysis for yield and yield contributing characters in chilli (*Capsicum annum*) landraces. *Plant omics journal*. 5(4):337-344
- DOA. 2012. Present status, economic importance and challenges. Other Field Crops in Sri Lanka. Peradeniya. Sri Lanka. Department of Agriculture. 43 pp
- DOA. 2014. Agstat. Peradeniya. Sri Lanka. Socio Economic and Planning Centre. Department of Agriculture. 11:16

Patel, J. A., M. R. Shukla, K. M. Doshi, B. R. Patel, S. A. Patel. 1998. Combining ability analysis for green fruit yield and yield component in chilli (*Capsicum annuum*). Capsicum Eggplant Newsletter. 17: 34 – 37

# **AGRIBUSINESS AND AGRICULTURAL ECONOMICS**

## **Student Forum**

**09<sup>th</sup> December 2016**



## INVITED PRESENTATION

### Agribusiness And Agricultural Economics Morning Session

#### Impactful Research – Everyone's Priority

**Ajith de Alwis**

*Project Director, Coordinating Secretariat for Science Technology and Innovation,  
Ministry of Science Technology and Research/ Professor of Chemical Engineering,  
University of Moratuwa.*

*[ajith@costi.gov.lk](mailto:ajith@costi.gov.lk)*

Research is an activity of exploring the unknown. In exploring the unknown interesting knowledge can emerge which enriches oneself and more so can have far reaching consequences too. There are many an example of research leading to significant improvements for the quality of life of us on earth. There are negative contributions too. While development of tools was an advancement for the human beings weaponizing has lead to arms races and the strengthening of the intentions of greed and conquering each other.

There are many issues facing Sri Lanka.



#### Defining Issues for Us!

- **Energy** – CEB and CPC situation, renewable energy targets (20% in 2020),
- **Food** – Food Security, Postharvest Issues, Nutritional Security
- **Health** – CKDu, Cancer, NCD's, Health for All !
- **Soil Fertility** – Fertiliser subsidy, No 1 Pollution Issue
- **Ageing Population** – We are not becoming younger ! (Robotics !)
- **Natural Resources** – water, minerals, nano wealth
- **Biodiversity** - medicine, green chemistry and engineering
- **Transport** – lack of moving!, insatiable hunger for vehicles
- **Education** – Brain drain, Science illiteracy

All these are problems awaiting solutions. Solutions are not easy and each passing day will make the process of finding solutions difficult and the need for identifying solutions ever more important. Research is an answer – continuous, focused. Today there are about 15000 research projects of varying degree of intensity happening at one time across many an institutions. The number probably is much higher. However, it

is clear that much of this research is only resulting in simple attainment of a goal of passing an examination, realizing the dream of graduation etc. It is important that the process is channeled in achieving much more than the simple outcome.

Thus there is a significant need for impactful research in our institutions and in programs.



# **Farmers' Perception on the Gender of the Agriculture Instructors for Effective Technology Transferring in Paddy Farming Systems in Anuradhapura District, Sri Lanka**

**D.M.K. Dulanjila<sup>1</sup>, G.A.S. Ginigaddara<sup>1\*</sup>, N. Somarathna<sup>2</sup>,  
S.M.C.B. Karalliyadda<sup>1</sup> and S.P. Dissanayaka<sup>1</sup>**

*1 Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura, Sri Lanka.*

*2 Institute for Gender and Development Studies in Sri Lanka, Kandy.*

*\* Corresponding Author: sanjeewanieg@gmail.com*

## **Introduction and Objectives**

Agriculture is the major important economic sector in Sri Lanka. In order to increase the food production and the quality of the production which is needed to feed the increasing mouths, updated and upgraded technologies are being introducing into present agricultural systems in Sri Lanka.

Agricultural extension service is mainly occupied by the government department of agriculture and at present the private and non-governmental sectors are becoming significantly interested in agricultural extension service in Sri Lanka. Agricultural instructors (AIs) representing both males and females are involving in this process. According to the department of Agriculture, Sri Lanka, there are 465 and 317 male and female AIs respectively who are engaging in the extension services. Okley and Garforth in 1985 revealed that the whole extension process of a program depends upon the extension agent. Therefore effectiveness of the AI officer is considered as one of the measuring factors of the success or failure of the extension programs (Chukwu, 2013).

The research findings on the sensitivity of the gender of the extension personals on the effectiveness of the agricultural extension activities in Sri Lanka is lacking. Therefore this research study was conducted in Anuradhapura district of Sri Lanka to explore the relationship between farming production systems.

## **Research Method**

Anuradhapura District where the second largest female population engaged in agricultural activities was selected for the study which lies in geographical coordinates of 83° 35" North, 80° 38' 53" East. Twelve focus group discussions were completed with 10-15 farmers each representing male and female AIs' serving areas using a discussion guides. Farmers' perception about the different characteristics of the AI officers like organization ability, commitment for the programs, relationship with farmers, communication skills, providing solutions to farmers' problems, motivating farmers, providing updates on new technology, ability to simplify technical information to farmers and listening to farmers were collected during interviews and discussions using five point likert scale.

Descriptive statistical analyses were used to compare characteristics of AI officers and other analyses wherever necessary. The statistical significance of the variables in the descriptive part was tested using chi-square econometric model. Logistic function was used to identify the relationship between gender of AIs and farmers' overall satisfaction on AIs' job performance.

## Result and Discussion

The results of the analysis of farmers' gender sensitivity of AI officers on transferring new technologies revealed that, 42% of farmers are not bothering about the gender of the AI officer because they are only expecting quality information to uplift their production irrespective of the gender of the AI. However, 41% of farmers are willing to get the service of male AIs expressing that they can work easily with male AIs than female AIs and 17% are willing to get the service of female AIs expressing that they can discuss their problems with female AIs in a more friendly manner than male AIs. Some research results indicate that female AIs are lesser competent in technology transferring compared to male AI officers (Chukwu, 2008). Madu (2000) also reported that there is a negative attitude in Africa too in obtaining extension services from female extension officers. However, the results of logistic regression ( $p = 0.137$ ) in the present study revealed that there is no significant difference of the gender of the AIs on effective technology transferring in rice production systems in Anuradhapura district.

From the results of the analysis of the farmers' satisfaction on the characteristics of the AI officers, 83.3% of farmers were satisfied with male AIs' characteristics like commitment for technology transferring, organizational ability, motivating farmers for adopting new technologies, giving updates on new technology, ability to simplify given technology and listening ability while other 16.7% dissatisfied with the aforesaid characteristics. Further, 66% of respondents were satisfied with the communication skills, response to farmers' questions and given solution by male AI officers. On the other hand, 100% of farmers were satisfied with response for the farmer problems, organization ability, relationship with farmers, communication skills, solutions given for the farmers' problems, motivating farmers, providing updates for farmers' questions, ability to simplify given technology to farmers by female AI officers.

## Conclusions

Results of the study conclude that overall satisfaction of paddy farmers' on effective technology transferring in rice farming systems is not gender sensitive in Anuradhapura District. Farmers' satisfaction in terms of the characteristics of AI officers are also more or less neutral in terms of the gender of the Agricultural Instructors in Anuradhapura district, Sri Lanka.

## References

- Oakley, P. and Garforth, C. (1985). Guide to extension training, FAO training series 11, FAO: Rome.
- Chukwu, A. O. (2008). Determination of farmers socio-economic characteristics influencing Adoption of Maize-Cassava Intercropping technology, International Journal of Agriculture and Rural Development Vol. 11 (10).

Madu, T.U. (2000) “The place of women in agricultural development in the new Millennium”. Federal College of Agriculture, Isiagu, Ebonyi State, Nigeria

# **Low Profitability in Tea Industry: A Case in Upcountry Cluster - 1 of Elpitiya Plantation**

**A.I.Y. Lankapura, Y.M. Wickramasinghe and A.M.K.R. Bandara**

*Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura, Sri Lanka.*

*\* Corresponding Author: amilalankapura2@gmail.com*

## **Introduction**

Tea being the leading plantation crop of the nation, has been contributing significantly to socio-economic development earning foreign exchange and securing livelihoods of the people. However, many unfavorable conditions have created the system inefficient (Ganewatta and Edwards, 2000). Thus, most of the corporate sector tea plantations in Sri Lanka, including the Upcountry cluster-1 of Elpitiya Plantation have been facing severe financial crises. Such a continuing financial loss is intolerable because it will adversely affect the financial viability of the industry. Since this industry provides an array of economic and social benefits to the country, any downturn in its performance would harm the national economy too. Some compartmentalized investigations done in the past, have inadequately addressed the totality of the problem. Thus, investigating the issue using a holistic approach in order to identify the contributory factors to develop remedial measures for this low profitability is timely as well as nationally important.

## **Methodology**

The upcountry cluster - 01 of the Elpitiya Plantation comprising with four estates (Dunsinane, Sheen, Fearnlands and Meddecombra) were purposely selected as the study area, while the targeted population consisted of managerial and field staff, workers and other operational bodies. Proportional random sampling technique was applied to choose 160(n) workers from 3,140(N) considering each estate, various operations performed and male to female ratio. Primary data were collected from workers through a field survey using a pre-tested structured questionnaire. Moreover, focus group discussions and key informant interviews were conducted with the staff to ascertain management policies, resources availability and opinion on managerial issues. The estate records and tea related published and unpublished documents were used to extract time series secondary data such as yield, extent, cost of production and average net sales. A descriptive analysis was performed including both quantitative and qualitative measures such as percentages, means, indices and ordering. Total Productivity Index (TPI), which should exceed the cost of daily wage for the unit to be break - even was used to explain labor productivity (Sivaram and Herath, 1996). Further, the profit margin (Rs/kg) concept was used as a financial indicator to evaluate the financial performance.

## **Results and Discussion**

The results indicated that, low land and labor productivity is a serious issue.

Technological factors such as ageing of tea bushes (high proportion of old seedling tea -53% on average and 65.5% of uneconomical fields with high vacancy rates) and environmental factors (adverse climatic changes and damages of major pest and diseases) have reduced productivity in tea lands. Presence of low plucking intake (50% of the potential intake) and below norm pluckers (34.3%) have caused to reduce the amount of leaves plucked and that has resulted in underutilization of factory capacity.

Social factors such as absenteeism ( $|\bar{x}| = 15$  working days/ month), worker shortage, high degree of labor unionization, lack of motivation and low satisfaction (Kodithuwakku and Priyanath, 2010), higher percentage of aged and physically disabled workers (67%) with low educational levels and declining working hours of male workers ( $|\bar{x}| = 5.15$  hours/day) have reduced labor productivity.

Increasing wage rates and input prices, inefficient energy utilization (fuel wood and electricity) and cost involved in social benefits (5% of cost of production) have escalated the cost of production. Managerial factors such as high overheads (30-36% of cost of production) inefficient work norms and wage policies with inadequate field level supervision and economic factors like uncertain producer price at the auction also have contributed to the low profitability. Moreover, the poor replanting rate (<1%) has adversely affected the production establishing the value of a proper replanting rate (Mohamed and Zoysa, 2006).

## Conclusions and Recommendations

The low profitability in the tea sector is mainly due to poor land and labor productivity, increasing cost of production, uncertain producer price and lack of collective role among the government, estate management, trade unions and workers. Therefore, upgrading existing production technology, increasing the degree of mechanization, diversifying marginal tea lands, product diversification and accelerating the pace of replanting and vacancy filling and implementing effective mechanism to monitor field activities should be done with immediate effect. Moreover, adopting a cost centered approach, including cost-effective norms, raising worker dignity and morale are other areas that should receive due attention of the management.

## References

- Ganewatta, G., & Edwards, G. W. (2000, January). The Sri Lanka tea industry: economic issues and government policies. In *44th Annual Conference of Australian Agricultural and Resources Economics Society, University of Sydney, Australia* (pp. 23-25).
- Kodithuwakku, S. & Priyanath, H. (2010). Reasons for the Improvement of Labor Productivity in Tea Plantations after Privatization with Special Reference to the Estate Laborers in the Ratnapura District. *Sabaragamuwa Univ J*, 7(1). <http://dx.doi.org/10.4038/suslj.v7i1.1842>
- Mohamed, M. & Zoysa, A. (2006). Current status and future research focus of tea in Sri Lanka. *J Agric Sciences*, 2(2), 32. <http://dx.doi.org/10.4038/jas.v2i2.8129>
- Sivaram, B. & Herath, D. (1996). *Labour Economics in Tea* (pp. 68 - 74). Talawakelle, Sri Lanka: Tea Research Institute Sri Lanka.

# Evaluation of Issues and Challenges of Tea Smallholders in Kegalle District in Sri Lanka

A.A.C.H. Dharmasena<sup>1\*</sup>, A.G.L. Dilhani<sup>1</sup>, S.U. Pinnagoda<sup>2</sup>, H.M.P. Madushani<sup>2</sup>,  
R.M.J.C. Rathnayake<sup>1</sup>, S.H.P. Malkanthi<sup>2</sup>

<sup>1</sup> Department of Export Agriculture, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka. PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> Department of Agribusiness Management, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka. PO Box 02, Belihuloya. 70140. Sri Lanka.

\* Corresponding Author: [hansanied@yahoo.com](mailto:hansanied@yahoo.com)

## Introduction and Objectives

World famous Ceylon tea (*Camellia sinensis*) is one of the major plantation crops in the island. Contribution of the small holders to national tea output is 76%. Total number of tea holders in Kegalle district is 14,203 out of which 14,089 are small holders. According to the data of Economic Census 2013/2014, the total extent of tea small holdings in Kegalle district is 21,345 acres. Therefore, Kegalle district is playing a significant role in the small holding tea production of the country.

## Objectives of the Study

- To assess the demographic features of tea small holders.
- To examine the present status of tea small holders in Kegalle district.
- To identify the challenges of tea small holders in Kegalle district.
- To assess the perception of farmers on tea cultivation

## Research Methods

Study area of this research was Kegalle district in Sri Lanka. To evaluate issues and problems of tea small holder sector, a field survey was conducted during November-December Months of the year 2015 using a pre-tested questionnaire.

The questionnaire consisted of 4 main areas as;

- Socio-demographics characteristics of farmers
- Area cultivated and cropping system
- Management practices
- Problems related to management practices, labour, transport, selling, extension etc, and
- Perception of smallholders towards tea cultivation

The survey was carried out using 300 smallholders from 10 divisional Secretariats in Kegalle district. Thirty small holders were randomly selected from one village in each divisional Secretariats. Selected villages are presented in Table 01.

Table 1: Selected villages for the research

DS division	Selected village
Mawanella	Attanagoda
Galigamuwa	Karagala
Bulathkohupitiya	Ambuwakka
Aranayake	GanthunaUdagama
Yatiyanthota	Mathamagoda
Ruwanwella	Morawatta
Dehiowita	Kanagama
Warakapola	Alpitiya
Deraniyagala	Deranyagalauthura
Kegalle	Rotuwa

Selected villages have recorded a significant tea productivity throughout the year. Finally, perception towards tea cultivation of smallholders were also evaluated using 6 statements. They were evaluated using 5 point Likert scale.

Data were analyzed using descriptive statistics such as frequencies, mean values, percentages etc. For the data analysis, SPSS software (version 21) was used.

## Results and Discussions

According to the findings, more than 70.3% smallholders belong to age above 45 years, majority (61.7%) of smallholders are male, 59.3 % are part time farmers and 49.7% are full time farmers. When considering educational level of tea smallholders, majority of farming community are educated. 99.0% of tea smallholders have their own lands for tea cultivation and most of the tea smallholders (81.0%) have cultivated below 1 ac land. 76.6% of tea cultivations are below 10 years old. Therefore, they have a short history compared to other tea growing districts in Sri Lanka. When considering the cropping system, majority (50.0%) of them are mixed cropping while 31.3% are intercropping and 18.7% are mono-cropping. 71.5% practice 7 days of plucking interval and thus do not use machineries for plucking. Lung pruning is practiced by majority (81.3%) of the tea smallholders.

Majority of tea cultivations are recently started cultivations. So there is a trend to cultivate tea by smallholders in Kegalle District. 64.7% smallholders receive low price for tea, 8.3% are with the problem of insufficient extension service and 12% have pest and disease problems in their cultivations. 12% of cultivations are infected with diseases, 81.2% are affected with Blister blight. There are price fluctuations during the season and when government policies are changed. The labor problem is not significant in the Kegalle area. Majority of 54.5% respondents agree that they are able to find laborers easily. Higher proportion of laborers are skilled, accounting as 87.2%. Most of the farmers have positive thoughts about cultivating tea if they receive reasonable price and also they are willing to expand their cultivation further, accounting as 61.3%. The corruptions occurred while selling tea leaves are 12.1% according to growers' opinion.



Proper extension services, reasonable price, training programs will lead to overcome the constraints and that will initiate the improvement of the tea small holding sector.

## Conclusions

This study identifies major issues and challenges faced by small holding tea planters in Kegalle district as lower price and diseases. Blister blight is the commonly found disease due to high rainfall in the district. The most important problem is price fluctuation. There is no sufficient support from the government to motivate the planters because most of them are complaining about insufficient extension services. Majority of farmers prefer mono-cropping and inorganic fertilizers. Most of them cultivate pepper in tea lands to earn more profit. There are adequate skilled laborers in this area and there is only little corruption reported in selling.

## References

- Perera,P.(2014).Tea Smallholders in Sri Lanka: Issues and Challenges in Remote Areas, *International Journal of Business and Social Science*5(12),107-117, [https://www.google.lk/a&uact=8&ved=0ahUKEwi07oXDqp7QAhUUR48KHWjwBdIQFggbMAA&url=http%3A%2F%2Fijbssnet.com%2Fjournals%2Fvol\\_5\\_no\\_12\\_november\\_2014%2F13.f&usg=AFQjCNFvHGRQTVYONUnWS9CnREn\\_Fbq8ug&sig2=nGEFz4oF2mTt5YLLb aj\\_OA](https://www.google.lk/a&uact=8&ved=0ahUKEwi07oXDqp7QAhUUR48KHWjwBdIQFggbMAA&url=http%3A%2F%2Fijbssnet.com%2Fjournals%2Fvol_5_no_12_november_2014%2F13.f&usg=AFQjCNFvHGRQTVYONUnWS9CnREn_Fbq8ug&sig2=nGEFz4oF2mTt5YLLb aj_OA).
- Samaraweera, G.C. Ping,Q.YanJun,L. (2013). Promoting tea business in the tea smallholding sector in developing countries through efficient technology transfer system: Special Reference to Sri Lanka.African Journal of Business Management,7(22),2186-2194,
- Ministry of Plantations Industries.(2013). *Statistical Information on Plantation Crops 2015*. Battaramulla, Sri Lanka. Ministry of Plantations Industries.
- Department of Census and Statistics Sri Lanka.(2015). *Summary Report on Agricultural Activities Economic Census 2013/2014*. Battaramulla,Sri Lanka.Department of Census and Statistics Sri Lanka.



# Flower Retailing: A Case of Flower Vendors Based In Religious Institutions

N.U.M. Perera<sup>1\*</sup>, P.E. Kaliyadasa<sup>1</sup>, A.M.C. Amarakoon<sup>1</sup>, J.K.M.D. Chandrasiri<sup>2</sup>  
and S.M.P.C. Padmini<sup>3</sup>

<sup>1</sup> Department of Export Agriculture, Faculty of Animal Science and Export Agriculture,  
Uva Wellassa University, Sri Lanka.

<sup>2</sup> Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI),  
Colombo 07, Sri Lanka.

<sup>3</sup> Sri Lanka Council for Agricultural Research Policy (SLCARP), Colombo 07, Sri Lanka.

\* Corresponding Author: [uperera1991@gmail.com](mailto:uperera1991@gmail.com)

## Introduction

Production and selling of local fresh flowers has become a key business at many religious places in Sri Lanka for many years. Mostly the women are engaged in this activity as a self-employed venture. These niche markets for local fresh flowers were hidden and less studied (Niranjana and Gunasena, 2006). Evaluation of present status and problems associated with this small business is very much important.

## Objectives

### *General Objective of this study*

Explore the relationship between socio-economic status and constraints faced by the flower vendors in the areas of “Kiri-vehera temple in Katharagama” and “Maha Saman Dewalaya in Ratnapura”.

Specific objectives are:

1. To find out the constraints faced by flower vendors attached to “Kiri-vehera temple in Katharagama” and “Maha Saman Dewalaya in Ratnapura”.
2. To identify the potentials for involvement of younger generation in this particular business with special focus to barriers for them to sustainably involve in it.
3. To recommend appropriate solutions to overcome the constraints identified in (2)-above

## Research Methods

### *Data and Methodology*

A survey was conducted using a structured questionnaire among flower vendors who were attached to – KIRI-VEHERA TEMPLE IN KATHARAGAMA (KVTK) and MAHA SAMAN DEWALAYA IN RATNAPURA (MSDR) in Sri Lanka. Both “formal/registered vendors” and “informal/non - registered vendors” were selected as the population. The targeted sample size was the whole group of established registered

flower vendors containing 58 respondents. Thirty respondents were from KVTK and twenty-eight respondents were from MSDR. Respondents were directly asked about identified twenty major constraints they face during vending activities, using a five-point likert scale from very unimportant to very important. Each respondent was asked to rank five most affecting factors out of ten most affecting factors for younger generations' potential involvement in the business.

Constraint levels were measured by constructing “constraint indexes” (Jayasinghe-Mudalige and Henson, 2006). Multiple linear regression1, Constraint index2 and potential for younger generations' involvement3 were measured by using following indices.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_n X_n + \epsilon_i \quad (1)$$

$$\text{Constraint Index} = \frac{\text{Score obtained by a respondent}}{\text{Possible Maximum Score}} \quad (2)$$

$$\text{Younger generations' constraint index} = \frac{\text{Score obtained by a constraint statement} \times 100}{\text{Possible Maximum Score}} \quad (3)$$

The selected independent variables were age of the respondent, marital status, education level, household size(HOS), gender of the respondent(GOR), experience in industry, working hours per day(WHO), distance from residence to working place, stall availability(STA), other income (not having any other income source)(OIS) and vending area(VEA).

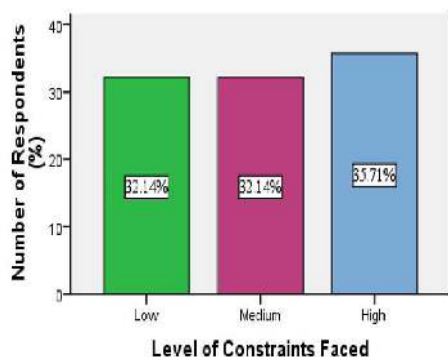
## Results and Discussion

### *Final Fitted Model for Regression Analysis:*

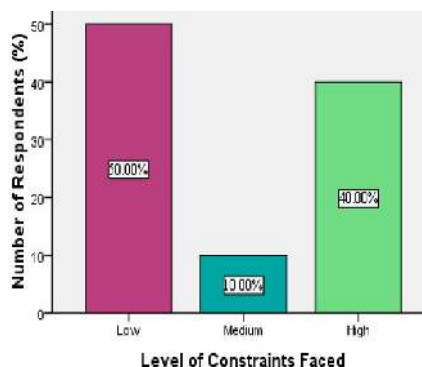
$$\text{COIN} = 0.537 + 0.00517 \text{ HOS} - 0.0290 \text{ GOR} - 0.00438 \text{ WHO} + 0.0278 \text{ STA} + 0.0252 \text{ OIS} - 0.0514 \text{ VEA}$$

The results of the regression analysis revealed that level of constrains (constraint index values) faced by the flower vendors who do their business activities in the areas of KVTK and MSDR are significantly affected by six socio – economic factors based on obtained P-value. They are; HOS, GOR, WHO, STA, OIS and VEA.

Majority of the flower vendors attached to MSDR face higher amount of constraints when compare with the vendors at KVTK premises.



**Figure 01: Categorized Constraint Index Values (MSDR)**



**Figure 02: Categorized Constraint Index Values (KVTk)**

Constraint List:#01-High cost on purchasing flowers#02-Lack of market demand and its' fluctuation,#03:Lack of adequate market facilities,#04:Relatively low prices,#05:Non availability of proper selling location/area,#06:Lack of awareness on programmes providing capital for expansion,#07:Lack of financial and banking resources/ capital,#08:Lack of management experience, business skills, and scientific knowledge,#09:Poor infrastructure (electricity, water supply),#10: Multiple responsibilities,#11:Competition,#12:Poor storage facilities,#13Inadequate and undeveloped transportation and communication,#14:Labour issues,#15:Lack of support by government and other related authorities,#16: Seasonal variation of flower supply and shortage of flowers,#17:Consequent price fluctuations and price instability,#18:Laws and regulations, policies (registration, payments etc.), #19:Unfaithful Customers and#20:Lack of information on market trends/ requirements.

#### Major Constraints Identified

In MSDR; #5, #11, #18	} Extremely Severe Constraints
In KVTk; #2, #15	
In MSDR; #2,#3,#6,#7,#9,#10,#15	} Severe Constraints
In KVTk; #1,#4,#10,#11,#16,#18,#20	

#### Major Constraints Identified As Factors Potential for Younger

##### Generations' Involvement:

In MSDR; less social acceptance and recognition, #5, #11, #18	} Extremely Severe Constraints
In KVTk; #5, #7,#11,#15,#18	

#### Conclusions

Study reveals that majority of the vendors are females (84.5%) and the vendors have a mean monthly income level of Rs. 24966 ( $\approx$  Rs. 25,000). Most of the respondents

(87.9%) are satisfied as a flower vendor and there is a moderate level of younger generations' present involvement in the sector (46.3%), but the level of constraints they face is considerably high. When consider the overall studied area; lack of market demand & its' fluctuation, non-availability of proper selling location/area, multiple responsibilities, lack of support by Government and other related authorities, laws and regulations, policies were identified as most affecting constraints. High level of competition, less social acceptance and less recognition, lack of ability in obtaining financial and banking resources, non-availability of proper selling location, laws - regulations and policies and lack of support by government & other related authorities were identified as most affecting factors that affect the potential of the younger generations' involvement in the business.

## References

- Jayasinghe-Mudalige, U. K. and Henson, S., 2006. Economic incentives for firms to implement enhanced food safety controls: case of the Canadian red meat and poultry- processing sector. *Review of Agricultural Economics*, 28(4), 494-514.
- Niranjan, S.K.D. F and Gunasena, H. P.M., 2006. Floriculture Sector Development Programme: Small and Medium Scale Entrepreneurs in Sri Lanka. Sri Lanka Council for Agricultural Research Policy.
- Sriwarnasingha, A.N., Beneragama, C.K. and Nalaka, G.D.A., 2013. 1-Methylcyclopropene (1mcp) on the Vase-Life and Floral Opening of Cut Nil Manel (*Nymphaeanouchali*) Flowers. Degree: Faculty of Agriculture Rajarata University

# Improving Crop Yields And Economic Returns of Coconut by Intercropping with *Gliricidia*

H.M.D.E.H. Mudalige<sup>1\*</sup> and H.S.R. Rosairo

Department of Agribusiness Management, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka. PO Box 02, Belihuloya, 70140. Sri Lanka.

\* Corresponding Author: [ehmudalige@gmail.com](mailto:ehmudalige@gmail.com)

## Introduction and Objectives

Coconut is a major plantation crop in Sri Lanka. But unpredictable market and price fluctuations of coconut cannot guarantee the sustainable income for farmers (Gunathilake, 2004). In a mature coconut plantation, nearly 75 percent of productive land remains unutilized, and utilizes only 44 percent of total available light. In economic terms, monoculture coconut brings low returns per unit land area (Nair and Balakrishnan, 1976). Intercropping a plant such as *gliricidia* (*Gliricidia sepium*), the fourth largest plantation crop in Sri Lanka, is timely and sustainable because, it has a potential to generate dendro power and improves the organic matter content of soil by 40% at a depth of 15cm and reduces the soil temperature by 10°C (Gunathilake and Wasantha, 2004). Intercropping may lead to various types and levels of expenditures compared to monocropping of coconut. But can affect to the yield of coconut. Suitability of such intercrop in economic terms can be varied. The aim of this study is to investigate the improvement of coconut yield and economic returns of intercropping *gliricidia* with coconut.

## Research Methods

In the study, three adjacent coconut fields named C13 (coconut with lopped *gliricidia*), C14 (not intercropped) and C15 (coconut with non-lopped *gliricidia*) were compared by analyzing the costs and benefits. These three fields are situated in *Mawathagama* in Sri Lanka which belongs to the intermediate zone of the low country and receives an annual rainfall of around 1900 to 2500mm. All three coconut fields have been established in 1955 and intercropped with *gliricidia* only in the fields C13 and C15 in 2008. Mainly monthly reports and accounts were used as secondary data sources to obtain the income and expenditure data. The observations at the field, conversations with the workers, field officers, executive staff, and office staff were also used as primary data. SAS 9.0 version of statistical analyzing software was used to analyze data for testing the impact of the *gliricidia* on the yield of coconut. Three-way analysis of variance (ANOVA) was conducted to compare the mean values of nuts per palm at each field in each picking and Duncan's multiple range test was used to determine means significantly differ from each.

## Results and Discussion

According to the data there was a significant difference ( $P < 0.05$ ) of the coconut yield during 2012 to 2016. The highest yields were observed in C15 and C13 while lowest yield was in C14. CRI has shown that *gliricidia* has produced total of 48.0mt

ha<sup>-1</sup>yr<sup>-1</sup> as leaf (wet weight) and it has achieved maximum at the fourth year after planting and the trend appears to continue (Gunathilake and Wasantha, 2004). So it is possible to suggest that yield of coconut has been affected by the nutrients of the leaves decomposed on the fields of C13 and C14 after fourth year. Thus, *gliricidia* intercropping has a positive impact on the coconut yield. C13 and C14 have the lowest expenditure among the three fields respectively. The highest expenditure was in C15 field as the non-lopped huge *gliricidia* trees disturb the field activities for laborers. Therefore, it is suggested that the cost of operations is lower in well-managed (lopped) intercropping's. Accordingly, intercropped *gliricidia* with coconut has lowered the cost of coconut cultivation. Highest gross income and profit per hectare was generated in C13 and C15 respectively in each year. The lowest profit was generated in C14 proving that *gliricidia* intercropping enhances the profit of coconut cultivation. Initial total cost of establishing *gliricidia* was Rs. 24.34 per coconut tree in 2009. As a fuel wood with higher calorific value, the present market for *gliricidia* wood is around Rs 5000 per metric ton for energy generation. According to the data related to the wood yield, the company can generate Rs 57,780 per hectare annually by selling the *gliricidia* fuel wood.

## Conclusions

*Gliricidia* intercropping has enhanced the yield of coconut in C13 and C15 fields than the mono cropping of coconut in C14 proving that there is a positive impact on the yield of coconut. *Gliricidia* intercropping reduces the cost of production of coconut and enhances the income and profit of coconut cultivation. The main limitation of the research was the difficulty in gathering data related to costs and benefits in these fields. Enhancing the awareness about fuel wood farming is a better option to minimize the foreign exchange for fossil fuels as it is a better solution for global through a world of energy providing trees.

## References

- Gunathilake, H.A.J. (2004). Monoculture to Crop Diversification: A Paradigm Shift towards Coconut Production. In T.S.G. Peiris and C.S. Ranasinghe (Ed.), *Proceedings of the International Conference of the Coconut Research Institute of Sri Lanka- Part* (pp.82-110). The Coconut Research Institute of Sri Lanka, Lunuwila 61150, Sri Lanka.
- Gunathilake, H.A.J. and Wasantha, H.G. (2004). *Gliricidia* for Production of Green Manure and Green Energy in Coconut Plantations. In A.K.N. Zoysa and M.T.Z. Mohamed (Ed.), *Proceedings of the first Symposium on Plantation Crop Research- Current Trends and Future Challenges*. (pp.43-52). The Tea Research Institute of Sri Lanka, Thalawakelle, Sri Lanka.
- Nair, P.K.R. and Balakrishnan, T.K. (1976). Pattern of light utilization by canopies in a coconut/cocoa crop combination. *Indian Journal of Agricultural Science*, 46, pp.453-462.

# Impact of Provision of Food Safety Information Overtime on Consumer Demand

**K.D.T.M. Gunawardana\* and U.K. Jayasinghe-Mudalige**

*Department of Agribusiness Management, Faculty of Agriculture and Plantation  
Management, Wayamba University of Sri Lanka, Makandura,  
Gonawila (NWP), 60170, Sri Lanka.*

*\* Corresponding Author: maheekz91@gmail.com*

## Introduction and Objectives

In a world, where the food consumption patterns change rapidly, use of processed food has become a major part of life. Consumers, especially those with a certain level of ‘wealth to afford’ and ‘education to comprehend’ are becoming more and more health conscious, and in turn, seeking for the nutrition benefits beyond the taste and pleasure from the food that they consume. Inevitably, such trends direct the consumers to look sensibly about the information available on the level of food safety as they purchase a certain food product especially the types of food ingredients contained in it and impacts of which on their health (Henson and Caswell, 1999). This study, on this rationale, evaluates whether the food safety related information linked to certain food ingredients that can have a significant impact on consumer buying behavior, were presented to them persistently over a certain period of time using different approaches, i.e. highlight adversely the “negative” health effects of the ingredient.

## Research Methods

Consumer awareness and perceptions towards four different food ingredients that are supposed to have varying impacts on human health, including: (1) Sodium metabisulfite; (2) Monosodium glutamate (MSG); (3) Phosphoric acid, and (4) Cocoa butter substitute were considered. The research was designed to carry out in two phases to facilitate obtaining panel data from a sample of respondents (n=200) representing two distinct work disciplines, i.e. ‘teachers’ and ‘nurses’. Structured questionnaire was prepared in consultation with the subject specialists on food technology and applied nutrition as well as food economics and business. The pre-tested questionnaire was administered by means of two face-to-face interviews of which the later (Phase II) was carried out after a period of eight weeks from the former (Phase I). A deeper investigation into the changes to the attitudinal perceptions of each respondent on his/her food purchasing behavior was carried out in each phase; however, care was taken not to provide any further secondary food safety related information on these specific ingredients at the Phase II (Liaukonyte *et al*, 2015). The panel data obtained were, in turn, used to derive an ‘attitudinal perception index’ (API). Chi-square test was performed using the ‘Minitab’ (*version 15*) statistical software to evaluate the association of the level of awareness and perceptions of respondents between Phase I and II.



## Results and Discussion

About 76 percent of respondents in the sample were females. Further, nearly 60, 24 and 17 percent were educated up to a Diploma, Bachelor's and/or Postgraduate degree level respectively. The majority (61%) was aware of the fact that those "processed fruit juices" contain 'Sodium metabisulphite' for the most part as well as the probable impacts of which on their health. However, it was revealed that both teachers and nurses in the sample tend to purchase those products containing 'Sodium metabisulphite' and also the 'Cocoa butter substitute' repeatedly with compared to the products containing other ingredients in concern. Although there was not much difference reported with respect to the percentage, the lowest awareness was on the fact that "Processed Potato Chips" contains the 'MSG'. Further, it was found that the majority had got to know about the "health effects" of those food ingredients from the sources external to them; but, not from the product label directly and/or through self-learning.

The outcome of Chi-square analysis showed that a significant difference on the level of consumer attitudinal perceptions evaluated through API (at  $p=0.05$ ) between the two phases in concern when such information was provided proactively, i.e. by highlighting the effects of which on active/positive terms (Liaukonyte *et al*, 2015). However, in the case of provision of such information to the respondents by highlighting their effects "negatively", there was no significant difference in the consumer attitudinal perceptions between the two stages found.

## Conclusions

It was found that the provision of negative information to consumers change their mindset significantly as it prevents them from purchasing food items comprised of these ingredients in the fear of facing negative health effects. This implies that the food sector as a whole, i.e. producers, marketers and regulators, should build up an incentive and information based private-public partnerships to deal with and promote those products containing certain food ingredients. Such mechanism can avoid, to a larger extent, the "simple mistakes" from any side that can happen knowingly or unknowingly in their attempts to regulate, advertise, brand, label, package and certify such products, which, if not, can lead into "big and irreversible losses" to the food businesses in concern.

## References

- Henson, S.J., and Caswell, J. (1999). Food Safety Regulation: An Overview of Contemporary Issues. *Food Policy*, **24**, 589-603.
- Liaukonyte, J., Streletskaya, N.A. and Kaiser, H.M. (2015). The Long-Term Impact of Positive and Negative Information on Food Demand. *Canadian Journal of Agricultural Economics*, 1-24 (DOI: 10.1111/cjag.12074).



# **An Assessment of Cultural Services of Urban Coastal Ecosystems: Value of View as Recreation and Tourism Service**

**T.P.S.R. Guruge<sup>1</sup>, L.P.S.S.G. Senarathne<sup>1</sup>, U.K. Jayasinghe-Mudalige<sup>1</sup>  
and Devaka Weerakoon<sup>2</sup>**

<sup>1</sup> *Department of Agribusiness Management, Faculty of Agriculture and Plantation  
Management, Wayamba University of Sri Lanka, Makandura,  
Gonawila (NWP), 60170, Sri Lanka.*

<sup>2</sup> *Department of Zoology, Faculty of Science, University of Colombo, Sri Lanka.*

*\* Corresponding Author: guruge84@yahoo.com*

## **Introduction and Objectives**

Benefits from an ecosystem to support sustainable human well-being – commonly referred to as ‘ecosystem services’ – are fundamentally categorized under four major groups, namely: “Provisioning”, “Regulating”, “Cultural” and “Supporting” (Groot *et al.*, 2002; Barbier and Strand, 1998). Often in environmental studies, the ecosystem services been taken as a bundle of services and the individual value of certain attributes such as cultural services, which account for non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences is largely overlooked in literature. It has also been learnt that human cultures are strongly influenced by ecosystems and the alterations in linked amenities can have a significant impact on cultural identity and social stability. On this understanding, the purpose of this study was to assess the value of recreation and ecotourism of an urban coastal ecosystem, which is made out of urban systems and coastal systems as classified in Millennium Ecosystem Assessment’.

## **Research Methods**

It was presumed that there is a tradeoff between ecosystems services and the utility that an individual derives from one subset of ecosystem services over another is a function of the frequency that she chooses the one selected over the other subset in repeated choices (Benson *et al.*, 1998; Wattage and Mardle, 2008). Accordingly, a Choice Experiment (CE) was applied to assess the value of recreation and ecotourism services of the urban coastal ecosystem selected, *i.e.* Negombo urban area with a clearly defined natural environment, *i.e.* lagoon with good scenic view and a tourism market of domestic and foreign visitors. The officials attached to administrative unit of the hotels adjacent to the Negombo estuary were met through three Focused Group Discussions to ascertain the ‘attributes’ and ‘levels’ pertaining to CE, and in turn, to collect data through a series of face-to-face interviews (n=34) supported by a structured questionnaire. Complete Factorial Design (CFD) had 243 profiles (five attributes with three levels; including ecosystem service attributes and monetary attribute). The orthogonalization procedure was used to recover only the main effects of 18 lagoon profiles (choice tasks) that were randomly blocked into six different versions (choice cards).

## Results and Discussion

Ninety five percent of the respondents possess more than 10 years' experience in hotel administration. According to the respondents the hotels in Negombo have been attracted by both domestic and foreign visitors due to the lagoon and/or beach. Domestic or foreign visitors usually engage in activities including, sports fishing; motor boat and leisure boat rides; relaxation, and photography. Further they were asked to cite the major services of lagoon and the results affirmed the flood control (92%); coastal protection (87%); lagoon fisheries (85%), and recreation and tourism (81%) as major services of lagoon.

Both “full” view (Rs. 4,772) and “partial” view (Rs. 4,499) had significant impact (P-Values respectively; 0.02 and 0.03) on implicit price of overall ecosystem services at 95% confidence level. Further the values of views could have changed depending on distance from the lagoon according to the availability of access to lagoon front amenities. The outcome of analysis suggests that the ‘willingness-to-pay’ to conserve lagoon view as elucidation to the loss of recreation and tourism services resulting from the deterioration of quality of lagoon view was Rs. 9,271. The added value of this scenic beauty represents approximately 41% of the total services produced by the ecosystems. Scenic beauty of view reflects the importance of recreation and tourism service as an ecosystem service of lagoon. Scenic beauty as a recreation and tourism service has many interlinks with multiple stakeholders i.e. as a scenic drive the lagoon view attract local and foreign visitors who contribute to the financial health of many hotels and restaurants in Negombo lagoon area.

## Conclusions

The study presents a comprehensive valuation of scenic beauty as recreation and tourism service of ecosystem. This value is and has a good potential if the positioning of the site and biodiversity of lagoon becomes consolidated in the competitive market of ecotourism. According to the study scenic beauty added more than one third from the total ecosystem services. Large number of visitors have been using this service, which are dependent of the health of marine ecosystem and tourism. Therefore in formulating conservation policies and exploiting development activities the policy makers must account the fact and importance of view as a component of ecosystem services.

## References

- Barbier, E. B, and Strand, I. (1998). Valuing mangrove fishery linkages: a case study of Campeche, Mexico. *Environmental and Resource Economics* 12, 151–166.
- Benson, E.D., Hanson, J.L., Schwartz, A.L., and Smersh, G.T. (1998). Pricing residential amenities: The value of a view. *Journal of Real Estate Finance and Economic*, 16 (1), 55-73.
- Groot, R.S., Wilson, M.A. and Boumans R.M.J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Journal of Ecological Economics*, 41, 393–408.

Wattage, P. and Mardle, S., (2008). Total economic value of wetland conservation in Sri Lanka identifying use and non-use values. *Journal of Wetland Ecology and Management*, 256 (8), 1517-1572.

# **Banana Value Delivery Network; Study on Recognizing What Cause the Imperfection in Value Delivery Network Present in Embilipitiya–Ratnapura District**

**W.M.T.B. Weddagala, B.M.R.L. Basnayake, H.M.L. Wijesekara,  
N.R.D.S. Dharmathilake, K.K.A.Kiriveldeniya and D.A.M. De Silva**

*Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O.Box 02, Belihuloya. 70140. Sri Lanka.*

*\* Corresponding Author: Tharaka\_92@hotmail.com*

## **Introduction and Objectives**

The value chain as both a concept and tool has been used for the last 30 years to understand and analyze industries (Porter, 1980). The concept clearly demonstrates the stakeholders of the process and their functions. Present study utilized the value chain concept to analyze the situation of banana industry. In Sri Lanka, about 50,000 ha of land area are under banana cultivation and the annual production is about 39,772,000 bunches (Wasala *et al.*, 2012). Banana value chains were short and complex where upstream representing the small and medium scale banana growers. Intermediaries with multiple roles were the key players in the banana downstream and they connect banana farmers to consumers. Banana consumers in the domestic market paid for the benefits that they receive from the consumption of banana. High post-harvest losses, poor quality of the banana in end markets and chemical poisoning indicate the inefficient banana value chain. As a result, most of the vulnerable members of the value chain were not gaining the benefits they expected due to the loop holes existing within the value delivery network. As a matter of fact the price of consumer spend on banana purchasing become high and also middlemen and even farmer do not gain the benefit as they were expecting. Improper pricing mechanism, lack of market information, poor market infrastructure, lack of awareness on quality maintenance of products and poor post-harvest management cripple the smooth flow of banana from farm to consumer. Limited number of studies paid attention to identify the banana value chain and its behavior. Our approach focused to find out the present status of the banana value chain and investigate the functions and roles of upstream node.

## **Methodology**

Our approach was to identify the banana value chain, through its structure, functions, roles as well as the actors. Country's leading banana producing area was selected for the research purpose and research locations were Thunkma and Atekuwa of Embilipitiya divisional secretariat. Further, availability of both upstream and downstream actors of the banana value chain was the other unique feature area. Rapid market chain analysis was adopted to recognize the banana value chain. Interviewer administered pre-tested questionnaires were used to collect primary data from banana farmers (42) and intermediaries (23).

Further, In-depth interviews were conducted with the key informants of the banana

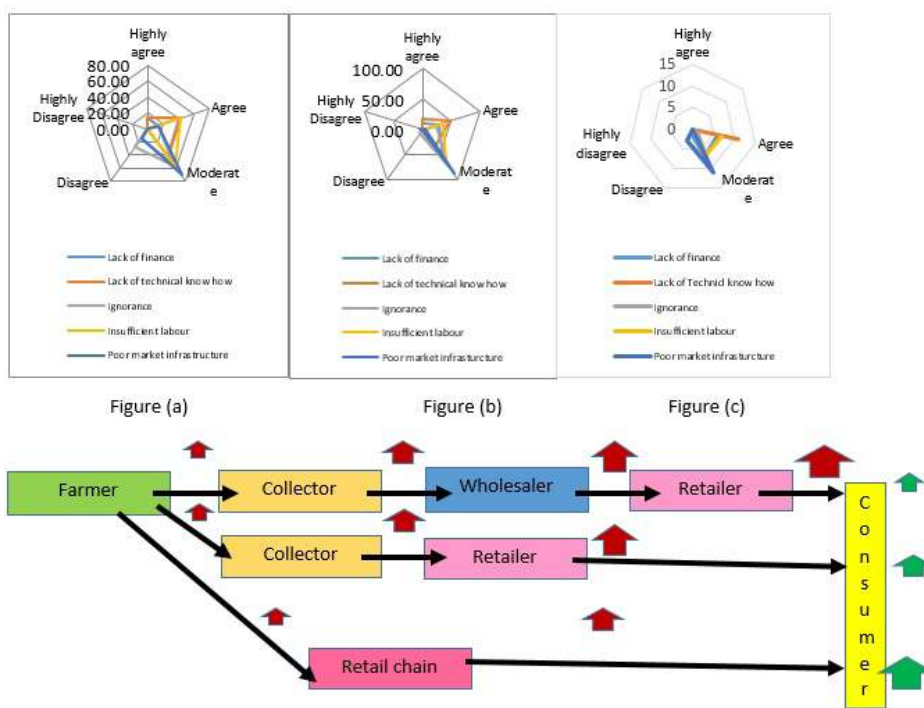
value chain and our focus was on members of upstream as well as downstream nodes of the value chain. Banana farmers were categorized into 3 groups based on extent of cultivation such as, small scale <1AC, medium scale 1-5> AC and large scale 5<AC. Special attention was paid to identify the value addition activities, problems and issues of three different farmer groups. Further, in-depth interviews were used to identify the value chain structure, vertical and horizontal links, power and governance. Lead farmers, auctioneers, collectors, retailers were provided the input for the interviews. Our focus was on banana value delivery network which was very much dependent on the existing market logistics to connect the consumers. The proposed approach, value delivery network provided the better understanding compared to traditional liner value chain approach.

## Results

Upstream of the banana value chain is comprised of three different groups of banana farmers. Production volume, variety, investment, and network size of the farmers are varied according to their size of operation. Further, large and medium scale farmers maintain their own network to supply banana to distinct market places and own transport facilities and establish large networks act positively on their performance. In contrast, small scale farmers have less bargaining power in the market places in price decisions and poor resource status leading to minimum investment on infrastructure. Small scale banana farmers were price takers with limited networks with market intermediaries. Limited value addition was a common feature among three different farmer groups. Figure no: 1 explains the value addition of large, medium and small scale growers and the reasons behind the low level of value creation.

Farming operations were male dominant business and family members mainly contributed mainly on agronomic practices, harvesting, handling and packing operations. Seventy five percent of the banana plantations were cultivated as monocrop while rest was in mixed cropping systems. In general, all farmer categories place minimum value addition efforts due to lack of knowledge and know-how, limited availability of financing options, and non-regularized market operations. Market infrastructure available was very poor and heavy post harvest losses were the ultimate outcome. Quality of fruits at farm gate level was reasonably high due to better practices of producers while poor transport, handling and packing operations lead to deteriorate the quality.

Banana markets were organized once a week in Thunkama on Thursday and Atekanuwa on Monday. Most of the market operations were informal and market leader manage the functions. Farmers used their own transport or hired transport to reach the market place prior to the business day. Farmer's efforts on producing better quality banana and receiving reasonable price for their products assured through their production and postharvest operations. They used banana leaves as wrappings for banana bunches and usually transported at night. Price was determined by the informal manager of the market place and the price is based on quality and size of the fruits. Both male and female buyers acted as intermediaries and they were joining the market from various destinations of the country. Entire market operations were informal and transactions based on mutual agreements, trustworthiness, and network support.



**Figure (d) Banana value delivery network: (proportionate postharvest losses in red arrow & value delivered in green arrow)**

**Figure 01: Key features of the upstream node of the banana value delivery network**

**(a- Value addition-large scale, b-value addition-medium scale, c- value addition-small scale, d-banana value delivery network)**

Farmers adopt two options for organizing its farming and marketing activities: an internal hierarchical structure that composites of family and close business partners integrates activities into its management and market relationship with external members. Market transactions support the coordination between multiple buyers and sellers. Thus, many of the benefits associated with integration which primarily the elimination of transaction costs. Strategic benefits to the farmers were customer relationship, service and content innovation, and infrastructure management. Benefits gained through the network were very much important to the banana producing farmers to entertain better returns and stay within the sector. Infrastructure and logistics were most common unavailable facilities to the farmers and which claimed highest postharvest losses. Highest recorded postharvest losses were with the lengthier value chains with several intermediaries, collectors, traders and retailers. Poor handling and packing techniques, bulk transport, improper transport facilities and absence of cold chain facilities claimed huge post-harvest losses and limited returns to entire value chain members. In contrast, organized retailers, such as retail chains like Cargill's Ceylon Plc., Keels Super, directly purchase from farm gate, farmers need to maintain the quality of their supplies. Further, they use better handling and packing operations (plastic crates, separated bunches, paper wrappings for bunches), proper vehicles and

storage to minimize postharvest losses. Short value chain in that nature entertains both ends of the value chain, assuring better returns to operator. Further, the retailer driven system produced less quality deterioration, minimize postharvest losses and waste.

## Conclusions

Value delivery network of banana was complex and large number of intermediaries was identical in both informal markets. Upstream nodes, especially banana farmers engaged in production of various varieties of banana in different volumes. Farmers dedicated to produce good quality fruits expecting better market prices for their products and assure healthy profits. Informal market functions were governed by the large number of intermediaries. Both male and female vendors actively participated in market operations where farmers or producers received little bargaining power. Poor handling, packing, transportation and storage functions of intermediaries are responsible for deteriorating the quality as well as the value of the products. Further, unethical postharvest practices of intermediaries damage the consumer perception of chemical free, fresh quality banana to consume. Consumer's voice is powerless to bargain or demand quality and hygienic products. Both upstream and downstream end nodes were less powerful and act as price takers. Powerful intermediaries control the value chain and responsible for huge postharvest losses with unethical marketing practices. In contrast, organized retailers as the one consolidate intermediary handling all value chain functions able to deliver better value to the consumer through quality, hygienic banana. Shorter arms of the banana value chain with single or limited intermediaries deliver highest value to the consumer compared to lengthier arms.

## References

- Wasala, W.M.C.B, Dharmasena, D.A.N., Dissanayake, T.M.R. and Thilakarathne, B.M.K.S. Physical and Mechanical Properties of Three Commercially Grown Banana (*Musa acuminata* Colla) Cultivars in Sri Lanka. *Tropical Agricultural Research* Vol. 24 (1): 42 – 53 (2012).
- Porter, M. (1980). *Competitive Strategy: Techniques for Analyzing Industries and competitors*, FreePress, New York, USA
- Madhavan, R., Koka, B. and Prescott, J. Networks in transition: how industry events (re) shape inter-firm relationships, *Strategic Management Journal*, , Vol. 19, 1998, pp. 439-459.
- Normann, R. and Ramirez, R. (1994). *Designing Interactive Strategy: From the Value Chain to the Value Constellation*, John Wiley & Sons, Chichester,



# Urban Consumers' Demand for Fruit Attributes using Grapes, Sweet orange, Pear and Pomegranate: A Conjoint Analysis

R.G.S.M. Ranasingha<sup>1\*</sup>, J.C. Edirisinghe<sup>1</sup>, R.H.M.K. Ratnayake<sup>2</sup>

<sup>1</sup> Department of Agribusiness Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka

<sup>2</sup> Department of Horticulture and Landscape Gardening, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka

\* Corresponding Author: shashikalaranasingha@gmail.com

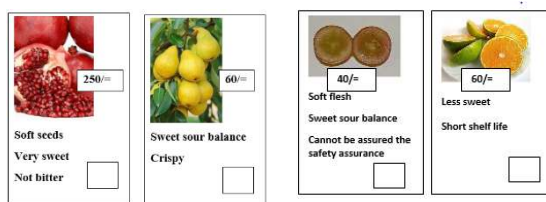
## Introduction and Objectives

Sweet orange (*Citrus sinensis*), grapes (*Vitis vinifera*), pear (*Pyrus communis*) and pomegranate (*Punica granatum*) are popular fruits among urban consumers in Sri Lanka. However, these fruits are mostly imported to Sri Lanka, either because of unavailability of locally adapted cultivars or due to less consumer acceptance for the available local types. Mass fruit import adversely affect local fruit producers while spending the country's foreign exchange. Therefore, the Department of Agriculture in Sri Lanka attempts to introduce new and improved varieties to the local market. Identification of consumer preferences is important in designing products with maximum consumer demand to capture the market share. With a view to assist in future breeding programmes, this study evaluated consumers' stated preferences for sweet orange, grapes, pear and pomegranate. The objectives were to assess the fruits' attributes of importance to consumers and to define an overall product with optimum combination of features.

## Research Methods

A Conjoint Analysis (CA) was used to collect data. It measures the satisfaction from a product with multiple attributes (Green and Srinivasan, 1990) by systematically varying product attributes through assigning each attribute level a value that indicates the relative importance of that level to the respondents (Wang *et al.*, 2003; Hair *et al.*, 2010). Six such attributes were selected except for Pomegranate that had seven (Table 1). Each attribute had two levels making very large number of possible product (fruit) profiles. Respondents' task was to rank these fruit profiles from best to worst. Because ranking large number of profiles is difficult, they were reduced to eight by taking an orthogonal fractional factorial design. Finally, respondents ranked eight profiles from 1 to 8 from each fruit (Figure 1). The sample for the ranking exercise was 205 randomly selected urban consumers in the Colombo district and the data were collected through face-to-face interviews. The nature of ranked data dictated the use of a Rank Ordered Logit model for estimation. For the ease of interpretation, odds ratios were calculated by exponentiation of the estimated coefficients. The Relative Importance (RI) placed by consumers for product attributes were calculated based on methods similar to Harrison *et al.* (2002).





**Figure 01: Example for the stimulus cards used.**

## Results and Discussion

Crispness and price in pear are statistically significant with 95% confidence level. The highest relative importance (RI) for pear is crispness (71.7%) followed by size (10.9%), shape (8%), sweetness (4.8%) peel (3.4%) and price (1.2%). Thus, crispness is the critical attribute in pear. Consumers preferred non-bitter pomegranate and soft seeded fruits by 1.43 times and 1.4 times higher than bitter fruits and hard seeded fruits, respectively. The preference for safety assured grapes is 3.19 times higher compared to non-safe grapes. Consumers' preference ranking for product attributes of grapes are: safety assurance (53.70), sweetness (14.37), firmness (11.77), size (11.39), seeds (8.68) and price (0.10). They have safety concerns over imported grapes. In sweet orange, sweetness and shelf life are the significant attributes at five percent error level. Shelf life of sweet orange is of 64.5% importance to consumer followed by sweetness (17.9%), peel colour (10.2%), seeds (6.2%), price (1%) and flesh colour (0.2%). The most favourable combination of attributes for each fruit was identified. A small, pear shape, crisp pear with a yellow peel and a sweet-sour balanced taste is preferred at a cost of Rs. 60. Pink colour, large pomegranate at Rs.100, with soft seeds with red colour, less sweet and non-bitter aril would satisfy the customer. Safety assured, large, very sweet, seeded and firm grapes at a low cost are most preferred. A seedless sweet orange with high sweetness, high shelf life at a cost of Rs. 30 is most desired with green peel colour and orange flesh colour.

**Table 01: Attributes and their levels**

Attribute	Pear	Pomegranate	Grapes	Orange
Peel Colour	Green, Yellow	Pink, Yellow		Green, Orange
Size	Small, Large	Small, Large	Small, Large	
Shape	Round, Pear			
Sweetness	High, Low	High, Low	High, Low	High, Low
Crispness	High, Low			
Aril Colour		Red, Pink		
Hardness of Seed		Hard, Soft		
Bitterness		Bitter, Not		
Seeds			Have, Seedless	Have, Seedless
Firmness			High, Low	
Safety Assurance			Assure, Not	
Flesh Colour				Orange, Yellow

Shelf Life				High, Low
Price*	100/=, 60/=	250/=, 100/=	100/=, 40/=	60/=, 30/=

Note: \*Per fruit for pear, pomegranate and orange. For grapes, it is for 100g

## Conclusions

The urban consumers were concerned mainly on a few key attributes of grapes, sweet oranges, pears and pomegranate in their purchasing decisions. Therefore, breeders may concentrate on the attributes that are relatively more imperative for the consumers to make a significant effect on their purchasing decision. Among the attributes included in the conjoint study, price was the least important. Instead of lowering the price to capture market share, it may be more important to include the desired features when introducing new fruit varieties. Thus, the findings are useful as a reference for fruit breeders to design their products.

## References

- Green, P. E. and Srinivasan, V. (1990). Conjoint analysis in marketing: new developments with implications for research and practice. *The Journal of Marketing* **54** (4), 3-19.
- Harrison, R. W., Stringer, T. and Prinyawiwatkul, W. (2002). An analysis of consumer preferences for value-added seafood products derived from crawfish. *Agricultural and Resource Economics Review* **31**, 157–170.
- Wang, M. H., Thomas, K. R., Chan, F. and Cheing, G. (2003). A conjoint analysis of factors influencing American and Taiwanese college students' preferences for people with disabilities. *Rehabilitation Psychology* **48**(3), 195-201.
- Hair Jr, J. F., Black, W. C., Babin, B. J., Anderson, R. E. and Tatham, R. L. (2010). SEM: An introduction. *Multivariate data analysis: A global perspective* 629-686.

# Mobile Market Decision Support System and its Application in Agricultural Marketing in Sri Lanka

**W.M.T.B. Weddagala\*, B.M.R.L. Basnayake, H.M.L. Wijesekara, N.R.D.S. Dharmathilaka, K.K.A.Kiriveldeniya and D.A.M. De Silva**

*Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University, P.O.Box 02, Belihuloya*

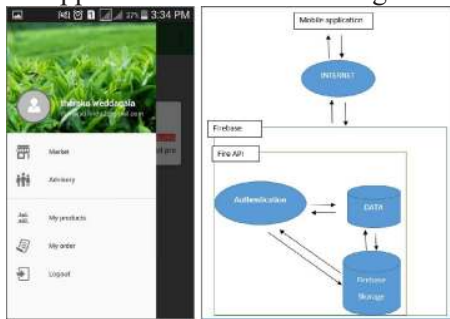
**\* Corresponding Author: Tharaka 92@hotmail.com**

## Introduction and Objectives

Complexity of agricultural value chains causes decision making is an impossible task for individual actor and generates necessity for more efficient and effective decision support system. (Matsatsinis and Siskos, 2003). The latest advances in e-marketing and mobile-marketing have propitiated the rapid creation and expansion of mobile applications in marketing of agricultural products. (Martinez-Perez, 2014). Our research is to facilitate market decisions through mobile technology which is readily available with value chain actors in Sri Lanka but not actively using for agricultural marketing. The main objective is twofold, develop marketing decision support system (MDSS) and of implementation of MDSS for underutilized crop marketing. And our expectations were providing a common platform for exchange information, supporting appropriate decision making, expanding and promoting the traditional food production, providing efficient advisory service for further developments in the sector, protecting and encouraging the entrepreneurs of underutilized crop production. Decision support systems and mobile applications available for several other sectors but not for the market decision support. Our approach is to cater for the very important need.

## Methodology

Research methodology was two fold. First mobile application developed on android platform due to its easiness and mass availability of mobile phones. Android studio was used as the application development program where JAVA was used as the programming language. All the data handle by the application was uploaded into cloud back-end which has a real-time updating and data processing ability. For the authentication of using this application user accounts log in method was implemented.



**Figure 01: a. –Main page of the MDSS      b. – Internal functioning process of data**

Second part concentrated on developing the data base of underutilized crops value chain actors where we have selected registered producers of the Hadabima Authority, Industrial Development Board, and HelaBojunHala of Department of Agriculture. Key concern was to develop producer data base from the quality and hygienic value added product suppliers to the domestic market. Intermediary data base composed of selected sole supermarkets, mini marts and large retail stores and the selection based on their willingness to join the data base. Further, intermediaries were agreed to purchase the products from registered supplier farmers with the system. A group of professional marketers and academics were joined as marketing advisors for the value chain members. Members of university academic staff, Sri Lanka Standards institution, Department of Agriculture and Industrial Training Institute were the representing organizations. Randomly selected consumers from Colombo, Kandy, and Rathnapura districts were registered with the system to complete the value chain downstream. MDSS's services for the value chain members were varied and categories were developed to cater for their very important needs. i.e. For producers- product promotion, brand development, information on competitors, market trends and advisory support; for Consumers and intermediaries- prices, product types, contact information of registered consumers. Final phase, implementation was started with the completion of data base development and team members were engaged with the close monitoring of the MDSS operations.

## Results and Discussion

Our approach was to analyze the state of art of MDSS in agricultural marketing with real value chain members. Our first objective was to develop MDSS and mobile application to facilitate the functions was successfully completed. This new reality, MDSS provide common platform for value chain actors join together. Advisory services were keen to develop market strategies for both producers and intermediaries. Market information, legal aspects, food quality and nutritional aspects entertain the requirements of consumers. Initially, we were having difficulties in training of value chain members for the system operations. Both young and old members were engaged actively on the platform and shared the information. Dynamic nature of agricultural marketing and the new daily information exceeds the limits of the human intellect. Therefore, the MDSS bridge the gap in decision making and information sharing. Further, MDSS improve the market access of the selected value chain members, especially located in remote areas of the country and potential consumers in urban areas. MDSS facilitate to link value chain members in common platform and information sharing through the system help them to make better sustainable decisions. The primary market niche of the commercial MDSS was the producers, consumers and intermediaries.

## Conclusion

Our approach, MDSS, aimed to facilitate smooth functioning of underutilized crops value chain via MDSS. MDSS facilitate to close the information gap value chain actors, help to create sustainable decisions. Mobile application helps to link a value chain within common platform and smoothen function in the value chain. And also help to enhance the living conditions of rural community through promising returns to their products. Producers, middlemen and consumers were the key users and advisory

support help them to shape their functions. Further we recognize the need of awareness knowledge on MDSS and technological knowledge to efficient functioning of the mobile app.

## References

- De la Torre-diez, I, Martinez-perez, B, lopez-coronado, M, diaz, J.R., Lopez, M.M., (2015). Decision support systems and applications in ophthalmology: literature and commercial review focused on mobile apps, *Journal of medical systems*, 39:1:174 doi.10.1007/s10916-014-01742
- Martinez-perez, B., dela Torre- Diez, I, lopez-coronado, M,et al., (2014). *Journal of medical systems*, 38:4 doi .10.1007/s10916-013-0004-4.
- Matsatsinis and Siskos (2003). *Intelligent support systems for marketing decisions*, Kluwer Academic publishers,ISBN 1-4020-7194-9
- Ponweera, P.A.D.M.D. and Premaratne, S.C. (2011). Enhancing Paddy Cultivation in Sri Lanka through a Decision Support System, *Journal of Emerging Technology and Advanced Engineering*, ISSN 2250-2459.

# **Factors Affecting the Occupational Health and Safety Performance: A Case Study in a Fruit and Vegetable Processing Factory in Sri Lanka**

**M.S. Elapata\*, R.P. Mahaliyanaarachchi**

*Department of Agribusiness Management, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka, PO Box 02, Belihulouya. 70140. Sri Lanka.*

*\* Corresponding Author: maheshwari.elapata@gmail.com*

## **Introduction and Objectives**

Occupational Health and Safety (OHS) is a vital strategy that ensures the health of workers, improves productivity, quality of products and services, motivates workers, increases job satisfaction and thereby contributes towards the overall quality of life of individuals and society (Amponsah-Tawiah *et al.*, 2011). The role of research in improving working conditions is now gaining a new impetus. Thus OHS management systems like OHSAS 18001:2007 is one result of this concern. Even though many organizations in Sri Lanka have gained this certification, safe and sound OHS practices are still questionable. Nevertheless, studies in concern to OHS in the food industry in Sri Lanka are limited. Thus it was deemed to be appropriate to find out the factors affecting Occupational Health and Safety performance in the food industry.

## **Research Methods**

The study was conducted in a fruit and vegetable processing factory. In the view of this proposed study deductive approach was used as the research approach. Based on the research questions formulated in this study, a descripto-explanatory research purpose was adapted. Survey and case study research strategies were used in this study. A reliability analysis for the likert scale statements in the questionnaire was carried out as shown in Table 1. 132 industrial workers and 46 supervisors and executives of the factory were selected. The dependent variable *safety performance* was identified as accident occurrence to a person resulting in various degrees of injury. High, moderate and low safety performing groups were identified by the level of accident/s that each respondent had in the past. Industrial workers who had no injury in the past were identified as workers with highly performing safety records, those who had encountered minor injuries were identified as workers with moderately performing safety records and those who had major injuries were identified as workers with low performing safety records (Sawacha, *et al.*, 1999). Both descriptive and inferential statistics were used in this study to analyze the collected data. Descriptive statistics that were used were mean, frequency and standard deviation. Spearman Correlation, Rank Based Quotient and Factor Analysis were the techniques of statistical analysis used in this study to analyze the data set.

**Table 01: Cronbach's coefficient alpha for the likert scale statements in the Questionnaires**

Aspects in the Questionnaire	No of Items	Cronbach's alpha coefficient
Questionnaire for the supervisors and executives		
Personal Reasons for the poor safety behavior	13	0.833
External Reasons for the poor safety behavior	12	0.922
Questionnaire for the industrial workers		
Workers' Contribution to safety performance	10	0.798
Co-workers Influence on safety performance	7	0.984
Supervisors' Influence on safety performance	11	0.868
Organizational Factors	30	0.866
Constraints in promoting OHS	9	0.921

Source: Author Compiled based on the survey data,2016

## Results and Discussion

Majority of the industrial workers have encountered minor injuries (68%) thus indicating that the majority showed a moderate *safety performance*. The results suggests that the industrial workers rarely proposed innovative methods of risk reduction(mean score of 2.3409). Reporting near misses to the supervisors was also rarely carried out by the workers (mean score = 2.4379). Nearly half of the industrial workers have encountered near misses (45%). However, only 27% of the workers have encountered an injury repetitively, which indicates most of the workers have ensured non-recurrence of the injuries. Majority of the industrial workers were exposed to ergonomic hazards (42%) where most of them had encountered back pains due to prolonged standing when carrying outs tasks in the production line. Weak relationships were found between *safety performance* and educational level of the workers, working experience, and attendance of the OHS trainings, safety communication among co-workers, safety communication between supervisors and workers. However, long working hours, Hazard Identification, Training and Competence showed a moderate relationship with *safety performance*. The most dominant factor that affects *safety performance* was the Top Management Commitment which was strongly correlated with *safety performance*. The major constraints identified in promoting the OHS were Organizational constraints (Lack of trainings) and dispositional characteristics of the workers (Staffs' habitual practices).The supervisors and the executives strongly agreed workers being careless, unconsciousness of the workers and difficulty to break old habits as the personal reasons for poor safety behavior of the industrial workers. They also identified that handling dangerous equipments and machines and also long working hours especially during high production seasons as the external reasons for poor safety behavior of the workers.

## Conclusions

Inspite of the importance of OHS, workers tend to ignore the safety behaviours

like reporting near misses and proposing innovative methods of risk reduction indicating their negligence on the importance of OHS. Automation of work had led to repetitive motions and manual work handling had led to awkward, wrong postures at work resulting in more ergonomic hazards. There are varying factors affecting *safety performance*. However Top Management Commitment was identified as the most dominant factor influencing *safety performance* as motivated employees are persisting to improve safety when they are aware that the management is more apparent and supportive of the safety activities. The staff's habitual practices and lack of training on OHS were identified as the main constraints in promoting OHS indicating that the organization should review their OHS training needs of all employees in order to enhance the competencies and awareness on OHS aspects. Thus the study revealed that the food industry in Sri Lanka should focus more and strengthen their policies regarding safety concerns.

## References

- Amponsah-Tawiah, K., & Dartey-Baah, K. (2011). Occupational health and safety: Key issues and concerns in Ghana. *International Journal of Business and Social Science*, 2(14).
- Sawacha, E., Naoum, S., & Fong, D. (1999). Factors affecting safety performance on construction sites. *International journal of project management*, 17(5), 309-315.



# Major Drawbacks on the Perception of Fishermen for Culturing of Carp Species in Inland Freshwater Reservoirs in Galenbindunuwewa Area

**B.R. Jayathilaka<sup>1\*</sup>, R.H.G.R. Wathsala<sup>1</sup> and A.P.S. Fernando<sup>2</sup>**

<sup>1</sup> *Department of Animal and Food Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura.*

<sup>2</sup> *Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura.*

*\* Corresponding Author: bhatnagaramit75@gmail.com*

## Introduction and Objectives

Endemic species give less production quantities in freshwater reservoirs in Sri Lanka<sup>1</sup>. Introduction of exotic carp species in 1976 has caused significant development in inland fisheries in Sri Lanka<sup>2</sup>. However, tilapia still plays a major role in inland fishery sector as a dominant group of fishes, especially in the areas where societies are largely dependent on freshwater fisheries and also where low-income earning rural communities in the country<sup>2</sup>. Fishermen who engage in freshwater fisheries in Galenbindunuwewa area are not willing to stock carp species although government authorities need to promote carp species. There is a disagreement between fishermen in Galenbindunuwewa area and government authorities on the stocking of carp species. This study was conducted to find out major drawback factors which affected on perception of fishermen on stocking of carp species into their reservoirs. It is important to make decisions on stocking strategies to generate more socio-economic benefits for fishermen from inland freshwater fisheries in Sri Lanka.

## Research Methods

The study was conducted in Galenbidunuwewa secretariat division of Anuradhapura district in Sri Lanka during the time period of July to December in 2015. The total numbers of sixty fishermen were randomly selected for the study as respondents representing from major reservoirs, namely; Hurulu wewa, Aluthdivul wewa, Manankattiya, Kiulekada and Illuk wewa in Galenbindunuwewa area. A researcher administered questionnaire survey was carried out to collect data. In addition, direct observations were also used whenever it was appropriate and required to gather data. The variables were fisherman annual income earnings from each fish species, market demand for each fish species, size compatibility (size of fish), consumer preference level, and catching effort for each fish species. Here, all of those variables were independent variables and measured as categorical rank data by using Likert scales. Fishermen perceptions and perception levels are dependent variables. Relationship between fishermen perceptions and factors which affected to perception level were analyzed by using non parametric categorical rank data analysis method as probit model and Pearson correlation method. Minitab version 16.1 was used to statistical analysis.

## Results and Discussion

Relationship between lower perception levels of fishermen with fishermen income earnings from carp was insignificant ( $p > 0.05$ ). It is because of income changes are more associated with fluctuations of fish harvest quantity from season to season rather than variety of fish. There was a significant ( $p < 0.05$ ) strong positive ( $r = 0.799$ ) relationship between lower perceptions of fishermen on carp species and market demand. It is concluded that fishermen hold lower preference to carp species since they have low market demand. There was a significant ( $p < 0.05$ ) strong positive ( $r = 0.824$ ) relationship between fishermen perceptions on carp species and lower consumer preference. Accordingly the existence of lower demand for carp could be a reason to reject stocking of carp species into their reservoirs by fishermen. However, there was no significant ( $p > 0.05$ ) relationship between fishermen perception levels with fishing effort. The reason would be, that they did not concern about catching effort of fish species. There was a significant ( $p < 0.05$ ) strong positive ( $r = 0.932$ ) relationship between fishermen perceptions on carp species and size compatibility. The size of fish would be key factor that affected on marketability of each species and found that carp has lower marketability due to their inconvenient sizes.

## Conclusions

Correlation analysis demonstrated that strong ( $R \geq 0.8$ ) positive and significant ( $p < 0.05$ ) correlations between lower preference for carp species by fishermen and lower market demand ( $r = 0.8$ ), inconvenient size compatibility ( $r = 0.9$ ) and low consumer preference ( $r = 0.8$ ) while correlations were insignificant with fishing effort and incomes from carp species. Lower market demand, inconvenient size compatibility and low consumer preference are crucial factors that affected on negative preferences of fishermen on carp species that preferred by authorities to promote in reservoirs in Galenbindunuwewa area. Therefore, revision of present stocking strategy could be generated more socio-economic benefits for fishers.

## References

- De Silva SS. Reservoirs of Sri Lanka and their fisheries. Fisheries Technical Paper 298. FAO, Rome. 1988; 128.
- Athauda S. Is tilapia becoming an invasive fish in Sri Lanka? [Internet] <http://www.researchgate.net/publication.html> (Accessed on: 26/03/2005)

# **AGRICULTURE AND AGRI ENVIRONMENT**

## **Student Forum**

**09<sup>th</sup> December 2016**



# Effect of Biofilmed Biofertilizers on the Development of Leaf Rot and Powdery Mildew Diseases of *Gerbera jamesonii*.

M.T.N Wickramage<sup>1</sup>, K.A.C.N Seneviratne<sup>2</sup>, P.K.Dissanayake<sup>1</sup>

<sup>1</sup> Department of Export Agriculture, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya.70140. Sri Lanka.

<sup>2</sup> Royal Botanical Gardens, Peradeniya.

\* Corresponding Author: [thisakinik@gmail.com](mailto:thisakinik@gmail.com)

## Introduction and Objectives

Floriculture has become an important sector in agriculture in the world. In floriculture sector cut flower market plays an important role. *Gerbera jamesonii* is an important cut flower grown in Sri Lanka which ranks fourth in the international cut flower market. Most of the gerbera varieties are highly susceptible to diseases such as powdery mildew, leaf rot, *Alternaria* leaf spot, Bacterial leaf spot, *Botrytis* blight, *Fusarium* stem rot. Usage of fungicides and other agrochemicals is an extra cost in gerbera production and it further affects the quality of the marketable products as well. Continuous use of agrochemicals for the growth of the plants and against the pests and diseases causes serious threats upon both human health and the environment. Bio filmed Bio fertilizer (BFBFs) is a cost effective, environmentally friendly, 100% natural and chemical free fertilizer which promotes the growth of the plants and increase the microorganism activities in the soil while improving the quality of the soil. This research was carried out to examine the effect of BFBFs on the leaf rot and powdery mildew diseases of *Gerbera jamesonii*.

## Research Methods

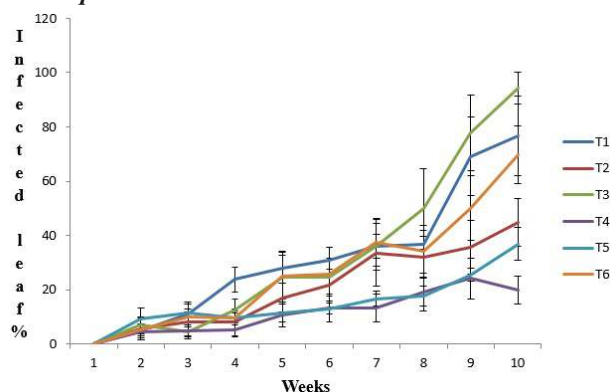
A pot experiment was conducted at Royal Botanic Gardens, Peradeniya. Healthy and vigorous, uniform one month old gerbera seedlings were used. Fresh weight of the plants was obtained removing the soil around the cube which hold small roots of gerbera seedlings before planting. Potting media was consisted with top soil, compost, and sand and coir dust according to 1:1.5:1:0.5 ratio. The experiment was Completely Randomized Design with ten replicates. The experiment consisted with six treatments, namely, 100% BFBF (T1), 100% Chemical fertilizer (T2), 50% Chemical fertilizer (T3), BFBF + 50% Chemical fertilizer (T4), 100% Chemical fertilizer + 100% Fungicide as a Dithiocarbamate (T5), distilled water (T6) which used as the control treatment. When applying the treatments same volume was used for each plant and all the treatments were applied twice per week as a soil application and also as a foliar application. Disease development was observed while applying the treatments. Visual observations were used to assess the disease development of gerbera plants. Number of infected leaves out of the total number of leaves (Disease incidence index) in a plant was counted weekly. After ten weeks, plants were uprooted carefully and final fresh weights of the plants

were measured. Data were subjected to analysis of variance to determine significant difference among means.

## Results and Discussion

Combined used of BFBFs with the chemical fertilizer (T4) treatment showed Significantly low leaf rot disease development than all the other treatments. 50% Chemical fertilizer application treatment (T3) has shown the highest percentage of infected leaves by leaf rot disease followed by the treatment BFBFs alone (T1). According to above results moderate application of chemical fertilizer with the BFBFs provide nutrients with increase microbial biomass of the Bio film rather than application of 50% Chemical fertilizer alone. The sufficient nutrients and colonization of beneficial microorganisms give the ability of production higher IAA (Indole acetic acid) content which helps converting soil pH in to an acidity condition with that most of the pathogenic microbe's growth are suppressed. The application of BFBFs alone does not give those benefits because of lack of nutrients in soil medium causes to decrease the efficiency of the microbes activities and thus microbes on biofilm started to get the nutrients from soil media competitively with the plants, and this makes the plants became too weak with the lack of nutrients in soil media and it causes plants to more prone to diseases. Other treatments did not give significant results when considering leaf rot disease development. When considering powdery mildew disease T5 (100% CF+ Fungicide) treatment, it showed lowest percentage of infected leaf compared to other treatments. In powdery mildew disease development also all the treatments did not give significant reduction of disease development. Powdery mildew disease is an air born disease, but when considering leaf rot disease symptoms it seems it is a type of soil born disease. To give bio control effect using BFBFs for powdery mildew pathogen it needs to destroy special fruiting bodies which already presence as cleistothecia in leaf and plant debris with soil before they start production and release of spores to the environment.

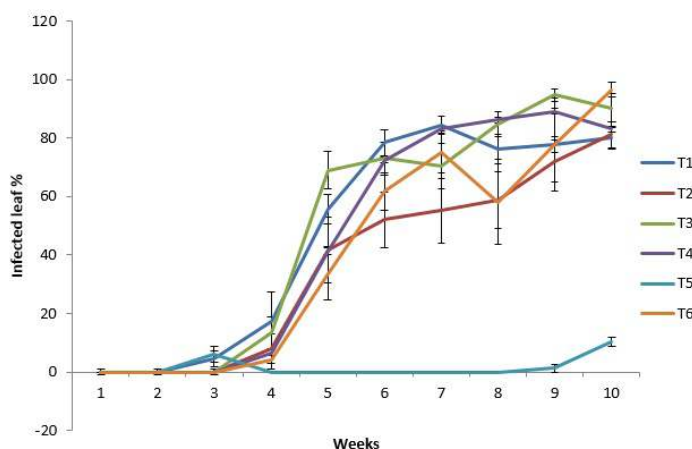
### 1. Leaf rot disease development with the time



**Figure 01: Leaf rot disease development with the time. T1 = Full strength Bio filmed Bio fertilizer only. (BFBF only) T2 = Full strength recommended chemical fertilizer only (100% CF only). T3 = Half strength of recommended chemical fertilizer only (50% CF only) T4 = Half strength of recommended chemical fertilizer + Bio filmed Bio fertilizer (50% CF +**

**BFBF) T5 = Full strength Fungicide+ Full strength Chemical Fertilizer only .T6 = Distilled Water only.**

## 2. Powdery mildew disease development with the time



**Figure 02 : Powdery mildew disease development with the time. T1 = Full strength Bio filmed Bio fertilizer only. (BFBF only) T2 = Full strength recommended chemical fertilizer only (100% CF only). T3 = Half strength of recommended chemical fertilizer only (50% CF only) T4 = Half strength of recommended chemical fertilizer + Bio filmed Bio fertilizer (50% CF + BFBF) T5 = Full strength Fungicide+ Full strength Chemical Fertilizer only .T6 = Distilled Water only.**

## Conclusions

Application of BFBFs with the 50% of chemical fertilizer treatment reduces the leaf rot disease in Gerbera plants. However the BFBFs found ineffective in reducing powdery mildew disease of Gerbera plants.

## References

- Bandara, W.M.M.S., Seneviratne, G. and Kulasooriya, S.A., (2006). Interactions among endophytic bacteria and fungi: effects and potentials. *Journal of biosciences*, 31(5), 645-650 pp.
- Hettiarachchi, R.P., Dharmakeerthi, R.S., Jayakody, A.N., Seneviratne, G., de Silva, E., Gunathilake, T. and Thewarapperuma, A.,(2014). Effectiveness of Fungal Bacterial Interactions as Biofilmed Biofertilizers on Enhancement of Root Growth of *Hevea* Seedlings. *Journal of Environmental Professionals Sri Lanka*, 3(2).
- Buddhika, U.V.A., Athauda, A.R.W.P.K., Seneviratne, G., Kulasooriya, S.A. and Abayasekara, C.L., (2014). Emergence of Diverse Microbes on Application of Biofilmed Biofertilizers to a Maize Growing Soil. *Ceylon Journal of Science (Biological Sciences)*, 42(2).

# Effect of Oyster Mushroom (*Pleurotus* Spp.) and Spent Mushroom Substrate (SMS) Onroot Knot Nematodes (*Meloidogyne* Spp.)

V.N.M.Wickramasinghe<sup>1</sup>, M.L.M.C.Dissanayake<sup>1</sup>, K.M.D.W.P. Nishantha<sup>2</sup>  
and Indra Eriyagama<sup>2</sup>

<sup>1</sup> Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> Horticultural Crop Research and Development Institute, Gannoruwa, Peradeniya.

\* Corresponding Author: mnadeeshaup@gmail.com

## Introduction and Objectives

The root-knot nematode, *Meloidogyne* spp. is considered as one of the most widespread nematodes its damage results in poor growth, a decline in quality and yield of the crops and they have the ability to break the resistance of the host plant and make it more susceptible to other pathogens. There is a great need to develop environmental friendly control options for managing the root-knot nematodes. Thus the present study was conducted with a broad objective to assess the effect of different oyster mushroom (*Pleurotus* spp.) and spent mushroom substrate (SMS) against root knot nematodes (*Meloidogyne* spp.). The specific objectives of the study were (a) to identify the root-knot nematode spp. found in plant house tomato cultures, (b) to select an effective oyster mushroom species for nematode control, (c) to determine the effective application rate of spent mushroom substrate (SMS) to control the root-knot nematodes and (d) to determine the best age of spent mushroom substrate (SMS) to control the root-knot nematodes.

## Research Methods

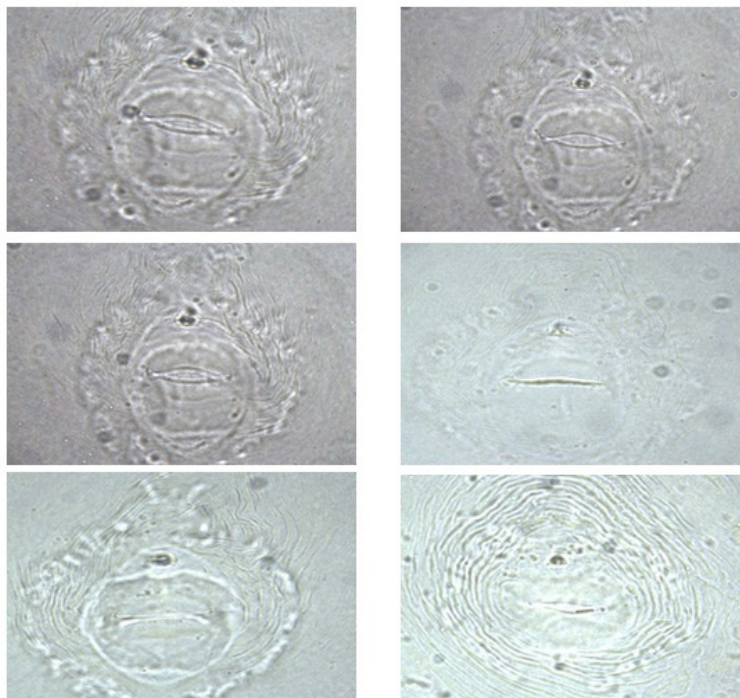
Root knot nematodes identification was done by observation of female perineal pattern of anal area under dissecting microscope and pictures were taken. Standard root-knot nematodes perineal pattern images were used to identify the species. Laboratory bio assay was conducted to evaluate the effect of *Pleurotus ostreatus*, *P. florida*, *P. sajor-caju*, *P. cystidiosus*, *P. djamor*, *P. eryngii*, and Buthan oyster on egg hatchability of *M. incognita*. 4% of fungal suspension of all seven species were prepared and applied to 20 uniform egg masses separately of *M. incognita*. Data were collected at 24, 48, 72 hours intervals and at the end of 72 hour unhatched eggs were counted. Plant house pot experiment was conducted with tomato plants to determine the effective application rates and effective stage of the spent mushroom substrate (SMS). SMS in different stages (Incubation complete, one month old, two months old, and two and half months old) were inoculated to potting mixture in two rates as 15g and 18g from each substrate. One week after transplanting, treatments were inoculated with identified *M. incognita* on potting mixture except one treatment. Fifty five tomato plants were used for the experiment and five replicates were used for one treatment. Plant height, fresh shoot height, fresh root height, numbers of root galls per 1g of root and nematode egg masses per 1g of root were recorded in all treatments and compared with the control (no treatment applied but infected with nematodes), nematicide applied plants and healthy



plants. Data were statistically analyzed using Statistical Analytical Software (SAS) packages. Duncan's Multiple Range Test and proc catmod was used to determine the significance of the treatment effects at  $p < 0.05$  level and chi-square value.

## Results and Discussion

The figure 1 pictures were taken by observing root knot nematode perineal pattern in anal area under the dissecting microscope with the magnification of  $10 \times 100$ . Root-knot nematodes collected in plant house were identified as *Meloidogyne incognita* when compared with the standard images (Department of Plant Pathology & Genetic, United states).

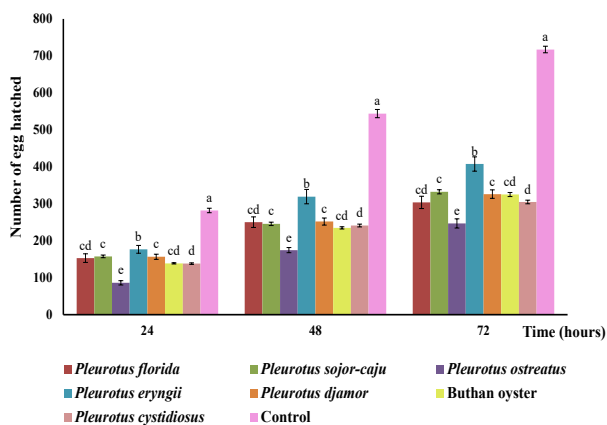


**Figure 01: Identified female root knot nematodes perineal pattern**

The Figure 02 shows the variation of egg hatchability among treatments after 24, 48 and 72 hours. It shows that egg hatchability was increased after 24, 48 and 72 hours in each treatment.

According to the result of laboratory bio assay, maximum egg hatchability was recorded in control treatment. Because it contained the distilled water which is given the optimum condition to the root knot nematode egg hatchability. And also minimum egg hatchability was recorded in *Pleurotus ostreatus* fungal suspension containing treatment. So there was significant difference between them. And there is significant difference between control and all other treatment at chi-square  $< 0.05$  level of probability according to proc catmod.





**Figure 02: Effect of egg hatchability after 24, 48 and 72 hours**

The findings of this study were confirmed in Marino and Silva (2010) and Kwok *etal*, (1992). Plants treated with oyster mushroom substrate at two and half months stage and 18g rate showed a significant difference from all other treatments with maximum reduction of nematode infection in plant house experiments.

## Conclusions

According to the tested female root knot nematode perineal pattern nematodes in the plant house culture contains *M. incognita*. The laboratory bio assay demonstrates *P. ostreatus* fungi species show a maximum reduction of nematode egg hatchability. Among the tested oyster mushroom species, the most effective species for root-knot nematode control is *P. ostreatus*. According to the plant house experiment results, it can be concluded that the most effective oyster mushroom substrate application rate is 18g and effective stage is 2 ½ months old spent oyster substrate for the control root-knot nematodes.

## References

- Aslam, S. and Saifullah (2013). Organic management of root-knot nematodes in tomato with spent mushroom compost. Sarhad Journal of Agriculture 29 (1):63-69.
- Ching, S., and Wang, K.H. (2014). Evaluating the effects of oyster mushroom compost for plant-parasitic nematode management. Department of Plant and Environmental Protection Sciences. University of Hawaii at Manoa.
- De Silva, N. P. S., Ekanayake, H. M. R. K. and Nishantha, K. M. D. W. P. (2001). Effect of *Trichoderma* isolates on egg hatchability of *Meloidogyne incognita*. Annals of the Sri Lanka Department of Agriculture. 3:225-230.
- Marino, R. H., and Silva, D. G. C. (2013). Control of nematode by *Pleurotus ostreatus*, Scientia Plena, 9(10):100-202

# Common Diseases of Orchid Grown in Western and Sabaragamuwa Provinces: Identification, Pathogenicity and Molecular Detection Techniques

## Introduction and Objectives

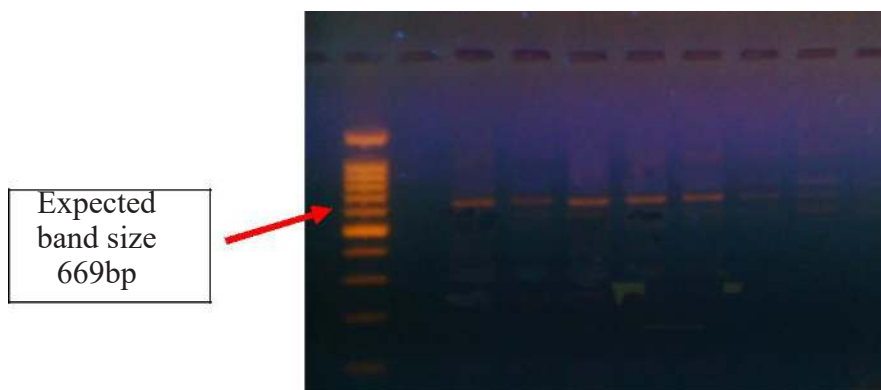
The family Orchidaceae is one of the largest flowering plant families in the world which has an incredible range of variety in shape, color and size and is used for cut flower production and as potted flowers (Sanjaya *et al.*, 2015). Pest and diseases are major problems of orchid cultivation. Orchid cultivation has a number of diseases which are caused by virus, fungi and bacteria. Most of orchid cultivators do not have the proper knowledge on different orchid species and the diseases (Sanjaya *et al.*, 2015). Correct identification of causal organism is important to avoid indiscriminate use of chemicals to reduce the cost of production and get the quality products. This research was aimed at identification of common virus, fungal and bacterial diseases of orchids grown in Western and Sabaragamuwa provinces and to develop detection techniques for further confirmation of viral diseases (CymMV, ORSV, CymRSV) in orchids.

## Research Method

Orchid samples with disease symptoms were collected from Western province and Sabaragamuwa province from large, middle and village level growers (23 samples). Samples were separated based on disease symptoms and tested by DAS-ELISA commercial kits (DSMZ) for detection of Cymbidium Mosaic Virus, Odontoglossum Ring Spot Virus and Cymbidium Ring Spot Virus. Positive and negative controls were used from the ELISA kit. DAS-ELISA positive samples were further subjected to RT-PCR and PCR using specific primers and optimized the conditions for the detection of Cymbidium Mosaic Virus and Odontoglossum Ring Spot Virus. Silica Fractionation method (Gunasinghe *et al.*, 2009) was used to extract RNA for RT-PCR assay. PCR reactions were carried out in two different annealing temperature ranges starting from 40-50 °C and 50-60 °C to optimize the annealing temperatures. Bacterial and fungal isolates from diseased orchid plants were cultured on NA and PDA media respectively. After incubation period (around 7 days) fungal cultures were identified using macroscopic and microscopic characters such as white spongy rosette pattern colony and black color concentration to inoculums area, White, gray to dark brown and medium grey to dark grey dense colony, reverse dark brown and pinkish orange conidial masses near the inoculation point, cottony growth, blackish brown zonation and simple dark stroma with pycnidia and excluding conidial and conidia were round fusiform hyaline in nature etc. Gram negative and gram positive bacterial cultures were differentiated by 3% KOH test. Koch Postulate was performed for all fungal isolates to test the pathogenicity.

## Results and Discussion

By DAS ELISA CymMV and ORSV infections were detected mildly. This could be due to the low concentration of virus in the orchid plants. CymRSV could not be detected through ELISA. , among the three viruses; CymMV, ORSV and CymRSV, CymRSV had extremely rare appearance in orchids. Neither the presence confirmed nor RT PCR and PCR method was optimized for ORSV. Only mildly positive reaction was observed with ELISA which indicated the low antigen concentration in the samples. w CymMV was confirmed by RT-PCR, PCR and identified optimal annealing temperature for CymMV as 52.4 °C



**Figure 01: Amplified products of CymMV at different annealing temperatures with the specific primer pair [CymMVCP-F1 (ATGGGAGAGYCCACTCCARCYCCAGC) and CymMVCP-R1 (TTCAGTAGGGGGTGCAGGCA)]**

(Ladder-Molecular size marker 100bp, Lane 1- 50 °C, Lane 2-50.6 °C, Lane 3-51.1 °C, Lane 4-52.4 °C, Lane 5-53.9 °C, Lane 6-55.3 °C, Lane 7-56 °C, Lane 8- 57.3 °C, Lane 9-58.4 °C, Lane 10-59.4 °C, Lane 11-59.7 °C, Lane 12-60 °C)

Four fungal species namely *Phomopsis* spp, *Colletotricum* spp, *Gleosporium* spp, *Pythium* spp were identified to cause diseases in orchids. Seven gram negative and three gram positive bacterial strains were isolated from orchids and pathogenicity was not confirmed. The fungal isolates *Colletotricum* spp and *Gleosporium* spp were reproduced same symptoms and consistently re-isolated from diseased plants demonstrating that these two species are pathogenic to orchid plants.

This experiment showed that the incidence of viral infection is very low than fungus and bacterial infections. The main causes for fungal and bacterial attacks were high relative humidity insufficient air circulation. Eun *et al*, (2002) described that CymMV and ORSV viruses are relatively stable and are disseminated by contaminated tools and pots and not transmitted by insect vectors. This could be the reason for the low incidences of virus diseases in orchids in Western and Sabaragamuwa provinces

## Conclusions

Serological studies confirmed that Cymbidium Mosaic Virus (CymMV) and Odontoglossum Ring Spot Virus (ORSV) incidences were low in orchid cultivations in both Western and Sabaragamuwa provinces.

PCR amplification of CymMV is possible with specific primer pair CymMVCP-F1 (ATGGGAGAGYCCACTCCARCYCCAGC) and CymMVCP-R1 (TTCAGTAGGGGGTGCAGGCA) at an annealing temperature of 52.4 °C .

Fungal species *Phomopsis* spp, *Colletotrichum* spp, *Gleosporium* spp, *Pythium* spp fungal species were identified as pathogenic to orchids. Seven gram negative and three gram positive bacterial species isolated from orchids were not pathogenic. The fungal isolates *Colletotrichum* spp and *Gleosporium* spp were pathogenic to orchid plants.

## References

- Eun, A. J. C., Huang, L., Chew, F. T., Li, S. F. Y., & Wong, S. M. (2002). Detection of two orchid viruses using quartz crystal microbalance (QCM) immunosensors. *Journal of Virological Methods*, 99(1), 71-79.
- Gunasinghe, A.D.S.K., Dassanayake, E.M., and Ubesekara, N.M. (2009). Successful detection of viruses by Reverse Transcription Polymerase Chain Reaction reaction. *Annals of Sri Lanka Department of Agriculture*, 11(1), 57-62.
- Sanjaya, K. W. V., Vijesekara, H. M. S. S., Wickramasinghe, I. M. A. C., & Amalraj, C. R. J. Orchid Classification, Disease Identification And Healthiness Prediction System. *Scientific and technology research*, 4(3).

# Isolation and Characterization of Rhizobia from Leguminous Plants and Determining their Plant Growth Promoting (PGPR) Traits

S.H. Wijesundera<sup>1</sup>, A.P. Halmillawewa<sup>2</sup>

<sup>1,2</sup> Department of Microbiology, Faculty of Science, University of Kelaniya, Sri Lanka.

\* Corresponding Author: sandushi.wijesundera@gmail.com

## Introduction and Objectives

Rhizobia play an important role in agriculture, as biological nitrogen fixers by forming a symbiotic relationship with legumes. This symbiosis accounts for biological nitrogen fixation (BNF) and has the potential to increase the biologically fixed nitrogen content in agricultural fields hence improving the soil fertility. The symbiotic interaction of rhizobia with legume crops is imperative regarding sustainable food production, and also attention has been given towards legumes as energy crops for biofuel production. Therefore, enhancing legume cultivation has become an important goal in world agriculture.

The current study was aimed at isolating indigenous rhizobia from common legume crops and characterizing them in order to determine presence of plant growth promoting traits and their potential to be developed into biofertilizers. Different abiotic stresses and heavy metal stress could influence rhizobia and their symbiotic action. Ability to withstand these conditions was also tested in the isolated strains.

## Research Methods

Rhizobial strains were isolated from sterilized root nodules of legume crops, Cowpea (*Vigna unguiculata*), Yard long bean (*Vigna unguiculata ssp. Sesquipedalis*), Peanut plant (*Arachis hypogaea*) and Winged bean (*Psophocarpus tetragonolobus*). Initial isolation was performed on Yeast Extract Mannitol Agar (YEMA) with Congo red. Glucose peptone agar test, Hofers' alkaline test, and Lactose agar test were performed on the isolates for preliminary identification. Bromo Thymol Blue (BTB) test was done to differentiate the acid producing fast growers from alkaline producing slow growers. Phosphate solubilization and nitrate reduction tests were performed by spotting on Pikovskaya's agar medium and using peptone water with 0.2% KNO<sub>3</sub> respectively. Ability to tolerate abiotic stresses, such as pH, salinity and temperature were tested. Tolerance of bacterial strains against different concentrations of heavy metals (Cu, Cd and Pb) was also tested. The swarm medium mentioned by Tambalo *et al*, (2010) was used to detect swarming motility. An Eckhardt gel electrophoresis was done to determine the presence of mega plasmids. A plant assay was performed using legumes similar to the ones from which they were originally isolated, in order to confirm their identity as rhizobia.

## Results and Discussion

Nine bacterial strains were isolated from four different legume crops. All strains isolated produced white/cream coloured colonies on YEMA medium with Congo red during the

initial isolation. Preliminary identification tests were performed to distinguish isolated rhizobial strains from *Agrobacterium*. According to BTB test only one strain was an alkali producing slow grower. Others were fast growing acid producing strains. This result was congruent with growth rates of these isolates.

Among isolated strains, four cowpea-nodulating and fast growing strains were recognized as more effective strains with positive traits to be used as bio fertilizers. Results showed by them for different biochemical tests are given in the **Table 01**.

Phosphate solubilization, Nitrate reduction, and swarming motility were tested as PGPR traits. Rhizobia possessing nitrate reductase (NR) enzyme activity can minimize adverse effect of nitrates on nodulation. Therefore, showing NR activity can be considered as a PGPR trait.

Many environmental factors can affect the ecology of rhizobial inoculants and thereby may lead to poor productivity. Therefore, tests were performed to determine the resistance of isolated strains to varying temperature, pH and salinity conditions.

Similarly, as agricultural soils may have heavy metal contaminations, heavy metal tolerance in rhizobia can be considered as an added advantage when using them as biofertilizers. Therefore, heavy metal tolerance was also tested in isolated strains.

Plant assays confirmed the nodulating ability of the isolated strains with their respective plant host. Eckhardt gel electrophoresis revealed no bands indicating the lack of mega plasmids in our isolates.

**Table 01: Results given by most effective rhizobial strains**

		Rhizobial Isolate			
		C6-n3-2	C7-n1-1	C7-n1-2	C8-n1
Legume crop used for isolation		Cowpea	Cowpea	Cowpea	Cowpea
Growth rate		Fast grower	Fast grower	Fast grower	Fast grower
Nitrate reduction test		+	+	+	+
Phosphate solubilisation efficiency		25%	41%	80%	71%
Heavy metal tolerance levels	Cu	Up to 10 ppm	Up to 30 ppm	Up to 10 ppm	Up to 30 ppm
	Cd	Up to 50 ppm	Up to 50 ppm	Up to 50 ppm	Up to 50 ppm
	Pb	Up to 30 ppm	Up to 30 ppm	Up to 30 ppm	Up to 30 ppm
Abiotic stress tolerance ranges	Temperature	6 °C – 38 °C	10 °C – 38 °C	25 °C – 38 °C	6 °C – 38 °C
	pH	only 7.0	7.0 - 9.0	7.0 - 9.0	only 7.0
	Salt (NaCl%)	0.1 % - 2.0 %	0.1 % - 20 %	0.1 % - 2.0 %	0.1 % - 2.5 %
Swarmed distance during 4 weeks		3.8 cm	2.7 cm	2.4 cm	-

## Conclusions

Bacterial strains isolated from root nodules of cowpea, yard long beans, winged bean and peanut plants were confirmed as rhizobia through nodulation assays. Out of the nine isolated strains one could be a *Bradyrhizobium* spp. as they were slow growers who gave an alkaline reaction on BTB medium. All the other isolates can be classified as fast growers. According to results obtained for different tests performed, out of the nine isolates four cowpea-nodulating, fast growing strains (C6-n3-2, C7-n1-1, C7-n1-2 and C8-n1) can be considered as more effective strains with positive traits to be used as biofertilizers.

## References

- Arrese-Igor, C., García-Plazaola, J. I., Hernandez, A., & Aparicio-Tejo, P. M. (1990). Effect of low nitrate supply to nodulated lucerne on time course of activities of enzymes involved in inorganic nitrogen metabolism. *Physiologia Plantarum*, 80(2), 185-190.
- Serrano, A., & Chamber, M. (1990). Nitrate Reduction in *Bradyrhizobium* s p.(Lupinus) Strains and its Effects on their Symbiosis with *Lupinus luteus*. *Journal of plant physiology*, 136(2), 240-246.
- Tambalo, D. D., Yost, C. K., & Hynes, M. F. (2010). Characterization of swarming motility in *Rhizobium leguminosarum* bv. *viciae*. *FEMS microbiology letters*, 307(2), 165-174.

# Development of Local Detection Kit for Banana Bunchy Top Virus

H.S.B. Piyasiri<sup>1</sup>, C. Ranasinghe<sup>2\*</sup>, R.T Ekanayake<sup>2</sup>  
and M.G. Thammitiyagodage<sup>3</sup>

<sup>1</sup> Department of Botany, University of Sri Jayawardenapura, Sri Lanka.

<sup>2</sup> Plant Virus Indexing Centre, Homagama, Sri Lanka.

<sup>3</sup> Medical Research Institute, Department of Animal science, Borella, Sri Lanka.

\* Corresponding Author: [chithranir@yahoo.com](mailto:chithranir@yahoo.com)

## Introduction

Banana is one of the most important fruit crops in Sri Lanka. It is propagated mostly from the suckers (Dale, 1987). Among viral diseases, banana bunchy top disease (BBTD) caused by *Banana bunchy top virus* (BBTV) is an economically important disease of banana (Hooks *et al.*, 2008). Effective management strategy depends on early detection of infected banana plants. Sometimes BBTV remains latent for a considerable time and some infected plants are non-symptomatic (Hooks *et al.*, 2008). Therefore, identification of BBTD only based on the symptoms is not sufficient. Indexing of banana plants is essential and it requires effective and reliable detection methods. Enzyme Linked Immunosorbent Assay (ELISA) is a sensitive technique for indexing BBTD (Thomas and Dietzgen, 1991), but cost of commercially available antiserum is high and locally produced polyclonal antiserum efficacy is low. Therefore, the present study was focused to produce polyclonal antiserum to detect BBTV.

## Research Methods

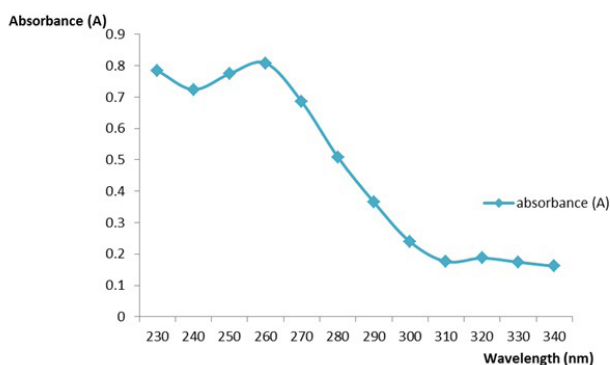
The young banana mid-rib tissues were crushed with liquid nitrogen and extracted against optimized 0.2 M Potassium phosphate buffer (pH 7.4) containing additives. Suspension was clarified with Triton x-100 (2%, v/v) and Chloroform: n-butanol (1:1, 10% w/v). The virus particles were concentrated by precipitating with Polyethylene glycol (PEG, 10%, w/v). Extract was further purified in a Cesium sulphate gradient (1.325 g/mL) and dialyzed. Purity and concentration of virus preparation was determined by UV spectrometry formula (Noordam, 1973). A coat protein band of BBTV was separated on Polyacrylamide gels. Portion of suspension was observed under transmission electron microscope. Immunization was carried out with five doses of antigen at one week intervals, mixing with Freund's incomplete adjuvant. First bleed was withdrawn one week after the third injection and other three bleeds were withdrawn at weekly intervals. Serum was separated and titre was estimated. Protocol was optimized by indirect ELISA with locally produced antiserum. Extraction buffer, antiserum dilution, protein-A conjugate dilutions and incubation time after addition of substrate were optimized. Sensitivity and specificity of the produced antiserum were tested.

## Results and Discussion

Isometric virus particles, 20 nm - 22 nm in diameter were observed under transmission electron microscope which was similar to BBTV particles. High level of light scattering was observed at 260 nm and low level of light scattering was observed at 340 nm, according to the purified virus absorption profile (Figure 1). Depending on the absorbance values at 260 nm and 280 nm, virus purity and concentration were 1.58 and 228 µg/mL respectively. The successfulness of the purification was based on



usage of extraction buffer, combination of clarification agents and adsorption to PEG. A single protein of 20100 kDa was identified in SDS- PAGE confirmed the presence of BBTV coat protein. Antiserum titre of first to fourth bleeds were 1/64, 1/128, 1/512, 1/128 respectively (Table 1). Antiserum of all bleeds was used for optimization process as all bleeds gave high titre. Optimized extraction buffer contained PBS-T, Polyvinylpyrrolidone (2% w/v), Na<sub>2</sub>SO<sub>3</sub> (0.13%, w/v) and Egg albumin (0.2% w/v), optimized antiserum dilution and protein- A conjugate dilutions were 1:100 and 1:200 respectively and optimized incubation times were 60 min and 90 min, after addition of substrate. Optimized conditions were effectively used in the confirmation process of environmental samples. Tested BBTV infected banana samples were given positive results and healthy samples were given negative results to the polyclonal antiserum, shows the successfulness of the locally produced polyclonal antiserum against BBTV and suitability of the optimized conditions in indirect ELISA protocol.



**Figure 01: Ultraviolet absorption spectra of purified Banana bunchy top virus suspension, wavelengths at 230 nm to 340 nm with the increment of 10 nm**

**Table 01: Micro precipitation of BBTV infected plant sap with different dilutions of locally produced polyclonal antisera for BBTV**

Bleed/ antiserum	Healthy sample (Negative control)	Antisera dilutions							
		1/2	1/4	1/8	1/16	1/32	1/64	1/128	1/512
First	-	++++	++++	++++	+++	++	-	-	-
Second	-	++++	++++	++++	++++	++	+	-	-
Third	-	++++	++++	++++	++++	++	+	+	-
Fourth	-	++++	++++	++++	++++	+++	+++	-	-

(-) – Absence of micro precipitation, (++++ – High micro precipitation, (+++) – Moderate micro precipitation, (++) – Low micro precipitation, (+) – Very low micro precipitation. Antisera of first to fourth bleeds were diluted up to 1/2 to 1/512.

Antiserum titre is considered as a dilution of antiserum where the micro precipitation first disappears. According to Table 1, antiserum titre of first bleed was 1/64, second bleed was 1/128, third bleed was 1/512 and fourth bleed was 1/128.

## Conclusion

It is concluded from the study, that BBTv purification was carried out using a new method which was applied successfully for the first time to remove most host macromolecules. The results presented in this study show, that all bleeds were suitable for the detection of BBTv in terms of indirect ELISA under optimized conditions. Sensitivity and specificity of the produced antiserum was high. It could be worth to increase the titre of the antibodies further against BBTv.

## References

- Dale, J.L. (1987). Banana bunchy top: an economically important tropical plant virus disease. *Advances in virus research*. **33**: 301-325.
- Hooks, C.R.R., Wright, M.G., Kabasawa, D.S., Manandhar, R. and Almeida, R.P.P. (2008). Effect of banana bunchy top virus infection on morphology and growth characteristics of banana. *Annals of Applied Biology*. **14**: 1-9.
- Noordam, D. (1973). *Identification of plant viruses: methods and experiments*. Wageningen. Centre for Agriculture Publishing and Documentation. pp. 60-185.
- Thomas, J.E. and Dietzgen, R.G. (1991). Purification, characterization and serological detection of virus- like particles associated with banana bunchy top disease in Australia. *Journal of general virology*. **72**: 217-224

# Effect of Anti-transpirant In Sustaining Rubber Leaf Physiology Under Dry Climatic Conditions

P.S.V. Rupasinghe<sup>1\*</sup>, E. Munasinghe<sup>2</sup> and N.S. Withanage<sup>1</sup>

<sup>1</sup> Department of Export Agriculture, UvaWellassa University of Sri Lanka.

<sup>2</sup> Adaptive Research Unit, Rubber Research Institute of Sri Lanka.

\* Corresponding Author: shanividnikarupasinghe@gmail.com

## Introduction

Establishment of rubber in sub optimal climatic condition has been addressed successfully, some limitations are still there to be considered. Harvesting of rubber tree is determined by its growth and reaching 50 cm girth is considered as an indicator to commence the harvesting process. Under optimum agro-climatic conditions this target could be achieved within six years for better economical return. However, this would be a hard target when cultivate rubber in non-traditional areas, *i.e.*, in Intermediate and Dry Zones. Long dry spells together with high temperatures are major climatic limitations which affect the growth of the rubber plant (Rodrigo and Iqbal, 2006). Therefore, present study was aimed to assess the effect of anti-transpirant in sustaining rubber leaf physiology under dry conditions.

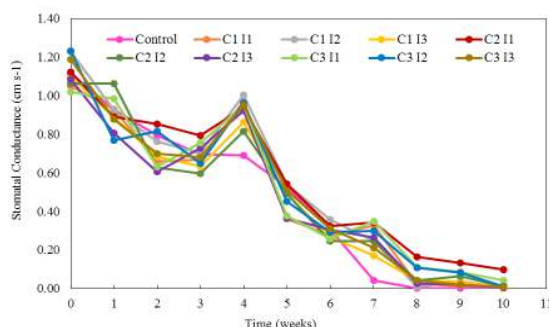
## Materials and Methods

The experiment was conducted in Padiyathalawa GN Division of Ampara district (7° 22' N 81° 16' E) during 11 weeks (from 13<sup>th</sup> May to 22<sup>nd</sup> July, 2015). The experiment was randomly arranged as two factor factorial design in three blocks. Three concentration levels *i.e.* 0.3 mL/L, 0.45 mL/L and 0.6 mL/L (C<sub>1</sub>, C<sub>2</sub> and C<sub>3</sub>) of anti-transpirant, Green Miracle were tested in three levels of application intervals *i.e.* 2, 3 and 4 weeks (I<sub>1</sub>, I<sub>2</sub> and I<sub>3</sub>), *i.e.* nine treatment combinations over untreated control. Environmental parameters *viz*, rainfall (mm), maximum and minimum temperatures (°C), solar radiation (μmolm<sup>-2</sup>s<sup>-1</sup>), relative humidity (%), wind speed (ms<sup>-1</sup>) and soil moisture content (%); physiological parameters *viz*, stomatal conductance (cms<sup>-1</sup>), chlorophyll content (SPAD), photosynthesis (μmol m<sup>-2</sup> s<sup>-1</sup>) and relative water content (%); growth parameters *viz*, plant diameter (mm), plant height (cm) and total leaf count of the plants were recorded over a period.

## Results and Discussion

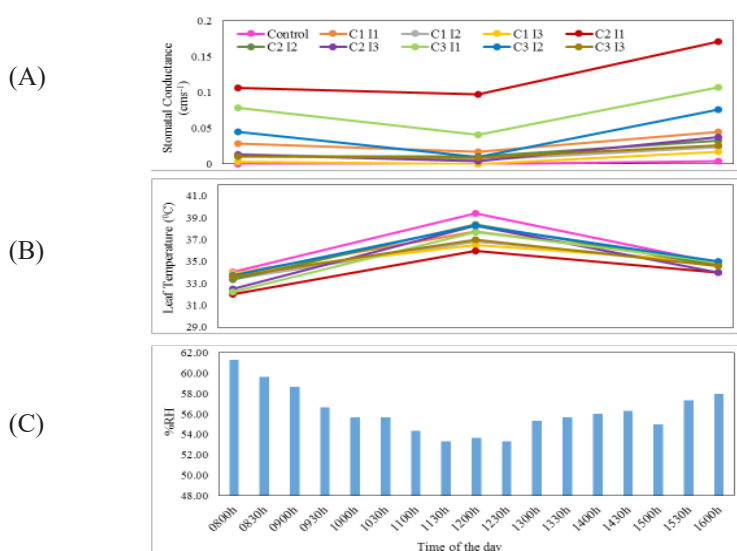
The meteorological data gathered during the experimental period have provided evidences to confirm the prevailing dry weather condition of this area having only 140.8 mm rainfall during first 7 weeks of the experiment and thereafter zero rainfall. Further, relative humidity has decreased with the time and remained 56% at the latter stage. The area experienced high solar radiation together with high maximum and minimum air temperatures. Prevailing high wind speed at the latter part of the experiment period facilitates transpiration which leads low moisture content in leaves. Under such climatic conditions, different application concentrations and intervals of

anti-transpirant have been reacted differently on physiology and growth of the plant. However, the changing pattern in all physiological parameters could be explained according to the meteorological parameters of the atmosphere. Heading to dry conditions, *i.e.* zero rainfall and low RH towards the latter stage, the stomatal conductance tended to decrease (Figure.1). This was an adaptation of a plant to dry climatic condition by conserving leaf water content by reducing the stomatal conductance.



**Figure 01: Variation of Mid-day Stomatal Conductance of Different Treatments Over the Measurement Period**

This situation was further explained by the figure 2 which illustrate the diurnal variation of stomatal conductance with respect to diurnal changing pattern of RH and leaf temperature. When atmospheric RH decreases, vapor pressure deficit and leaf temperature increases resulting low stomatal conductance for low transpiration (Graham, 1982). Under such condition, leaf photosynthesis is directly affected (Moldau, 1973; O'Toole, 1977 and Troughton, 1969) and ultimately the leaf chlorophyll content reduced (Youniset *al*, 2000; Prakash and Ramachandran, 2000).



**Figure 02: Diurnal Variation of Stomatal Conductance of all Treatment Combinations at 10<sup>th</sup> Week of the Measurement Period (a) together with Respective Leaf Temperature (b) and Relative Humidity (c)**

Interestingly, all treatment combinations performed well over the control in physiological parameters such as stomatal conductance, leaf photosynthesis rate, photosynthetic parameters of light response (maximum rate of photosynthesis and photosynthetic efficiency), chlorophyll content and growth parameter - leaf count. Among the all treatment combinations, plants subjected to C<sub>2</sub> I<sub>1</sub> (application of 0.45 mL/L anti-transpirant once in two weeks interval) outer performed in stomatal conductance, leaf photosynthesis rate, maximum rate of photosynthesis, photosynthetic efficiency and chlorophyll content confirming the effectiveness of the anti-transpirant under dry weather conditions. Maintenance of high relative water content of leaves treated by C<sub>2</sub> I<sub>1</sub> in dry period has further confirmed the above findings. Next to the C<sub>2</sub> I<sub>1</sub>, it was observed C<sub>3</sub> I<sub>1</sub> (application of 0.6 mL/L anti-transpirant once in two weeks interval) and C<sub>3</sub> I<sub>2</sub> (application of 0.6 mL/L anti-transpirant once in three weeks interval) combinations performed well under sub optimal weather conditions. On the other hand C<sub>3</sub> I<sub>1</sub> combination has come to the top level in growth parameters such as plant diameter and plant height followed by C<sub>2</sub> I<sub>1</sub>.

However, in selecting such treatment combinations for practical use, cost component should be taken into consideration as an important parameter. If self labour is employed for application, cost of chemicals used for outstanding treatment combinations were at reasonable level.

## Conclusions

Rubber plants with the application of anti-transpirant at different concentrations and application intervals outer performed over the untreated control in terms of stomatal conductance, chlorophyll content, photosynthesis and total leaf count of the plant. Application of anti-transpirant with a concentration of 0.45 mL/L at 2 weeks interval contributes to a significant increase (at 5% significant level) in stomatal conductance and chlorophyll content of leaves together with better results for photosynthesis rate, parameters of light response curve and relative water content over control. Application of anti-transpirant with a concentration of 0.6 mL/L at 2 weeks interval contributes better results for studied growth parameters. Hence, the application of Green Miracle anti-transpirant would be a better attempt to expand the rubber cultivation to non-traditional rubber growing areas of Sri Lanka, while sustaining the leaf physiology of rubber plant under dry climatic condition.

## References

- Graham, D. F. and Thomas, D. S. (1982). Stomatal conductance and photosynthesis. Annual Reviews in All rights reserved. Department of Environmental Biology, Research School of Biological Sciences. Australian National University. Canberra City. Australia.
- Moldau, H. (1973). Effects of various water regimes on stomatal and mesophyll conductances of bean leaves. *Photosynthetica*. Vol. 7, pp1-7.
- O'Toole. J. C., Ozbun, J. L. and Wallace. D. H. (1977). Photosynthetic response to water stress in *Phaseolus vulgaris*. *Physiology of Plant*. Vol. 40, pp 11-14.

- Prakash, M., Ramachandran, K. (2000). Effects of moisture stress and anti-transpirants on leaf chlorophyll. *Journal of Agronomy and Crop Science*. Vol. 184, pp153–156.
- Rodrigo, V. H. L and Iqbal, S. M. M. (2006). Rubber (*Hevea brasiliensis* Muell. Arg) Cultivation in the Eastern Province of Sri Lanka with alleviation of rural poverty and increase in the forest cover: a feasibility Study. International Conference on Humid Tropical Ecosystems: Changes, challenges, Opportunities. Kandy, Sri Lanka, pp 72.
- Troughton, J. H. and Slatyer, R. O. (1969). Plant water status, leaf temperature and the calculated mesophyll resistance to carbon dioxide of cotton leaves. *Australian Journal of Biological Sciences*. Vol. 22(8), pp 15-27.
- Younis, M. E., El-Shahaby, O. A., Abo-Hamed, S. A. and Ibrahim, A. H. (2000). Effects of water stress on growth; pigments and  $^{14}\text{CO}_2$  assimilation in three sorghum cultivars. *Journal of Agronomy and Crop Science*. Vol. 185, pp73–82.

# Over Dominance of *Alstonia macrophylla* Walla. ex G. Don in Pine Plantations at Lower Hantana, Sri Lanka

Jayamini Jayawardhane<sup>1\*</sup>, A.M.T.A. Gunaratne<sup>2</sup>

<sup>1,2</sup> Department of Botany, Faculty of Science, University of Peradeniya

\* Corresponding Author: jayaminijayawardhane1@gmail.com

## Introduction

The Hantana Mountain Range (HMR) is an Environmental Protected Area due to its significance on biodiversity and hydrology (Gunasekara, 2011). The presence of 23 invasive plant species threatens the biodiversity of this area (Hemachandra *et al.*, 2010). The effects of thinning and enrichment planting in *Pinus* plantations at Lower Hantana on restoration success has been assessed over the years (Hemage *et al.*, 2011; Weerasinghe *et al.*, 2014; Jayawardhane and Gunaratne, 2016).

*Alstonia macrophylla* (Apocynaceae) is an economically important species which is native to Malaysia (introduced to Sri Lanka), Indonesia, the Philippines, Thailand and Vietnam (Weerawardane, 2005). This invasive species dominates the pine plantations in Sri Lanka, which seems to be a problem for the regeneration of native flora (Tomimura, 2008; Jayawardhane and Gunaratne, 2016). Therefore, the effects of *A. macrophylla*, on regeneration of native species in restored pine stand (RP) and unrestored pine stand (UP) were assessed at lower Hantana.

## Methods

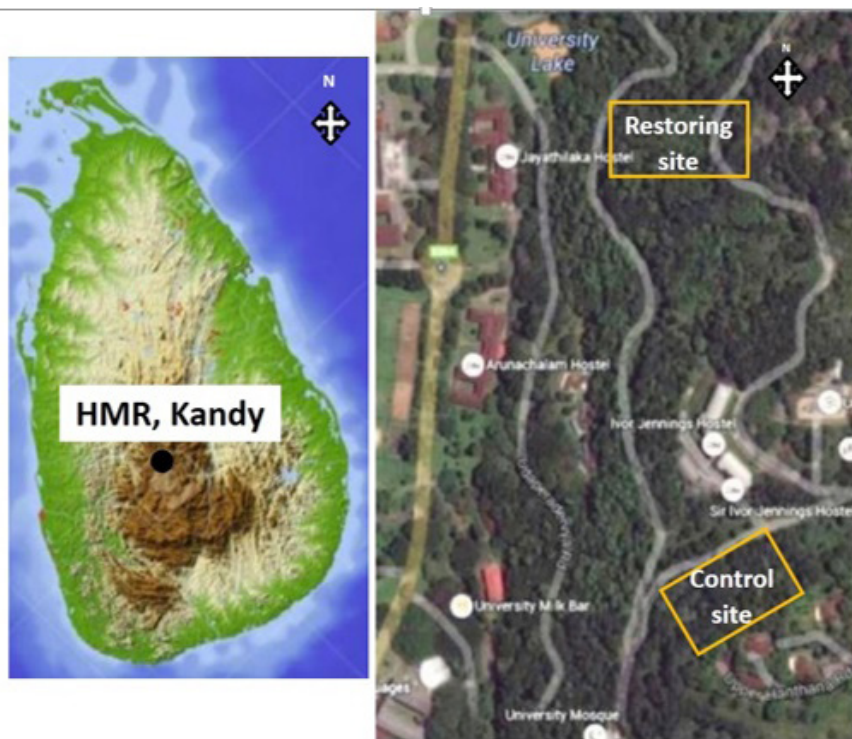
### Study Area

The HMR (7° 17' N and 80° 36' E) has a hot, humid and sub-temperate climate where mean annual temperature is 25.4 °C and mean annual precipitation is 2304.57 mm (1999- 2009) (Natural Resource Management Centre, Peradeniya, 2015). The study was conducted from March to August 2015, on the southwest slope of lower Hantana area.

### Vegetation Sampling

A restored pine stand (RP= 89\*57 m<sup>2</sup>) and an unrestored pine stand (UP= 43\*57 m<sup>2</sup>) were selected for the study and fifteen plots (5\*5 m<sup>2</sup>) were established randomly at each site. Inside each plot, 1\*1 m<sup>2</sup> sub plots were established randomly as three replicates per plot. The naturally regenerated seedlings (<50 cm) in subplots (1\*1 m<sup>2</sup>), saplings (50-300 cm) and trees (>300 cm) in plots (5\*5) were tagged and identified. The diameter at breast height (dbh) of plants (>1.3 m height) were recorded to the nearest 0.1 cm and plant height was measured with a clinometer.





**Figure 01: Locations of the RP and UP stands in HMR**  
(Google Earth Maps, 06th November, 2015)

### Data Analysis

Mean densities, height, diameter at breast height (dbh), relative abundance and frequencies were calculated for woody plants. Data were statistically analyzed using Microsoft Excel (2010) and MINITAB 14 (2014). A paired t-test and ANOVA analysis were carried out to compare the mean values between RP and UP.

### Results and Discussion

Collectively 1199 individuals of woody plant species were recorded from both sites (*Alstonia macrophylla*= 778, non-*Alstonia*= 421). They belonged to all the three life forms of woody plant species of non-*Alstonia* species and *A. macrophylla* in both pine stands (Table 1). Before restoration, the overstorey of the RP was dominated by *P. caribaea* (>90%) while 50-85% of the understorey was dominated by the grass *Panicum maximum* Jacq. This suggests that over the past 25 years of its existence, the natural recruitment of plant species in pine stands have been minimal at lower Hantana (Ambagahaduwa, 2008). However, more individuals of *Alstonia* have been recruited by 2015 in RP (RP= 49.6%, UP= 15.3% from total; mean density, *A. macrophylla*; RP= 9.54 individuals m<sup>-2</sup>; UP= 2.51 individuals m<sup>-2</sup>) (Figure 2) suggesting that the microclimatic conditions in RP were more favourable for the recruitment of *Alstonia* than the UP. Moreover, in both sites, *A. macrophylla* was the most abundant species with the highest frequency among all plots (RP= 73.3%, UP= 61.3%) (Table 2). Most of the woody species belonged to the dbh class between 0-4.9, indicating the



establishment of many new recruits probably after the total thinning of *P. caribaea* in 2010 (Figure 3). The percentage survival of seedlings and saplings of both plant groups are lower than the survival of trees (Figure 4).

Table 1. Number of individuals of woody plant species recorded from RP and UP stands at lower Hantana.

Growth stage of woody plants	Seedlings (<50 cm)		Saplings (50-300 cm)		trees (>300 cm)	
	RP	UP	RP	UP	RP	UP
Total	562	231	235	12	74	85
<i>A. macrophylla</i>	407	103	148	6	40	74
non- <i>Alstonia</i> species	155	128	87	6	34	11

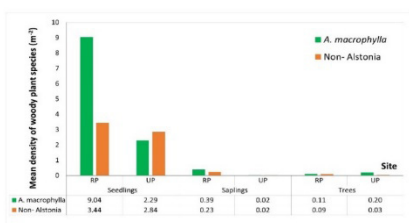


Figure 2. The mean density of woody plant species in the RP and UP stands at lower Hantana.

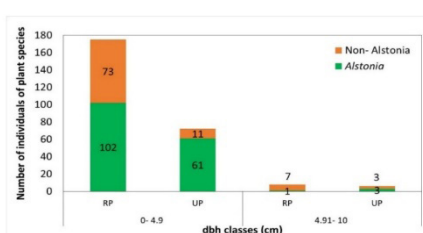


Figure 3. The dbh class distribution of woody plant species in the RP and UP stands at Lower Hantana.

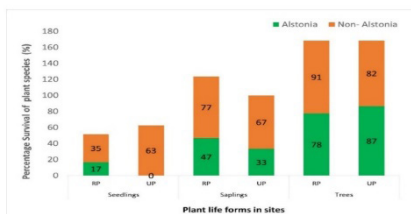


Figure 4. Percentage survival of *Alstonia* and non-*Alstonia* species in the RP and UP stands at lower Hantana.

Table 2. Total number of individuals (T), Frequency (%) among plots (F) and Abundance (A) of species under three life forms (seedlings, saplings and trees) recorded from RP and UP.

Scientific name	Plant family	Seedlings						Saplings						Trees					
		RP			UP			RP			UP			RP			UP		
		T	F	A	T	F	A	T	F	A	T	F	A	T	F	A	T	F	A
<i>Albizia odoratissima</i> (L.f.) Benth.	Fabaceae	12	17.8	0.02	9	16	0.04	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Alstonia macrophylla</i> Walla. ex G. Don	Apocynaceae	407	77.8	0.72	103	67	0.45	148	80.0	0.63	6	26.7	0.50	40	53.3	0.54	74	80.0	0.87
<i>Alstonia scholaris</i> (L.) R. Br.	Apocynaceae	0	0.0	0.00	0	0	0.00	4	13.3	0.02	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Artocarpus nobilis</i> Thw.	Moraceae	2	0.0	0.00	0	0	0.00	1	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Bridelia retusa</i> (L.) Spreng.	Euphorbiaceae	6	6.7	0.01	0	0	0.00	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Caryota urens</i> L.	Arecaceae	4	8.9	0.01	1	11.1	0.00	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Cassia spectabilis</i> DC.	Fabaceae	3	6.7	0.01	0	0	0.00	1	6.7	0.00	0	0	0.00	2	13.3	0.01	0	0.0	0.00
<i>Cinnamomum verum</i> J. Presl	Lauraceae	0	0.0	0.00	0	0	0.00	1	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Coffea arabica</i> L.	Rubiaceae	0	0.0	0.00	15	9	0.06	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Elaeocarpus serratus</i> L.	Elaeocarpaceae	0	0.0	0.00	0	0	0.00	1	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Ficus hispida</i> L. f.	Moraceae	0	0.0	0.00	0	0	0.00	1	13.3	0.00	1	0.08	0	0	0.00	1	6.7	0.01	0.01
<i>Filicium decipiens</i> (Wight & Arn.) Thw.	Sapindaceae	4	8.9	0.01	5	11	0.02	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Flacourtia indica</i> (Burm. f.) Merr.	Flacourtiaceae	1	2.2	0.00	0	0	0.00	1	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Hevea brasiliensis</i> (A. Juss.) Muell. Arg	Euphorbiaceae	1	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Leea indica</i> (Burm.f.) Merr.	Leaceae	8	13.3	0.01	0	0	0.00	0	0.0	0.00	0	0	0.00	2	13.3	0.01	0	0.0	0.00
<i>Litsea glutinosa</i> (Lour.) C. B. Robinson	Lauraceae	0	2.2	0.00	0	0	0.00	1	13.3	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Macaranga peltata</i> (Roxb.) Muell. Arg.	Euphorbiaceae	9	17.8	0.02	16	16	0.07	15	46.7	0.06	1	6.7	0.08	19	46.7	0.26	9	33.3	0.11
<i>Mangifera indica</i> L.	Anacardiaceae	0	0.0	0.00	0	0	0.00	1	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Melia azedarach</i> L.s.l.	Meliaceae	0	2.2	0.00	0	0	0.00	0	0.0	0.00	0	0	0.00	1	6.7	0.01	0	0.0	0.00
<i>Magnolia champaca</i>	Magnoliaceae	0	0.0	0.00	2	2	0.01	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Microcos paniculata</i> L.	Tiliaceae	1	2.2	0.00	0	0	0.00	1	6.7	0.00	0	0	0.00	2	13.3	0.01	0	0.0	0.00
<i>Mallotus tetraacacus</i> (Roxb.) Kurz	Euphorbiaceae	1	4.4	0.00	0	0	0.00	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Neolitsea cassia</i> (L.) Kosterm	Lauraceae	11	20.0	0.02	13	20	0.06	15	46.7	0.06	0	0	0.00	5	20.0	0.07	0	0.0	0.00
<i>Pagandra dichotoma</i> (Roxb.) Markgraf.	Apocynaceae	0	0.0	0.00	4	4	0.02	0	0.0	0.00	1	6.7	0.08	0	6.7	0.00	0	0.0	0.00
<i>Peltaphorum pterocarpum</i> (DC.) Backer ex Heyne	Fabaceae	1	6.7	0.00	0	2	0.00	0	0.0	0.00	0	0	0.00	1	0.0	0.01	0	0.0	0.00
<i>Pinus caribaea</i> Morelet	Pinaceae	1	2.2	0.00	5	9	0.02	1	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Pisidium guineense</i> Sw.	Myrtaceae	2	2.2	0.00	1	0	0.00	28	80.0	0.12	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Pittosporum ferrugineum</i> Dryander	Pittosporaceae	44	44.4	0.08	34	27	0.15	5	13.3	0.02	1	6.7	0.08	0	0.0	0.00	0	0.0	0.00
<i>Santalum album</i> L.	Santalaceae	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0	0.00	0	0.0	0.00	1	6.7	0.01
<i>Semecarpus nigroviridis</i>	Anacardiaceae	0	0.0	0.00	0	0	0.00	1	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Symplocos cochinchinensis</i> (Lour.) S. Moore	Symplocaceae	40	44.4	0.07	23	33	0.10	8	40.0	0.03	2	20	0.17	0	0.0	0.00	0	0.0	0.00
<i>Syzygium carophyllatum</i> (L.) Alstoa	Myrtaceae	0	0.0	0.00	0	0	0.00	1	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Trema orientalis</i> (L.) Blume.	Ulmaceae	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0	0.00	2	6.7	0.01	0	0.0	0.00
<i>Vitex altissima</i> L.	Verbenaceae	6	4.4	0.01	0	0	0.00	0	6.7	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00
<i>Xiziphus oenoplia</i> (L.) Miller	Rhamnaceae	2	2.2	0.00	0	0	0.00	0	0.0	0.00	0	0	0.00	0	0.0	0.00	0	0.0	0.00

## Conclusion

*A. macrophylla* which is an invasive species in Sri Lanka is dominating in the RP and UP plantations at lower Hantana, Sri Lanka. The over dominance of this species may threat the regeneration of the native plant species in these stands. Thus sound management practices are needed to manage them to achieve success in restoration program.

## References

- Ambagahaduwa, I.M. (2008): Restoration of plant diversity in monoculture *Pinus* plantations in Sri Lanka. M.Phil. Thesis, Postgraduate Institute of Science, University of Peradeniya, Sri Lanka, 1-27.
- Hemage, K. R. D., Gunaratne, A. M. T. A. and Meegaskumbura, M. (2011). Bird-plant interactions and bird diversity in unrestored and restoring habitats in Lower Hantana. Proceedings of the Annual Research Sessions, University of Peradeniya, 16,136.
- Jayawardhane, J. and Gunaratne, A.M.T.A. Does restoration promote recruitment of woody species in Pine plantations in Lower Hantana, Sri Lanka?. Proceedings of the Annual Research Sessions, University of Peradeniya, 20, 394.
- Weerasinghe, A.M.C.P., Gunaratne, A.M.T.A., & Madawala, H.M.S.P. (2014). Abundance and diversity of soil seed banks of different landuse types in upper Hantana, Sri Lanka. Proceedings of the International Forestry and Environment symposium , 2014 of the Department of Foretry and Environmental Science, Universaity of Jyawardenepura, Sri Lanka. doi: 10.13140/2.1.3260.384.

# Development of Bg 94-1 Transgenic Rice Containing *OSDREB2A* Gene

D.I.M Yahampath<sup>1</sup>, G.A.U Jayasekera<sup>2</sup>

<sup>1,2</sup> Department of Plant Sciences, Faculty of Science, University of Colombo, Sri Lanka.

\* Corresponding Author: isharayahampath@yahoo.com

## Introduction and Objectives

Rice (*Oryza sativa* L.) is one of the most important cereal crops feeding more than half of the world population. Rice productivity is greatly affected by water deficit conditions such as salinity and drought. Genetic enhancement of rice for improved performance under water limited environment, high salt and drought stress is of paramount importance. The *Osr40c1* is a putative root specific, ABA responsive gene induced by salinity conditions. The promoter region of *Osr40c1* gene contains four ABRE elements that control the expression via bZIP-type AREB/ABF transcription factors (Moons *et al.*, 1997). The *OsDREB2A* is the rice homologous for DREB2A in Arabidopsis (Dubouzet *et al.*, 2003). The *OsDREB2A* is strongly upregulated by dehydration and high salinity stresses and involved in an ABA-independent stress signal transduction pathway. The *OsDREB2A* transcription factors specifically bind to the dehydration responsive elements (DRE), core cis-acting sequences in promoters of stress responsive genes and regulate their expression in an ABA independent manner (Zhou *et al.*, 2010). The main objective of this study was to develop the transgenic rice plants from local rice cultivar Bg 94-1, containing *OsDREB2A* gene under the control of *Osr40c1* promoter.

## Research Method

The *Osr40c1* promoter region and *OsDREB2A* coding region used in this study were isolated by amplification from the *Oryza sativa indica* variety pokkali. Genomic DNA was isolated from Pokkali variety for PCR amplification of *Osr40c1* promoter region and the *OsDREB2A* coding region. Full length *Osr40c1* promoter and *OsDREB2A* coding regions of indica rice were identified and their identities were confirmed by insilico sequence analysis. Using sequence analysis information of indica *Osr40c1* promoter and *OsDREB2A* coding region, PCR primers were designed, synthesized and used for PCR amplification. PCR amplification resulted in generating expected DNA fragment of full length *Osr40c1* promoter and *OsDREB2A* coding region. Then *Osr40c1*-*OsDREB2A* transgene construct was cloned into the pCambia 1390 binary vector system and mobilized into the *Agrobacterium tumefaciens* GV3101 strain. The *Osr40c1*-*OsDREB2A* transgene construct was transformed into the Bg 94-1 rice genome using *A. tumefaciens* harboring pCambia 1390 binary vector carrying the *Osr40c1*-*OsDREB2A* transgene construct in order to develop transgenic rice from Bg 94-1 cultivar. The *CaMV35S*-*OsDREB2A* transgene construct was incorporated into the Bg 94-1 rice genome as the positive control in this study. Scutellum derived calli from mature rice seeds of Bg 94-1 were used as the explants and they were obtained from the optimized tissue culture protocol that was previously developed in our laboratory. After 3 weeks callus induction, scutellum derived calli were transformed

separately using *A. tumefaciens* harboring the binary vector system pCAMBIA 1390 containing the gene constructs *Osr40c1-OsDREB2A* and *CaMV35S-OsDREB2A*. Afterwards they were subjected to two consecutive rounds of hygromycin selection to obtain the putative transformants. After selection, the surviving putative transformed calli were transferred to fresh callus induction medium for further proliferation of calli. Nearly after 14 days of incubation in dark, actively proliferating calli were exposed to continuous illumination for the initiation of shoot regeneration. Finally intact plants were regenerated and recovered through tissue culture and developed the T0 generation transgenic rice plants. Transgene integration of T0 rice plants was analyzed using PCR technique. Genomic DNA extracted from the untransformed Bg 94-1 rice plant was used as the negative control and the pCAMBIA 1390 vector containing putative transgenic rice plant was used as the positive control to study the transgene integration through PCR technique. Transgene integration was confirmed by analysis of PCR amplicons derived from *CaMV35S* promoter, *Osr40c1* promoter and NOS terminator based primers.

## Results and Discussion

Callus initiation from mature seeds was observed within one week following culture. By culturing 300 seeds per time 40-50 actively proliferating calli were obtained and the number was increased up to 80-100 by sub culturing. Those were subjected to transformation and nearly 60-70 calli were recovered as healthy, non infected calli. During the hygromycin selection, the putative transformed calli appeared as pale yellow color cell masses, while untransformed calli were visible as dark brown color masses. Nearly 40- 50 micro calli were visible as pale yellow color buds on the top of the existing mother calli. The transformation efficiency of the calli was between 67%-72%. They were detached from the mother calli and transferred to fresh callus induction medium for further proliferation of calli. Actively proliferating calli were observed during the incubation period. Shoot primordia developed from 20-30 calli within three weeks of incubation under continuous light. Finally 7-10 intact plants were regenerated and recovered through tissue culture with the regeneration potential of 33% - 35%. The putative transformed rice plants containing the *Osr40c1-OsDREB2A* transgene construct belonging to T0 generation were positive for the PCR amplification of the NOS terminator and for the transgene integration.



***Transgenic Bg 94-1 rice plant containing Osr40c1-OsDREB2A transgene construct***

## Conclusion

It was possible to carry out *A. tumefaciens* mediated transformation in order to introduce *Osr40c1-OsDREB2A* transgene construct into scutellum derived callus cells of 94-1 seeds, and subsequently regenerate, select and recover putative transgenic rice plants belonging to T0 generation employing techniques developed previously in our laboratory.

# Microscopic Observation and Study of Commercially Available Bee Honey Samples for the Chemical Properties as per Sri Lankan Standard Specification (SLS 464: 1979)

K.G.R. Prathibha<sup>1\*</sup>, T.D.M.C.K. Wijayasiriwardana<sup>2</sup>, P.K. Dissanayake<sup>1</sup>

<sup>1</sup> Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> Herbal Technology Division, Industrial Technology Institute, Sri Lanka.

\* Corresponding Author: [kgrashmi@stdagri.sab.ac.lk](mailto:kgrashmi@stdagri.sab.ac.lk)

## Introduction and Objectives

Bees honey is the sweet substance produced by honey bees from the nectar of blossoms or from secretions of or on living parts of plants, which they collect, transforms and combine with specific substances like enzymes from bee's mouth and store in honeycombs. The raw honey is composed of sugar, water, and other substances. The honey is being utilized for several purposes. The honey flow lasts only for three to four weeks per year. For continuous market availability, it has to be stored without fermenting and granulating which obtained through proper processing. Due to lack of raw honey, diatory frauds tend to adulterate honey. The only prevailing method for honey standardization in Sri Lanka is Sri Lankan Standard Specification for Bees honey SLS 464: 1979. The objectives of the study were analyzing chemical attributes of commercial bee honey samples according to SLS 464: 1979, and observing pollen diversity in commercially available honey samples.

## Research Methods

Fifty four commercially available bee honey samples collected from all nine provinces were composited accordingly. Tests for detection of moisture content, total reducing sugar, acidity, presence of hydroxymethylfurfural (HMF), ash, and fructose: glucose ratio of honey samples were carried out according to the methods mentioned in Sri Lankan Standard Specification for Bees honey. Microscopic observation of each sample was carried out by ocular light microscope Leica DLMS. Five points from one mounted slide as in four corners and centre were observed through microscope. Refractometric method of Chataway (1932), revised by Wedmore (1955) was used to determine moisture. A modification of Lane and Eynon (1923) procedure which involved Soxhlet's modification of Fehling's solution was the method used to determine reducing sugar. Determination of apparent sucrose content was based on the Walker (1917) inversion method. Mineral content was determined as percentage of mass after ignition. Diluted honey samples were titrated against carbonate free sodium hydroxide. Fiehe's test was conducted to determine the availability of HMF. The excess of iodine in acidified honey solution remained after the reaction of sodium hydroxide with iodine was titrated against standard sodium thiosulphate solution to determine glucose content.

## Results and Discussion

The moisture content ranged from 16.68% to 21.64%. Thus all the honey samples were complied with SLS 464: 1979 which approves maximum moisture content of 25%. The minimum reducing sugar present in a standard honey sample is 65%. The total reducing sugars ranged from 60.41% to 70.27%. Northwestern and Uva provinces composite market honey sample did not comply with SLS 464: 1979. Sucrose contents ranged from 0.07% to 27.07% where maximum acceptable value is 8%. Only western province honey sample possessed a lower value. The ash content ranged from 0.0352% to 0.0880% which is below the standard maximum value of 0.5%. The acidity values ranged from 0.008% to 0.032% which did not exceed the maximum acceptance value of 0.2%. According to results North-western and Uva provinces composite market samples gave negative results for Fiehe's test. Rest of the samples from other provinces which gave positive results should undergo spectrophotometric determination of HMF content in order to draw conclusions on compliance. According to the standard, fructose: glucose ratio should be greater than 1. Fructose: glucose ratio range from 0.78 to 3.16. Hence, Southern province and Uva province composite market honey samples complied with SLS 464. The pollen diversity was different from one province to another. The amount of pollen found in particular provinces were also apparently in a wide range. Other characteristic found in honey exceed the number of pollen variation. But number of pollen found in each honey sample was higher than that of so called other characteristics.

## Conclusions

None of chemical attributes of commercially available honey samples complied with the Sri Lankan Standard Specification for Bee Honey SLS 464: 1979. Even though diverse pollens were observed in commercially available honey samples, results were insufficient to draw conclusions on their quality.

## References

- Codex Alimentarius. (2001). Revised codex standard for honey. (No. CODEX STAN 12-1981, Rev.1 (1987), Rev.2, (2001)).
- Prevention of Food Adulteration Act and Rules, (2004) <http://dbtbiosafety.nic.in/act/PFA%20Acts%20and%20Rules.pdf> 20.04.2016
- Punchihewa, R.W.K. (1994). *Beekeeping for Honey Production in Sri Lanka*. 1<sup>st</sup> Edition. Sri Lanka Department of Agriculture. Peradeniya. Sri Lanka
- Sri Lankan Standard, SLS 464:1979, Specification for Bees Honey, Sri Lanka Standard Institutions.



# *Aloe Vera* Gel Coating to Extend the Shelf Life of Mango (*Mangifera indica*) Var. Willard

D.M.A.E.I. Dewagedara, S.A.E.C. Wijesinghe\* and R.H.M.K. Ratnayake

Department of Horticulture and Landscape Gardening, Faculty of Agriculture  
and Plantation Management, Wayamba University of Sri Lanka, Makandura,  
Gonawila(NWP), 60170, Sri Lanka.

\* Corresponding Author: [wijesingheerandi@yahoo.com](mailto:wijesingheerandi@yahoo.com)

## Introduction and Objectives

Mango (*Mangifera indica* L; Family Anacardaceae) is a popular and economically important fruit crop in Sri Lanka. Fresh mangoes are wasted during handling, transportation and storage due to its highly perishable nature. Therefore, it is essential to develop a safe method to extend the shelf life of mangoes while preserving their internal quality. Use of edible coatings is one such method of extending shelf life. *Aloe vera* (*Aloe*/'*Komarika*'; Family Liliaceae) is a widely used medicinal plant and its fleshy leaf matrix (gel) has the potential to be used as edible coatings for fruits (Misir *et al.*, 2014). Nevertheless, only a few studies have been done on the use of *A. vera* gel based coatings to increase the shelf life of fruits in Sri Lanka. Therefore, this study was conducted to evaluate the potential of using *A. vera* gel coating to extend the shelf life of mangovar. *Willard*.

## Research Methods

This study was carried out at the Wayamba University of Sri Lanka from January to May 2016. Uniformly shaped and sized mango fruits were selected and fresh *Aloe vera* leaves were harvested from home gardens in Makandura area to prepare the gel coating. *Aloe vera* gel was extracted from fresh leaves after grinding in a blender. The resulting mixture was filtered using a muslin cloth to remove fibre and the gel was pasteurized at 70°C for 45min. For stabilizing, it was cooled immediately at ambient temperature and 4.5g/L of ascorbic acid was added followed by 4.5g/L of citric acid to adjust the pH to 4.0. Four gel concentrations (treatments) of 0, 33, 66 and 100% were prepared by changing *Aloe vera* gel composition and distill water(w/v) and they were equally applied on to fruits as two coats. Coated fruits were stored under room temperature at 32±2 °C and 68% Relative Humidity. Weight Loss Percentage (WLP), moisture content, Total Soluble Solids (TSS %), Titratable Acidity (TA %) and pH were measured at 3-day intervals (Brishti *et al.*, 2013). The experiment was arranged as Completely Randomized Design (CRD) with four replicates. Data were analyzed using Minitab statistical package (version 16).

## Results and Discussion

There were significant differences ( $p < 0.05$ ) in WLP, moisture content, TSS%, TA% and pH among treatments throughout the Fruit Preservation Period (FPP). Weight Loss Percentage gradually increased with longer storage period in all treatments. The lowest WLP was recorded in the 100% gel coated fruits in each FPP because the



gel coating acts as a physical barrier to prevent water diffusion between fruit and environment (Martinez-Romero *et al.*, 2006).

Uncoated fruits recorded significantly higher levels of TSS (14.6% at 3 d FPP, 15.7% at 6 d FPP and 18.1% at 9 d FPP) together with higher moisture contents. However, significantly lower levels of TSS (7.6% at 3 d FPP, 12.2% at 6 d FPP and 12.6% at 9 d FPP) were recorded in 100% gel coated fruits may be due to the *Aloe* gel decreases respiration and catabolism of sugars (Brishti *et al.*, 2013).

The mean pH value was 3.8 at 3 d FPP in uncoated fruits and was increased to 5.1 at 9 d FPP. The highest TA% were recorded in 100% gel coated fruits at each FPP. The retention of acids in coated fruits was due to the protective effect of gel coating as a barrier to transfer O<sub>2</sub> from the surrounding atmosphere (Valverde *et al.*, 2005).

*Aloe vera* gel coating extends the shelf life of mango var. *Willard* through retarding ripening process. The 100% gel coated fruits could be kept 12 days under room temperature while the quality of uncoated fruits was deteriorated even after 6 days. Further researches are required to evaluate sensory attributes of coated fruits and different storage conditions.

## Conclusions

*Aloe vera* gel coating delayed the ripening process in mango fruits where 100% *A. vera* gel coating can be effectively used in extending the shelf life up to 9 days under room temperature in mango var. *Willard*. Further, *A. vera* gel coating is a simple, environmental friendly and relatively inexpensive method of fruit coating. Hence, *A. vera* gel coating can potentially be popularized to minimize post-harvest losses of mango var. *Willard* in Sri Lanka.

## References

- Brishti, H.F., Misir, J. and Sarker, A. (2013). Effect of Biopreservatives on storage life of papaya (*Carica papaya* L.). *International Journal of Food Studies*, **2**, 126-136.
- Martinez-Romero, D., Albuquerque, N., Valverde, J.M., Guillen, F., Castillo, S. and Valero, D. (2006). *Postharvest Biology and Technology*, **39**, 93–100.
- Misir, J., Brishti, H.F. and Hoque, M.M. (2014). *Aloe vera* gel as a Novel Edible Coating for fresh fruits: a review. *American Journal of Food Science and Technology*, **2**, 93-97.
- Valverde, J., Valero, D., Martinez-Romero, D., Guillen, F., Castillo, S. and Serrano, M. (2005). Novel edible coating based on *Aloe vera* gel to maintain table grape quality and safety. *Journal of Agricultural and Food Chemistry*, **53** (20), 7807-7813.

# Small Holder Farming System Productivity Model for a hypothetical farm at Monaragala District in Sri Lanka

Helitha H. Nilmalgoda<sup>1</sup>, A.S. Karunaratne<sup>1</sup>, S. Walker<sup>2</sup> and P. O'reilly<sup>2</sup>

<sup>1</sup> Department of Export agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> Crops For the Future, Jalan Boroga, Semenyih, Selangor, Malaysia.

\* Corresponding Author: [eprhelitha@stdagri.sab.ac.lk](mailto:eprhelitha@stdagri.sab.ac.lk)

## Introduction and Objectives

About 87 percent (500 million) of the world's small holder farms (less than 2 ha) are in Asia and the Pacific region (Hazell *et al.*, 2010). Small farms continue to contribute significantly to agricultural production, food security, rural poverty reduction, and biodiversity conservation despite the challenges they face in the access to productive resources and service delivery. Agricultural production is unstable as a result of complex, dynamic and interrelated factors such as climate, markets and public policy that are beyond farmers' control. Farmers must therefore develop new farming systems incorporating innovations in objectives, organization and practices adapted to changing production contexts. In this regards, agronomists have expanded "farming system design" in the field of research. A variety of quantitative and qualitative design approaches have been developed to support the analysis of current farming systems and the design and evaluation of alternatives (Langeveld *et al.*, 2005). However, assessment of productivity in south Asian region is very much in infant stages. As a result, the lack of quantitative information about the small holder farming productivity have resulted in poor decision making. As a consequence, it directly affects on their socio economic lifestyle (Meko and Woodhouse, 2005). Hence to minimize the gap, a participatory and simulation-based model approach is formulated to assess the productivity of Small Holder Farming Systems (SHFS).

## Research Methods

### Model Development

The model is consisted of four sub models dealing with soil water, crop development, radiation usage and dry matter production (Figure 1). The model development includes a hypothetical farming system where a selected specific crop is intercropped with *Gliricidia sepium* as an energy crop where, the biomass is converted to energy output using the work done by Yogaratnam (2008). Based on the farm survey information at Monaragala district in Sri Lanka, five main crops including paddy (*Oryza sativa*), finger millet (*Eleusine coracana*), proso millet (*Panicum miliaceum*), cowpea (*Vigna unguiculata*) and maize (*Zea mays*) were considered as the crop combination in the farming system.

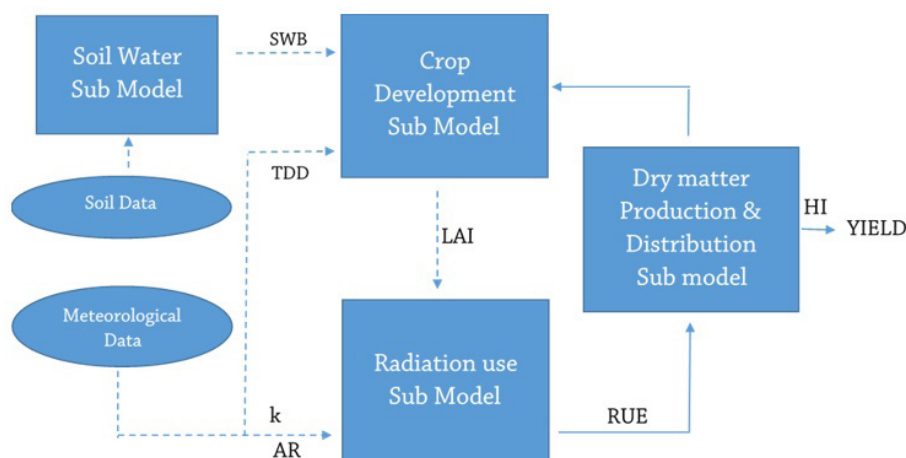
Predicted variables are

Phenology (days to anthesis, crop maturity)

Crop leaf area index (LAI at crop maturity)

Dry matter production (Aboveground biomass at crop maturity ((B) kg ha<sup>-1</sup>)

Dry matter distribution and yield formation at maturity ((Y) kg ha<sup>-1</sup>)



**Figure 01: Schematic overview of the model with input data (circles), information (dotted lines) and material (solid lines) flow through the sub models (boxes). SWB – Soil water balance; TDD - Thermal degree days (°C day); k - canopy light extinction coefficient; PAR - Photosynthetically active radiation (MJ m<sup>-2</sup> d<sup>-1</sup>); LAI - Leaf area index; RUE - Radiation use efficiency (g MJ<sup>-1</sup>) and HI - Harvest index**

The model was run on monthly time step to produce dry matter (B) and thereby yield (Y) through harvest index (HI). Model is formulated and run using OpenModel 2.3.0 computer software package.

### Model Calibration

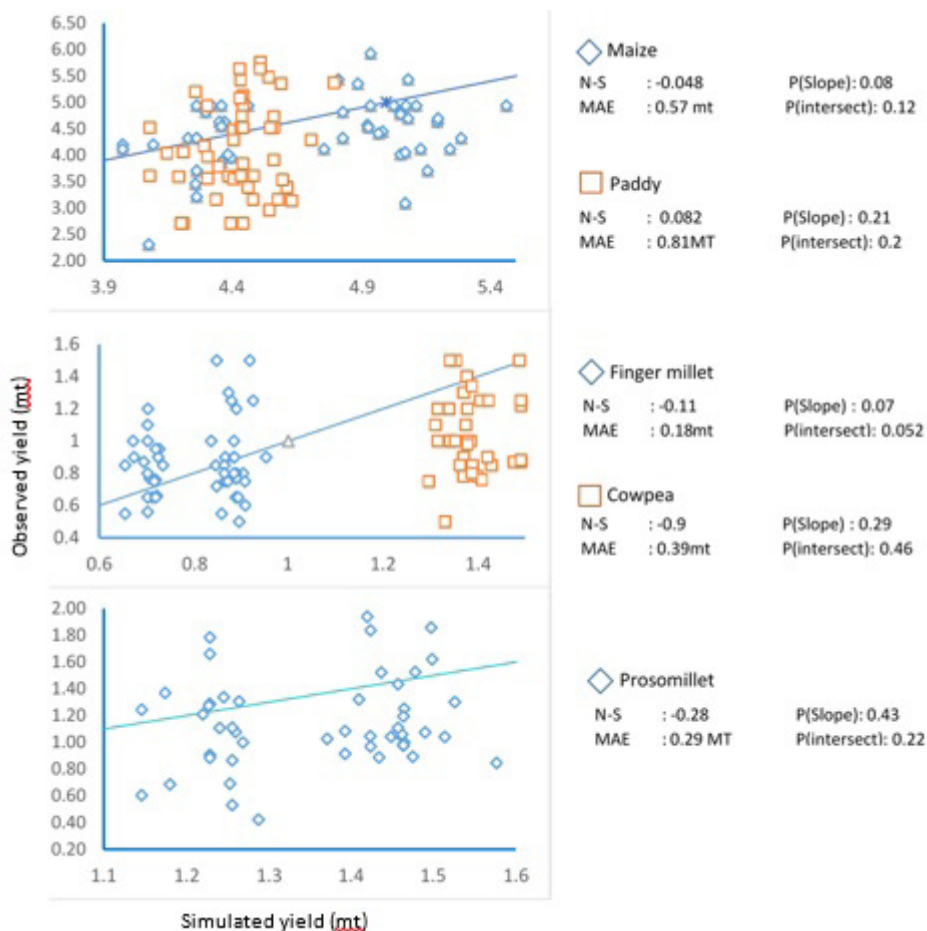
The model was calibrated using field experiment data conducted at the Sabaragamuwa University teaching farm (6°70'N, 80°79'E; 616m AMSL) for 6-months period in Maha season and crop specific parameters were obtained from the available literature.

### Model Evaluation

The calibrated model was then tested at 150 small holder farmer fields in Monaragla district. The model performance was evaluated using Mean Absolute Error and Nash Efficiency Index(E) (McCuen *et al.*, 2006). An efficiency of 1 (E = 1) corresponds to a perfect match of the model. The mean absolute error is an average of the absolute errors.

## Results and Discussion

Crop specific calibration results are shown in Figure 2. The results reported that the dry matter simulation equalling to an energy output of 10.854 MW ha<sup>-1</sup> per season from *Gliricidia*. Simulated Average yields simulation of 4.42± 0.022 MT ha<sup>-1</sup> paddy, 0.91± 0.013 MT ha<sup>-1</sup> finger millet, 1.36± 0.017 MT ha<sup>-1</sup> proso millet, 1.42± 0.016MT ha<sup>-1</sup> of cowpea and 4.72± 0.059 MT ha<sup>-1</sup> maize which-intern shows the capability to simulate crop yields in the hypothetical small holder farming system.



**Figure 02 : Relationship between estimated and measured yield of specific crops; N-S- Nash index; MAE-Mean absolute error**

## Conclusions

Specific calibrations for crop models show justifiable model performances which-interns show the capability to simulate crop yields in the hypothetical small holder farming system with *Gliricidia* intercropping. By combining the crop yields and the biomass energy output from the *Gliricidia*, farmer can estimate the small holder farm productivity.

## References

- Hazell, P., Poulton, C., Wiggins, S., & Dorward, A. (2010). The Future of Small Farms: Trajectories and Policy Priorities. *World Development*, 38(10), 1349-1361.
- Langeveld, J., van Keulen, H., de Haan, J., Kroonen-Backbier, B., & Oenema, J. (2005). The nucleus and pilot farm research approach: experiences from The Netherlands. *Agricultural Systems*, 84(2), 227-252.
- McCuen, R., Knight, Z., & Cutter, A. (2006). Evaluation of the Nash–Sutcliffe Efficiency Index. *Journal Of Hydrologic Engineering*, 11(6), 597-602.
- Meko, D. & Woodhouse, C. (2005). Tree-ring footprint of joint hydrologic drought in Sacramento and Upper Colorado river basins, western USA. *Journal of Hydrology*, 308(1-4), 196-213.

# Identification of the Groundwater Potential Zones in Vavuniya District Using GIS

R. Ramya<sup>1\*</sup>, A. Nanthakumaran<sup>1</sup> and I.P. Senanayake<sup>2</sup>

<sup>1</sup> Department of Biological science, Vavuniya Campus of the University of Jaffna, Vavuniya, Sri Lanka.

<sup>2</sup> Department of Earth Resources Engineering, University of Moratuwa, Moratuwa, Sri Lanka.

\* Corresponding Author: [ramyaastro91@gmail.com](mailto:ramyaastro91@gmail.com)

## Introduction and Objectives

Ground water is a major source for domestic and irrigation purposes in Sri Lanka and it plays a crucial role in livelihood and in economic activity. With rapid growth of population and urbanization water requirements for drinking and other purposes are dramatically increasing. The occurrence and distribution of groundwater in the country varies significantly depending on geology, rainfall and geomorphology. The over extraction and unplanned development of ground water resources have led to considerable depletion of water resources. To meet the growing demand for water for drinking, domestic and industrial sector and to address various issues related to ground water, there is a vital need to prepare a comprehensive map with identified strategies for scientific and sustainable management of the available ground water resources. Hence, Identification of groundwater zones can be vital to overcome the water scarcity. The objective of this study was to identify the ground water potential zones. This study was conducted in Vavuniya district since the water scarcity was observed over the years.

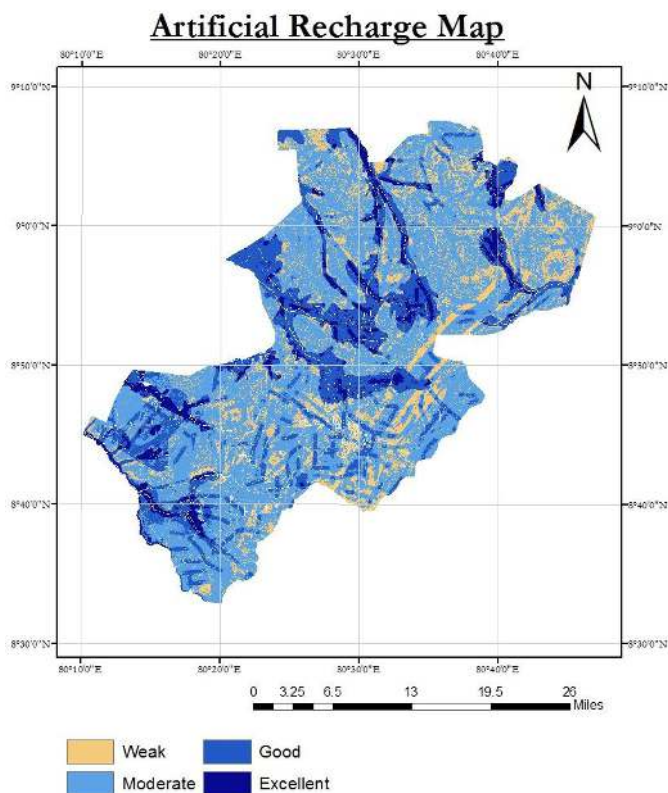
## Research Methods

Relevant thematic layers were developed such as geology, geomorphology, soil, slope, lineament density, land use and stream density. Geomorphological map of Sri Lanka (Verstappen and Hoschtitzky, 1987) and soil cover map (Land Use Division Department of Irrigation Sri Lanka, 1988) was obtained from the European Soil Portal (European Soil Portal, 2014) and digitized, later converted to raster to produce the Geomorphology and soil layers. Lithology layer was prepared by digitizing and rasterizing 1: 100,000 geology map of GSMB (Geological Survey and Mines Bureau of Sri Lanka). Drainage density layer was generated from drainage map which is digitized from 1: 50,000 topo sheet of Survey department by using spatial analyst tools in ArcGIS. Slope layer was generated from SRTM DEM (30 m) which was downloaded from USGS earth explorer, using spatial analyst tool. Lineament density layer was prepared from automatically extracted lineaments from SRTM DEM (W.L. Weerasekara, B.B. Mayadunna, I.P. Senanayake, & D.M.D.O.K. Dissanayake, 2014) in the study area by using 'Spatial analyst' tool in Arcmap. Multi-criteria evaluation technique was performed for all the thematic layers and their different classes. Each layer and class was assigned a weight and ranked depending on their suitability to hold ground water. All the thematic layers were then integrated in ArcGIS by using weighted overlay to produce groundwater

prospects map.

## Results and Discussion

Figure 1 shows the Groundwater potential Map of Vavuniya District.



**Figure 01: Groundwater Potential Map**

According to this study groundwater potential was high in the Southeast and Southern region of the study area. Around 7% of the area of Vavuniya falls into the 'Excellent' potential zone and 21% of the area of Vavuniya falls into the 'Good' potential zone, while 56% of the area belongs to the 'Moderate' potential zone according to the statistical results. 24 GN divisions had a 'Good' and 'Excellent' potential of groundwater out of 102 divisions in the Vavuniya district. Among these 11 GN divisions had a good groundwater potential partial.

## Conclusions

This study concludes that groundwater potential was high in the Southern region of the study area. Statistically, 7% of the study area showed 'Excellent' and 21% showed 'Good' potential of groundwater and 56% of area showed 'Moderate' potential.

The model developed using GIS in this study can be utilized to find out most suitable locations for groundwater recharge in any area of consideration within a short time



by providing the data viz. lithology, geomorphology, soil, land use, stream network, lineaments and slope. Finally, the results of this study can be effectively utilized in future developments of water resources in the dry zone of the country.

## References

- European soil Portal. (2015, 10 15). Retrieved from The soil maps of Asia.
- Geological Survey and Mines Bureau of Sri Lanka. (2001). Sri Lanka 1:100,000 Geology (Provisional Map Series).
- Soil Map of Sri Lanka. (1988). Land Use Division- Department of Irrigation Sri Lanka.
- Verstappen, H.T., & Hoschtitzky, M.E.D. (1987). Geomorphological Map of Sri-Lanka.
- W.L. Weerasekara, B.B. Mayadunna, I.P. Senanayake, & D.M.D.O.K. Dissanayake. (2014). Integrated remote sensing and GIS in lineament mapping for groundwater exploration–A case study in Ambalantota, Sri Lanka. *Proceeding of SAIMT Research Symposium on Engineering Advancements 2014, South Asian Institute of Technology and Medicine*, 62-65.



# Spatial Variability Studies of Selected Soil Properties for Crops Land Management in Ellapamaruthankulam

D. Kulendran<sup>1</sup> and P. Loganathan<sup>1</sup>

<sup>1</sup> Vavuniya Campus of the University of Jaffna, Vavuniya, Sri Lanka.

\* Corresponding Author: danusha1991@yahoo.com

## Introduction and Objectives

Today sustainable agricultural practices play a vital role in the world because as the population is increasing, there is a need to provide ample amount of food to them. Therefore it is necessary to identify the most suitable agricultural land for the sustainable agriculture management. Soil properties vary spatially from a field to a larger regional scale affected by both intrinsic (soil forming factors) and extrinsic factors (soil management practices, fertilization, and crop rotation). The variation of soil properties should be monitored and quantified to understand the effects of land use and management systems on soils. Geostatistical methods have been used successfully for predicting spatial variability of soil properties and Ordinary Kriging (OK) is one of the most basic kriging method.

The objective of the study is to assess the spatial variability of some selected soil properties of crops land in Ellapamaruthankulam area, situated in Vavuniya DS Division, recommend the reclamation measures for problem soils and make suggestions to cultivate the crop variety which is suitable for the existing soil property.

## Research Methods

The sampling area was 2.04 km<sup>2</sup>. Random sampling method was used to collect the soil samples for this research. Thirty soil sampling points were selected. Soil samples were collected from the top to 30 cm depth using core sampler. The sampling locations were recorded using Global Positioning System (GPS).

The collected soil samples were taken to the laboratory, air dried, crushed and sieved through the sieve of having 2mm mesh size. Cation Exchange capacity was determined by Ammonium extract method, pH was determined by 1:2.5 suspended method, EC was determined by 1: 5 suspended method, available nitrogen was determined by Kjeldal method, available phosphorus was determined by Olsen method and available potassium was determined by flame photometric method.

Geostatistical software (ArcGIS 10.2) was used to construct semivariograms and spatial structure analysis for the variables. Point map was created for cropland with measured value of each property. Then raster map was created. Then geostatistical estimation was done by ordinary kriging from raster. Select Lag interval, nugget, sill, range as default value and cell size is 150m.

## Results and Discussion

The entire land had high CEC and non-saline EC. Therefore, the effect of salinity is

negligible and the High CEC is normally good for agricultural soil. 89% of the land had neutral pH so they are most productive soils. 11% of the land had slightly acidic. This could be created by removal of bases by harvested crops, leaching, and an acid residual could have left in the soil from N fertilizers. As the evidence for this 71% of the crop land had high Nitrogen % which may be resulted due to high amount of fertilization of urea. So the acidic soil can be improved by adding lime or otherwise practicing cultivation like beans or other acid tolerant crop varieties such as beans, beetroot, sugarcane, cucumber, corn, tomato, pineapple and broccoli. But 29% of the crop land had optimum range of nitrogen %.

The entire land had a low phosphorus concentration and low potassium concentration. Low phosphorus concentration could be resulted due to inadequate fertilization or P reversion to fixed forms which is a larger factor than crop removal in depleting the extractable-P pool. Therefore, the low phosphorus concentration can be brought to an optimum level by addition of organic matter and adequate amount of phosphorus fertilizers. The low potassium content could be resulted due to inadequate fertilization of potash or the presence of  $\text{Ca}^{2+}$  in irrigation water and of soil minerals able to release  $\text{Ca}^{2+}$  are of importance in determining the amounts of  $\text{K}^{+}$  leached from soils. From 90 to 98% of the total potassium present in soils is found in insoluble primary minerals that are resistant to chemical breakdown. They release potassium slowly, but in small quantities compared to total needs of growing crops. Therefore, this field could be improved by addition of rice straw.

## Conclusions

The study reveals major variability in terms of soil properties and soil nutrients status in the crops land in Ellapamaruthankulam area. Spatial maps showed, Ellapamaruthankulam area had high CEC, non-saline EC, low phosphorus and low potassium level. 89 % of the crops land had neutral pH and 71 % of the crops land had high Nitrogen %. Slightly acidic soils can be managed by application of liming materials and growing acid tolerant cultivars such as beans, beetroot, sugarcane, cucumber, corn, tomato, pineapple and broccoli. High Nitrogen % could be reduced by adding required amount of urea fertilizer. Low phosphorus level could be increased by addition of green manure and addition of most feasible P-fertilizer products such as Single Super Phosphate & Partially Acidulated P Rock and low potassium level could be increased by incorporation of rice straw and application of K fertilizers.

## References

- Dharmakeerthi, R., Indraratne, S., & Kumara singe, D. (2007). Manual of soil sampling and analysis. Sri Lanka: Soil Science Society.
- Kilic, K., Kilic, S., & Kocyigit, R. (2012). Assessment of spatial variability of soil properties in areas under different land use. *Bulgarian Journal of Agricultural Sciences*, 722-732.
- Saldana, A., Stein, A., & Zinck, J. (1998). Spatial variability of soil properties at different scale within three terraces of the Henares River (Spain). *Catena*, 139153.

Xu, H., Tibke, G., & Skidmore, E. (1999). Spatial variability of soil properties along a transect of CRP and Continuously Cropped land. 10th International soil conservation organization, (pp. 641-647). Purdue University.

# Study on Bio Mass Energy Potential of the Kandyan Home Garden (KHG) System

**Dulanja Abeysinghe<sup>1</sup>, Sue Walker<sup>2</sup>, Asha S. Karunaratne<sup>1</sup>**

<sup>1</sup> *Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya. 70140. Sri Lanka.*

<sup>2</sup> *Crops For the Future, University of Nottingham, Semenyeh, Malaysia.*

*\* Corresponding Author: dulanjaabeyasinghe@yahoo.com*

## Introduction

Biomass had always been a major source of energy for mankind and is presently estimated to contribute of the order 10 – 14% of the world's energy supply. The major form of primary energy used in Sri Lanka was biomass (47.4%). Therefore, Sri Lanka has vast potential to produce energy from biomass as the country has high diversity of plants and rich domestic environment with dense biomass.

Kandyan Home Gardens are traditional agroforestry in wet hills and lowlands of Sri Lanka. Biomass production from the Kandyan home gardens has been well identified and it was clearly mentioned high amount of biomass is produced from kandyan forest gardens. In that respect, not much studies on green energy production from KHGs has been done.

Gross Calorific Value (GCV) or Higher Heating Value (HHV) is a characteristic of all fuel and is the amount of heat released during combustion. This can be used to measure the energy produce from unit weight of biomass. This study has focused on identifying plants which possess high calorific value and large energy component stored as biomass.

## Objectives

### *General Objective*

To identify the potential of generating biomass energy from KHG system.

### *Specific Objectives*

To identify underutilized energy crops from KHG which are suitable for biomass energy production.

To find out the types of plants used for biomass energy production in households in the Kandy district

To identify the consumption patterns of energy among households.

## Research Methods

A field survey was conducted covering 100 Kandyan home gardens to collect data on energy consumption and available plants to produce energy. Three different agro ecological zones where WM<sub>3b</sub> (Pujapitiya), WM<sub>3a</sub> (Ankumbura) and IM<sub>3a</sub> (Wattegama),

(Agro – Ecological zone map of Sri Lanka, Department of agriculture, 2003) were included as areas for the survey. Random sampling technique was used to collect data. Data were analysed using the Statistical Package for the Social Sciences (IBM SPSS version 22) and five plant species were selected according to the frequency of usage as fire wood and availability in the home garden.

Gross calorific value (GCV) of the each sample was determined using an Adiabatic Bomb Calorimeter, (TOKYO, JAPAN – NENKEN type- Adiabatic bomb calorimeter-9960), in accordance with European Standard (EN) 14918: 2009. In which, about 1g of oven dried wood was completely combusted with oxygen under 3000kPa pressure. Then these net calorific values were used to compare fire wood plants for the energy content of the plants. The statistical analyses of net calorific values were performed using SAS 9.0 (SAS Pre – production version, 2002).

## Results and Discussion

The survey data was normally distributed and then data set was checked for frequencies. Five plants were selected and tested for calorific values according to the frequencies as follows.

<i>Albizia</i>	- <i>Albizia lebbbeck</i>
<i>Clove</i>	- <i>Syzygium aromaticum</i>
<i>Kanda</i>	- <i>Macaranga peltata</i>
<i>Nut meg</i>	- <i>Myristica fragrans</i>
<i>Sapu</i>	- <i>Michelia champaca</i>

### Calorific values with Location

Location	Mean (MJ/Kg)
1 – Ankumbura (WM <sub>3a</sub> )	15.31 0.06 <sup>a</sup>
2 – Wattegama (IM <sub>3a</sub> )	16.02 0.56 <sup>a</sup>
3 – Pujapitiya (WM <sub>3b</sub> )	15.52 1.18 <sup>a</sup>

\* Means with the same letter in the same row are not significantly different

There is no any significant difference among Locations. But, the study found that the *Syzygium aromaticum* contain the highest calorific values of 17.15 MJ/Kg. The second highest was *Michelia champaca* with the calorific value of 16.64 MJ/Kg. They were followed by *Macaranga peltata* with the value of 15.57 MJ/Kg, *Albizia lebbbeck* of 15.43 MJ/Kg and *Myristica fragrans* of 13.29 MJ/Kg. Generally, there was no significant difference between the calorific values of the wood samples of the *Syzygium aromaticum* and *Michelia champaca*. But, it significantly differs from the *Albizia lebbbeck* and *Macaranga peltata* which are not significantly different from each other. The lowest calorific value was in *Myristica fragrans* and it was found to be a significantly different calorific value with other four species.

*Michelia champaca* was selected to calculate biomass requirement for the energy production. Electricity consumption value was tested for mean value using SPSS and

resulted mean was 61.5 Kwh<sup>-1</sup> (1Kwh<sup>-1</sup> = 3.6MJ) or 221.4MJ. This is the monthly electric energy requirement of a typical farmer family of the Kandy district. With the conversion efficiency of 45% (McKendry peter, 2001), 19.29Kg of wood with 36.61% moisture content, will be required to supply monthly energy requirement of the farm family with the integration of gasification system.

## Conclusions

Agro ecological zones covered under the study did not show significant difference in calorific values.

In relation to calorific value of the biomass, *Syzygium aromaticum* and *Michelia champaca* are the best and *Macaranga peltata* and *Albizia lebbeck* come next but these two are not significantly different from each other with it. The poorest in terms of the calorific value was *Myristica fragrans*.

The monthly energy budget for a typical farm family was 19.29Kg from the *Michelia champaca* wood.

## References

- Walker, J. C. F, (2006). Primary Wood Processing: Principles and Practice, Springer Science & Business Media, 606 pages(538-539),
- Jacke, D and Toensmeier, E (2005). Edible forest gardens, Volume one Ecological vision and theory for climate permaculture, ISBN 1 – 931498-79-2, 373 pages(69-109)
- McKendry peter, (2001). Energy production from biomass (part 2): conversion technologies, Peter McKendry, Applied Environmental Research Centre Ltd, Tey Grove, Elm Lane, Feering, Colchester CO5 9ES, UK, Bioresource Technology 83 (2002) 47–54, Elsevier
- Warren, T.J., Poulter, R., Parfitt, R., (1995). Converting biomass to electricity on a farm-sized scale using downdraft gasification and a spark-ignition engine. Bioresource Technology 52, 95–98.

# Efficiency of Biochar in Immobilizing Lead and Cadmium in Municipal Solid Waste Compost: Will the Raw Materials and the Pyrolysis Temperature Have an Impact on Immobilization Potential?

P.M.K.T. Kaushalya<sup>1\*</sup>, P.I. Yapa<sup>1</sup> and W.M.J. Weeraratne<sup>2</sup>

<sup>1</sup> Department of Export Agriculture, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> Central Environmental Authority, Battaramulla.

\* Corresponding Author: [pmktkaushi@gmail.com](mailto:pmktkaushi@gmail.com)

## Introduction and Objectives

Composting is one of the best methods for recycling degradable portion of municipal solid waste leading to the production of valuable manure for agriculture. Municipal solid waste compost (MSWC) which is rich in heavy metals is unfavourable for crop growth and agriculture due to the bioaccumulation of heavy metals in both plants and animals. Therefore, a specific method should be there to remove heavy metals from the compost. If producers can remove heavy metals in compost by using some treatments such as biochar application, the problem could be mitigated and the health risk of consumers could be minimized. The application of biochar (BC) was examined as a potential amendment to reduce the available form of heavy metals in MSWC. Biochar is a porous, carbonaceous product obtained from pyrolysis of organic materials (Paz-Ferreiro *et al.*, 2013). Biochar can be considered as a better innovation in the world due to its universal applications in carbon sequestration, metal remediation and some other functions as a soil amendment (Inyang *et al.*, 2012). And also it has a greater potential to beneficially reduce the bioavailability of both organic and inorganic contaminants including heavy metals (Beesley *et al.*, 2010). The porous structure of biochar gives itself high internal surfaces, and the ability to adsorb heavy metals (Bian, 2012). Therefore this study will be a significant step forward in renovating MSW composting technology in Sri Lanka. In this study we assume that biochar has a greater ability to reduce mobile and potentially bioavailable fractions of heavy metals in solid waste compost with various capacities according to the produced raw materials and pyrolysing temperatures of biochar.

## Objectives

To evaluate the effect of biochar for reducing the bioavailability of heavy metals (Pb and Cd) in municipal solid waste compost.

To investigate, assess and compare the effectiveness of two types of biochars produced at two different pyrolysis temperatures.

To investigate the characteristics of municipal solid waste compost produced by Kelaniya Pradeshiya Sabhawa.

## Research Methods

Compost was obtained from waste management and training centre of Kelaniya Pradeshiya Sabhawa. Field sampling of compost was done by combining several representative sub-samples into one composite sample. It was mixed thoroughly and stored under cool conditions (4°C) after transporting to the laboratory. Compost samples were air-dried and mechanically sieved to <2 mm of particle size.

Two types of biomasses (BM) (paddy husks and rubber nut shells) were used as raw materials to produce biochar. As an initial step of biochar production, the biomasses were smashed into small particles and were air-dried for 24 hours separately. Air-dried biomasses of both rubber nut shells (R) and paddy husk particles (P) were transferred separately into the crucibles and pyrolysis in the muffle furnace to produce biochar under two different temperatures (300 °C and 500 °C) at a limited oxygen environment (Paz-Ferreiro, 2014). Holding time of biomass (BM) in the muffle furnace was 1 hour for each biochar (BC) production. Biochar produced were ground by using motor and pestle. Finally they were sieved into 1 mm particles in size to increase the surface area of applied biochar (Paz-Ferreiro, 2014).

A compost mixture was prepared by mixing 50.0 g of compost and dry BM/BC with a mass fraction of 10% (w/w) and all amended composts were thoroughly homogenized in plastic containers (11.5 cm diameter, 10.5 cm height) and individually prepared prior to use. The soil was irrigated with equal amount of tap water (10 ml) three times per week to maintain compost moisture at water holding capacity level. This experiment consisted of 6 treatments ( $A_1$  - BM from paddy husk,  $A_2$  - 300 °C BC from paddy husk,  $A_3$  - 500 °C BC from paddy husk,  $B_1$  - BM from rubber nut shells,  $B_2$  - 300 °C BC from rubber nut shells and  $B_3$  - 500 °C BC from rubber nut shells) and a control. Each of them had 2 replicates. Randomized Design was adopted for the pot experiment.

Pd and Cd analysis were done to determine the effectiveness of biochar on quality of MSWC according to a standard procedure described by Rice *et al.* (2008). 0.5 g of the sample was weighed to a 50 ml beaker. 10 ml of 6M, HNO<sub>3</sub> acid and 2 ml of conc. HNO<sub>3</sub> were added to it. It was mixed well using a glass rod. This solution was heated at 150 °C until the final volume about 5 ml. Then, it was filtered using a Whatman no:05 filter paper to a 100 ml volumetric flask. This solution was diluted up to the level of 100 ml volume using distilled water. Analysis of Pb and Cd was done using Atomic Absorption Spectrophotometer (AAS).

## Results and Discussion

### *pH and Electrical Conductivity (EC) of biochar*

Both biomasses [BM(P) and BM(R)] showed acidic pH of 6.30 and 6.90 respectively. However, the pH of BCs produced from both BMs varied from weakly acidic to alkaline depending on the pyrolysis temperature. BC(R) produced at 500°C [500BC(R)] showed the significantly highest pH compared to the others due to higher temperature and type of feedstock. The differences of pH according to the feedstock and pyrolysis temperature are depended on the ability of separating alkali salts from different feedstock structures and the thermal power respectively.



Also, The EC values of BCs(P) produced at 300 and 500°C were 161.67 and 550  $\mu\text{S}/\text{cm}$  and BCs(R) produced at 300 and 500°C were 673 and 1157  $\mu\text{S}/\text{cm}$  respectively. Also, all the EC values were significantly different from each other except 300BC(P) and BM(R), and 500BC(R) showed significantly highest EC value than others. The increment of EC value can be observed with the increase in pH (Ahmad *et al.*, 2013). So, the highest EC value had been obtained at the highest pH level by 500BC(R)

### ***Cation Exchange Capacity (CEC) of biochar***

CEC values of BCs have been increased with the increase in pyrolysis temperature mainly due to concentration of  $\text{Ca}^{2+}$ ,  $\text{K}^{+}$ ,  $\text{Mg}^{2+}$  and  $\text{Na}^{+}$  elements. When comparing, both BCs(P) and BCs(R), BCs(R) have higher CEC values according to the higher concentrations of the elements than BCs(P) and 500BC(R) showed a significantly highest CEC value than others with higher amount of above mentioned elements. Also, these elements might not be lost by volatilization to show this characteristic (Al-wabel *et al.*, 2013).

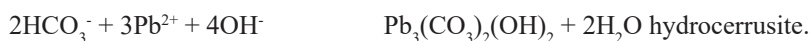
### ***Yield of biochar***

These results show that the yield of BC was reduced with increasing pyrolysis temperature. 300BC(R) showed significantly higher yield (45.48g) than other BCs. This decrease of yield at high pyrolysis temperature could be due to a greater loss of volatile matters (Ahmad *et al.*, 2014). BM with high lignin contents typically produces greater char yields (Laird *et al.*, 2011). So, BC(R) type has a relatively higher biochar yield than BC(P).

### ***Immobilization of lead (Pb)***

The amount of Pb was significantly decreased after the addition of BM or BC to MSWC. However, the ability of BCs to immobilize heavy metals was significantly higher than BMs. 500BCs treated MSWC showed significantly lower amount of Pb than 300BCs. These results mainly implied that the bioavailability of these metals was decreased significantly with the rise in pyrolysis temperature within the range of considered and this result, which described about the preferred pyrolysis temperature in BC, agrees with the finding of Paz-Ferreiro *et al.* (2014).

Although the difference between 500BC(P) (0.96mg/kg) and 500BC(R) (0.85mg/kg) treated MSWC were not significant and 500BC(R) displayed a relatively higher immobilization ability. According to Inyang *et al.* (2012), high sorption of  $\text{Pb}^{2+}$  from the media on sorbents through surface electrostatic attraction could be attributed to its high electronegativity constant (2.33), which results in a high tendency for specific adsorption. Also, carbonate and/or phosphate released from the biochars can react with Pb in the media with the presence of optimum moisture to form stable minerals on biochar surfaces through following reactions:



## ***Immobilization of cadmium (Cd)***

The immobilization ability was significantly higher in 500BCs than 300BCs. Heavy metal fractions that were bonded to organic matter is increased after biochar addition produced at higher temperature (Paz-Ferreiro *et al.*, 2014). However, 500BC(R) displayed a clear significant reduction of Cd availability than all the other treatments. According to the Park *et al.* (2013), possible mechanisms for the heavy metal retention by biochar materials include the formation of metal (hydr)oxide, carbonate, and specific metal–ligand complexation involving surface functional groups of char materials, particularly oxygen, phosphorus, sulfur, and nitrogen functional groups.

## **Conclusions**

The present study was conducted to investigate the potential of biochar as a compost amendment to increase compost quality by immobilizing bioavailable toxic metals to reduce the phytotoxicity of heavy metals in MSWC in Sri Lanka. Both pyrolysis temperature and the type of feedstock were the main factors which may determine most of the physico-chemical parameters of BC. Application of BC reduces the bioavailability of Pb and Cd in MSWC effectively and the highest Pb and Cd immobilization was observed from the shells of rubber nuts produced at 500°C temperature. The feedstock and the pyrolysis temperature are two often key determinant factors in deciding the quality of BC in relation to the remediation of compost. When compared to BC, BM is less effective in remediating compost because of the lack of active sites in BM to adsorb heavy metals.

## **References**

- Ahmad, M., Moon, D.H., Vithanage, M., Koutsospyros, A., Lee, S.S., Yang, J.E., Lee, S.E., Joen, C. & Ok, Y.S., 2014. Production and use of biochar from buffalo-weed (*Ambrosia trifida* L.) for trichloroethylene removal from water. *Journal of Chemical Technology and Biotechnology*, 89, 150-157.
- Al-Wabel, M.I., Al-Omran, A., El-Naggar, A.H., Nadeem, M. and Usman, A.R.A., 2012. Pyrolysis temperature induced changes in characteristics and chemical composition of biochar produced from conocarpus wastes. *Bioresource Technology*, 131, 374–379.
- Beesley, L., Moreno-Jimenez, E. and Gomez-Eyles, J.L., 2010. Effects of biochar and greenwaste compost amendments on mobility, bioavailability and toxicity of inorganic and organic contaminants in a multi-element polluted soil. *Environmental Pollution*, 1-6.
- Bian, R., 2012. Removal of heavy metal in solution by modified biochar immobilizer. *Ireea climag*. Inyang, M., Gao, B., Yao, Y., Xue, Y., Zimmerman, A.R., Pullammanappallil, P. and Cao, X., 2012. Removal of heavy metals from aqueous solution by biochars derived from anaerobically digested biomass. *Bioresource Technology*.
- Laird, D.A., Rogovska, N.P., Garcia-Perez, M., Collins, H.P., Streubel, J.D. and Smith, M., 2011. Pyrolysis and Biochar-Opportunities for Distributed Production and Soil Quality Enhancement. *Opportunities for Distributed Production and Soil Quality Enhancement*, 257-281.

- Park, J.H., Choppala, G., Lee, S.J., Bolan, N., Chung, J.W. and Edraki, M., 2013. Comparative Sorption of Pb and Cd by Biochars and Its Implication for Metal Immobilization in Soils. *Water Air Soil Pollut*, 224-1711.
- Paz-Ferreiro, J., Lu, H., Fu, S., Mendez, A. & Gasco, G., 2014. Use of phytoremediation and biochar to remediate heavy metal polluted soils: a review. *Solid Earth*, 5, 65–75.
- Rice, E.W., Baird, R.B., Eaton, A.D. and Clesceri, L.S., 2008. *Standard methods for the examination of water and wastewater*. 22<sup>nd</sup> ed., American public health association publishers, Newyork, USA.

# Effect of Soil Moisture on the Dry Matter Production and Partitioning in Two Black Pepper (*Piper nigrum* L.) Cultivars (Panniyur-1 and Gampaha Selection) at the Early Vegetative Growth Stage

S.K.S.N. Siriwardhana, K.G.A.P.K. Amarasnghe\* and D.C. Abeysinghe

Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka.

\* Corresponding Author: [apsaraamarasinghe@yahoo.com](mailto:apsaraamarasinghe@yahoo.com)

## Introduction and Objectives

Soil moisture deficient stress is one of the key abiotic stresses affected for the plant growth including black pepper (*Piper nigrum* L.). However with the projected climatic change, frequency of drought has increased and the rainfall patterns have become unpredictable (Niranjan *et al.*, 2013). This will create a negative impact on the black pepper growth as it is mainly grown as a rain-fed crop in Sri Lanka. Therefore screening climatic resilient black pepper cultivars that are better adapted to the drought condition is a timely requirement. Further, these selected cultivars could be used as parent material for developing improved cultivars that perform better under the changing climate. To accomplish this, it is important to pay attention on behavior of the pepper vines both at vegetative and reproductive stages, under critical soil moisture condition. Accordingly, this study was conducted to identify the effect of soil moisture deficient stress on the dry matter production and partitioning of two pepper varieties; panniyur-1 and local which is isolated from Gampaha district (Gampaha selection) at their early vegetative growth stage.

## Research Methods

The experiment was carried out at the Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), located in the low country intermediate zone (IL<sub>1a</sub>) from December 2015 to May 2016. Healthy homogeneous nursery plants from the selected cultivars (Pannure-1 and Gampaha selection) were obtained from Plant Production and Tissue Culture Research Center, Department of Export Agriculture, Walpita. They were transplanted in black polythene bags (10"×15") filled with recommended soil mixture used in field planting of pepper (Anon, 2009). Each vine was tied to a peeled gliricidia (*Gliricidia cepium*) pole and the re-potted polybags were arranged completely randomized design (RCD) in the green house. Plants were treated with five moisture levels, viz. soil field capacity (FC), 80%, 60%, 40%, and 20% of the field capacity. (Boutraa *et al*, 2010). Soil field capacity was measured according the method used by De Assis Prado, 2013. All pots were weighed at four day intervals and water loss was added to each pot to compensate for transpiration and evaporation for maintaining the relevant moisture level. Shoot dry matter content, root dry matter content, total dry matter content and root shoot ratio were evaluated at 25 day intervals under five moisture levels (80°C for 48 hr). Data were analysed using analysis of variance (ANOVA) using Minitab software (Version 16).

## Results and Discussion

The results revealed that the moisture stress significantly affect on dry matter partitioning in both cultivars ( $p < 0.05$ ). The effect of moisture stress on the plant dry matter content was clearly visualized at 75 days after the commencement of the treatments in which, the highest shoot dry weight was observed under the field capacity moisture level (11.6g/plant) followed by 80% FC (10.3g/plant), 60% FC (9.8g/plant), 40% FC (9.0g/plant) moisture levels and the lowest was observed under the 20% FC moisture level (6.5g/plant). Plants treated with field capacity moisture level showed the highest root dry weight (1.3g/plant) that was not significantly different from the dry weight of the plants treated with 80% FC moisture level (1.2g/plant) whilst that was significantly higher than the dry weight of plants treated with 40% FC (1.0g/plant), 20% FC (0.9g/plant) and 60% FC (0.9g/plant) moisture levels. The highest total dry matter content was recorded under the field capacity moisture level (12.9g/plant) followed by 80% FC (11.6), 60% FC (10.7g/plant), 40% FC (10.0g/plant) moisture levels while the lowest was observed under the 20% FC moisture level (7.4g/plant). For the three parameters tested, panniyur-1 showed higher values compared to local cultivar under every moisture level, except under 20% FC moisture level. The root shoot ratio was significantly higher in plants grown at 20% FC moisture level (0.19) compared to all other moisture levels (0.13-0.16).

## Conclusions

Panniyur-1 gained higher dry matter content under field capacity, 80%, 60% and 40% of FC moisture stress conditions compared to local cultivar. However under 20% FC moisture level local cultivar performed better than Panniyur-1. Shoot dry matter content and total dry matter content were gradually decreased when the moisture stress was increased. Root shoot ratio was increased considerably under the water stress condition as a method to withstand the stress. However further studies should be carried out as this is perennial in nature.

## References

- Anon. (2009). Department of Export Agriculture. Available from: <http://www.exportagrಿದೆpt.gov.lk/> (Accessed 12 December 2015).
- Boutraa, T., Akhkha, A., Al-Shoaibi, A.A. and Alhhejeli, A.M. (2010). Effect of water stress on growth and water use efficiency (WUE) of some wheat cultivars (*Triticum durum*) grown in Saudi Arabia. *Journal of Taibah University for science*, 3, 39-48.
- De Assis Prado, C.H. (2013). Available from: <https://www.youtube.com> (Accessed 09 December 2015).
- Niranjan, F., Jayatilaka, W., Singh, N.P. and Bantilan, M.C.S. (2013). Mainstreaming Grassroots Adaptation and Building Climate Resilient Agriculture in Sri Lanka. International Crops Research Institute for the Semi-Arid Tropics, 1-8.

# Compost as a Phosphate Fertilizer

**B.M.A.V. Gunarathna<sup>1</sup>, L.P. Vidhana Arachchi<sup>1</sup>, P. Weerasinghe<sup>2</sup>**

<sup>1</sup> Department of Export Agriculture, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> Horticultural Crop Research and Development Institute, Department of Agriculture.

\* Corresponding Author: [anuradha.vishaka25@gmail.com](mailto:anuradha.vishaka25@gmail.com)

## Introduction

The optimum growth and yield of most crops depends on availability of phosphorous (P). Phosphorous is added to the soil as phosphate fertilizer/inorganic fertilizer under chemical farming. Continual and over usages of chemical fertilizers have become a serious threat and harm to the ecosystem. The demand for P by the plants could partially or sometimes fully be met through organic fertilizers. However, availability of P in average organic fertilizer is not sufficient for crop growth. Additionally, the usage of organic fertilizers is reluctant by farmers due to practical problems and social myths. Taking these issues in to consideration, testing the possibility of using alternative phosphorous sources is extremely useful for successful crop production.

Sri Lanka has a large rock phosphate deposit at Eppawala, estimated to be about 40 million metric tons (Dahanayake and Subasinghe 1991). Eppawala Rock Phosphate (ERP) is specially recommended for perennial crops and it is not recommended for annual crops due to its low solubility. Therefore, the objectives of this study were to evaluate the suitability of compost enriched with ERP and jaggery washings, as an alternative to synthetic phosphate fertilizers and to find out a method to enhance the solubility of ERP.

## Research Method

The potential of different compost types as alternatives to phosphate fertilizers for Knol-khol (*Brassica caulorapa* L.) were studied. Jaggery washings and ERP were used for preparation of different compost types while observing the solubility of ERP. The Jaggery washings used in this study was a waste material in sugar cane industry. The experiment was carried out at Horticultural Crop Research and Development Institute, Gannoruwa. Seven treatments were used to compare the effect of different phosphorous sources on plant growth and the ERP solubility. Only Nitrogen (N) and potassium (K) fertilizers with soil were used as controls. Different phosphorous sources such as phosphor-compost, Jaggery washing-enriched phosphocompost, vermicompost, Jaggery washing-enriched vermicompost, TSP (Triple Super Phosphate), combination of TSP with compost were used for the other six treatments. All the pots were treated with 0.29g of Nitrogen (N) and 0.29g of potassium (K). Urea and Muriate of Potash (MOP) to supply nitrogen and potassium. Phosphor-compost and vermicompost were enriched with 7.5kg (5% of total weight of raw material) of ERP. Compost, phosphor-compost and vermicompost were prepared using the same raw materials.

## Results and Discussion

Results showed that the compost with recommended NPK fertilizers had a significant effect on phosphorous uptake and phosphorous use efficiency and thereby, those promoted the growth of knol-khol plants. However, there was no significant effect of phosphor-compost and vermicompost on vegetative growth of Knol-khol plant. Both phosphor-compost and vermicompost, which were treated with Jaggery washings, increased the available P compared to other treatments. Jaggery washing-enriched composts tends to be low down phosphorous use efficiency than jaggery washing alone treatments. The highest concentration of available P was observed in the treatment that consisted of compost with recommended NPK fertilizers whereas, the lowest with the recommended NPK fertilizers. In this experiment, required phosphorous level of knol-khol plant was supplied through different phosphorous sources. As far as the nutrients release is concerned, the characteristics features of compost or organic fertilizers are helpful to maximum utilization of nutrients from chemical fertilizers. Organic fertilizers have the ability to increase the Cation Exchange Capacity (CEC) of soil. Also, microorganisms in compost are able to convert the fixed forms of P into available forms. Organic matter can indirectly improve soil structure and microbial activity (Chattoo *et al.*, 1979). Organic matter is a significant reservoir of nutrients and can retain nutrients in plant available forms. Jaggery washings were used particularly to solubilize ERP. Indirectly it was helped growth of microbes as a food source. It is evident from results that ERP enriched with compost gave the highest phosphorous use efficiency than chemical fertilizers alone to give more available P.

## Conclusions

It is evident from the results that the ERP enriched compost gave a higher P use efficiency than chemical fertilizers alone. Normal compost, vermicompost and phosphor-compost can be applied for crops because, all those sources have the ability to increase plant performances. And jaggery washings had no significant effect on solubility of Eppawala Rock Phosphate.

## References

- Dahanayaka, K. and Subasinghe, S. M. N. D., 1991. Heterogeneity of the Eppawala rock phosphate deposit. Ceylon Journal of Science. 1, p. 1-7.
- Dahanayaka, K. and Subasinghe, S. M. N. D., 1991. Fertilizer research 28: 233. doi: 10.1007/BF 01049756.
- Chatto, M. A., Gandroo, M. Y., Zargar, M. Y., 1997. Effect of *Azospirillum* and *Azotobacter* on growth yield and quality of Knol-khol (*Brassica oleracea* L. var. *gonogylodes* L.). Veg. Sci., 24(1): 16: 19.

# **LIVESTOCK AND AQUACULTURE**

## **Student Forum**

**09<sup>th</sup> December 2016**



# Microbial Safety of Oysters (*Crassostrea madrasensis*) Harvested from Kalpitiya Lagoon in Sri Lanka

G.L.A. Subhashini<sup>1</sup>, K.W.S. Ariyawansa<sup>2\*</sup>, P.H. Ginigaddage<sup>2</sup>, K.S. Hettiarachchi<sup>2</sup> and C.N. Walpita<sup>1</sup>

<sup>1</sup> Sabaragamuwa University of Sri Lanka, PO Box 02, Belihuloya. 70140. Sri Lanka.

<sup>2</sup> National Aquatic Resources Research & Development Agency, Crow Island, Colombo 15. Sri Lanka.

\* Corresponding Author: [sujeewa@nara.ac.lk](mailto:sujeewa@nara.ac.lk)

## Introduction

Oysters are a nutritious sea food item, which is consumed predominantly in raw form and to a lesser extent cooked. Due to the filter feeding habit and living habitat in the estuary, they are concentrating and accumulating pathogenic microbes and toxic chemicals. Hence, subjected to stringent food safety standards are considered as a good income source for fishers. Kalpitiya lagoon in Sri Lanka has been identified as a potential site for oyster culture and farming has already commenced. If these farms are to produce oysters for local or export market, they should be in compliance with the microbial standards. The aim of the present study was to evaluate the microbial quality of the oysters harvested from two major areas of Kalpitiya lagoon, viz. Kandakuliya and Gangewadiya.

## Research Methods

Five oyster samples were collected from each site at two week intervals for three month period during December 2015 and January 2016. Total bacterial counts (TBC) (n=30), total coliforms (n=30), faecal coliforms (n=30) count and *E. coli* (n=30) were used as indicators to compare with the stipulated microbial standards by European regulations. At the same time, water samples were collected and salinity and temperature were measured. Total bacterial counts were enumerated using ISO 4833-1:2013 method. *E. coli* were tested using ISO 7251:2005(E) method. Total coliforms were enumerated at 36 °C using ISO 4831:2006 method.

## Results and Discussion

Results indicated that the TBC of samples ranged from  $2.2 \times 10^3$  to  $3.5 \times 10^5$  CFU/g and it was below the standard limit of European regulations ( $5 \times 10^5$  CFU/g). All the samples collected from both sites of Kalpitiya lagoon during experimental period were positive for coliform bacteria, which ranged from 2.3 to  $1.1 \times 10^3$  MPN/g. During December samples from both sites showed higher counts for coliform than the standard limit of European regulation (100 MPN.g<sup>-1</sup>). All samples except from Kandakuliya in January and Gangewadiya in February showed presence of *E. coli* more than the acceptable limit of European regulations (2.3 MPN/g of). There was no correlation between TBC of oyster samples with salinity ( $r = -0.4371$ ,  $P = 0.4617$ ) and temperature ( $r = 0.80750$ ,  $P = 0.1925$ ) of tested water samples.

Results indicated that most of the samples were contaminated with *E. coli* exceeding the safety level for raw consumption of oysters according to European standards. According to obtained results oyster harvesting area in Kalpitiya lagoon can be classified as class B as per European shell fish harvesting area classification criteria.

## Conclusion

Hence, it can be concluded that the oysters from these areas during the experimental period go beyond the level of microbial safety standards, showing the need of depuration or cooking by approved methods before consumption.

## References

- Sri Lanka Standards Institution (SLSI). Microbiological test methods, Part 3 Detection and enumeration of coliforms, faecal coliforms and *Escherichia coli*, SLS 516: Part 3:1982, Sri Lanka Standards Institution, Colombo, Sri Lanka.
- Sri Lanka Standards Institution (SLSI). Microbiological test methods, Part 1-General guidance for enumeration of microorganisms colony count technique, SLS 516: Part 1:1991, Sri Lanka Standards Institution, Colombo, Sri Lanka.
- Food and Agriculture Organization (FAO). 1988. *Status of oyster culture in selected Asian countries- Sri Lanka*. FAO fisheries Technical paper NACA-SF/WP/88/2. Rome: FAO 10 December 2015 <http://www.fao.org/docrep/field/003/ab716e/AB716E12.htm>.
- Council of European Union commission decision on the microbiological criteria applicable to the production of cooked crustacean and molluscan shellfish 1992.93/ 51/ EEC.
- Food and agriculture Organization (FAO). 2008. *Bivalve depuration: fundamental and practical aspects*. By Ronald Lee, Alessandro Lovatelli, Lahsen Ababouch. FAO fisheries Technical paper 511.Rome: FAO.
- Food and Drug Administration (FDA) 1989b. *National Shellfish Sanitation Program Manual of Operations, part II, Sanitation of the harvesting, processing and Distribution of shellfish*. Health service, shellfish sanitation branch. Washington.

# Effect of Hydrothermally Processed *Citrullus lanatus* (Water Melon) Seed Meal on Growth Performance of *Cirrhinus mrigala* Fry.

Pavithra Attanayake<sup>1\*</sup>, T.V. Sundarabarathy<sup>2</sup>

<sup>1</sup> Department of Biological Sciences, Rajarata University of Sri Lanka.

<sup>2</sup> Faculty of Applied Sciences, Rajarata University of Sri Lanka.

\* Corresponding Author: nishathra@gmail.com

## Introduction and Objectives

Fishmeal is common and high cost ingredient which is used in fish feed formulation due to its high percentage of protein and digestibility of diet. The proportion of global fishmeal production used in fish feeds has increased from 10% to 35% in the last fifteen years (Hardy, 2000). Because of these reasons use of fishmeal in fish feed formulation become a serious problem in the world due to its cost and availability. It is important to identify alternative protein sources which do not conflict with human food security. Watermelon seeds contain many nutrients including fatty acids, essential proteins, and many minerals and rich source of vitamins (Kerje and Grum, 2003). Hence watermelon seeds could be utilized as a substitute ingredient for fish feed in formulation of feed. The present study focused on formulating low cost feed for freshwater *Cirrhinus mrigala* fry using processed watermelon seeds as a substitute source of protein.

## Research Methodology

Complete randomized block design was used as experimental design with five treatments each with three replicates. Experimental diets were formulated by adapting Pearson square method and fish meal was substituted with processed (boiled for 40 minutes)

watermelon seed meal by 0% (D1, Control), 15% (D2), 30% (D3), 45% (D4) and 60% (D5). Hundred 22 days old *Cirrhinus mrigala* fry with mean initial weight of  $0.003 \pm 0.01$  mg and initial length of  $2.31 \pm 0.10$  mm were stocked in each tank ( $130 \times 130 \times 67$  cm<sup>3</sup>). Each experiment was conducted with 3 replicates. Fish were fed with formulated feeds at a rate of 5% of their body weight, two times per day 9.00 AM and 3.00 PM for 45 days. Mean initial weight, Mean final weight, Percentage of weight gain(%WG), Survival Rate, Specific growth rate (SGR) and Average daily weight gain(ADWG) were calculated. Results were analyzed by one way ANOVA and Means compared by Duncan's multiple range tests at 95% significant level. Relationship between body weight and length were determined by Pearson correlation test. Nutrient content of test feeds were analyzed by AOAC method (2000). Cost analysis was performed for formulated test feed using current price of ingredients in order to find the least cost feed for *C. mrigala* fry.

## Results and Discussion

The protein content and lipid content of processed watermelon seeds were  $16.92 \pm 0.196$  and  $22.19 \pm 0.202^a$  respectively. Highest percentage of protein ( $19.66 \pm 0.08$ ) and

lipid ( $22.99 \pm 1.23$ ) were recorded in Diet 1 due to high content of fish meal (Table 01).

Length-weight relationship exhibited a positive allometric growth ( $b > 3$ ) for all test feeds. Tiarniyu *et al.*, (2015) revealed that growth of the *Clarias gariepinus* fed with watermelon seed meal was decreases with the increasing level of raw watermelon seed meal in diet. They are carnivorous and couldn't utilize plant protein effectively and it may be also due to presence of anti- nutrient factors in raw watermelon seeds.

**Table 01 : Nutrients in formulated test feeds**

Diet	Protein	Lipid	Ash
D1	$19.66 \pm 0.08^a$	$22.99 \pm 1.23^a$	$9.85 \pm 0.16^a$
D2	$18.95 \pm 0.09^{bc}$	$22.15 \pm 1.60^a$	$8.86 \pm 0.60^{ab}$
D3	$18.37 \pm 0.30^c$	$21.71 \pm 0.34^a$	$7.98 \pm 0.68^{bc}$
D4	$18.89 \pm 0.35^{bc}$	$22.56 \pm 0.56^a$	$6.65 \pm 0.55^c$
D5	$18.95 \pm 0.51^b$	$21.86 \pm 0.80^a$	$5.12 \pm 0.65^d$

Means in the same column with different superscript (a,b,c,d) differ significantly ( $P < 0.05$ )

**Table 02: Growth parameters of *Cirrhinus mrigala* fries fed with five formulated test feeds**

Growth Parameters	Diet				
	D1	D2	D3	D4	D5
MIW	$0.3 \pm 0.00^a$	$0.28 \pm 0.02^a$	$0.33 \pm 0.05^a$	$0.32 \pm 0.03^a$	$0.3 \pm 0.00^a$
MFW	$0.76 \pm 0.05^a$	$0.76 \pm 0.02^a$	$0.72 \pm 0.04^b$	$0.72 \pm 0.04^b$	$0.76 \pm 0.02^a$
SGR	$1.820 \pm 0.10^a$	$1.817 \pm 0.09^b$	$1.527 \pm 0.09^c$	$1.553 \pm 0.16^{bc}$	$2.060 \pm 0.06^a$
% WG	$1.453 \pm 0.09^b$	$1.333 \pm 0.13^b$	$1.190 \pm 0.25^c$	$1.273 \pm 0.16^{bc}$	$1.853 \pm 0.09^a$
ADWG	$1.060 \pm 0.08^b$	$1.016 \pm 0.11^c$	$0.856 \pm 0.06^d$	$0.893 \pm 0.02^{cd}$	$1.317 \pm 0.04^a$
SR%	$92.00 \pm 0.00^{ab}$	$93.00 \pm 0.01^a$	$91.00 \pm 0.21^b$	$92.00 \pm 0.11^{ab}$	$93.00 \pm 0.06^a$

Mean in the same raw with different superscript differ significantly ( $P < 0.05$ )

Where;

MIW= Mean initial weight

MFW= Mean final weight

SGR= Specific growth rate

%WG= Percentage of weight gain

ADWG= Average daily weight gain

SR= Survival rate

Processed seeds may consist with low amount of anti-nutrient factors and *C. mrigala* fries adapted to use vegetative protein sources. These may cause to higher growth performance of *C. mrigala* fry. Significantly highest growth performance (SGR, %WG and ADWG) shown with Diet 5 (Table 2) ( $p < 0.05$ ) also confirms the above statement.

Although protein and lipid content were significantly different in Diets 5, 4, 3 and 1 ( $p < 0.05$ ), the positive allometric growth and growth performance revealed that all the test feeds with watermelon were suitable for mrigal fry.

Highest cost was gained by diet 1, Rs.54 /= per 1kg which was formulated by using 600 g of fish meal per 1kg and other amount of ingredients except seed meal. Least cost was achieved by diet 5, Rs. 30/= per 1kg which was formulated by using all other ingredients except fish meal. As selling prize of 1 kg mrigal fish is varied between Rs. 150-200/=, using of watermelon seed meal in fish feed may give benefits to the small scale farmer.

## Conclusions

Inclusion level of 60% processed watermelon seed meal can be utilized as substitute ingredient for fish meal to enhance growth performance of *Cirrhinus mrigala* fry without adverse effect on growth. Processed watermelon seed meal could be utilized effectively in small scale integration farming system where *Cirrhinus mrigala* culture with watermelon cultivation. However the optimum dietary protein requirement of mrigal fry is 40 – 45% (De Silva and Gunasekera, 1991) whereas lipid level is 5 – 9% (Marimuthu and Sukumaran 2001). Although the mrigal fry achieved the expected growth level in the present study, there may be a problem with the quality of fish meal used in the experiment where it contained comparatively higher percentage of lipid than protein. Hence further experimentation needed in this regard.

## References

- De Silva, S.S. and Gunasekera, R.M. (1991). An evaluation of the growth of Indian and Chinese major carps in relation to dietary protein content. *Aquaculture*, 92: 237-241.
- Kerje T. and Grum M. (2003). The origin of watermelon :A review of the literature. [www.vitacost.com](http://www.vitacost.com).
- Marimuthu, K. and Sukumaran, N. (2001). Effect of dietary lipid levels on growth and survival of fingerlings of the Indian major carp, *Cirrhinus mrigala*. *Fishery Technology, Society of Fisheries Technologists (India)*, 38: 48-50.
- Tiamiyu L.O., Ayuba, O.V., Okomoda, V.T. and Umar S., (2015)., Evaluation of Nutrient Composition of Raw and Hydrothermally Processed Watermelon Whole Seed (*Citrullus Lanatus*), *International Journal of Current Trends in Engineering & Technology* 1(2):72-75.

# Analysis of Nutritional Value and Study of Post Harvest Techniques of Malabar Sprat (*Ehirava fluviatilis*)

Madhuwanthi Weerasekara<sup>1\*</sup>, T.V. Sundarabarathy<sup>2</sup>

<sup>1</sup> Department of Biological Sciences, Faculty of Applied Sciences,  
Rajarata University of Sri Lanka.

<sup>2</sup> Faculty of Applied Sciences, Rajarata University of Sri Lanka.

\* Corresponding Author: [kaushmw@gmail.com](mailto:kaushmw@gmail.com)

## Introduction and Objectives

Fisheries sector in Sri Lanka contributes 70% of total animal protein requirement of the country. Freshwater fisheries can provide rather cheap protein to the poor than marine fishery. *Ehirava fluviatilis*, a clupeid fish confined to Parakkramasamudra (Hofer 1983.; Newrkla and Ducan, 1984), Rajanganaya reservoir (Amarasinghe and Sriya, 2002) and Bolgoda lake (Amarasinghe and Sriya, 2002) and not distributed other parts of the country. As its fishery is seasonal, postharvest loss during the season, lack of proper methods for preservation and lack of knowledge in nutritional value and the awareness are the major restrictions for further development of particular fishery. Hence, the study was focused on comparison of nutritional value of *Rajanganaya* freshwater *E.fluviatilis*(MSR) with brackish water *E.fluviatilis*from Bolgoda (MSB). Development of postharvest products and evaluate their consumer preference were the other main objectives.

## Research Method

*E. fluviatilis* collected from Rajanganaya reservoir and Bolgoda lake was analyzed for moisture, ash, protein and fat (AOAC 2000), each in replicates. Fish from Rajanganaya reservoir was used to prepare the processed fish as it is the nearest location to collect the fresh fish samples.

### Smoked fish

Cleaned fish was seasoned for 1-2 hours with ingredient mixtures, salt (S1), salt + pepper (S2), salt + tamarind (S3) and salt + pepper + tamarind (S4)and smoked over coconut smoke for 25-30 minutes.

### Canned fish

One kilogram of cleaned fish with head (C1) was placed in a pressure cooker and 100 g of tamarind pulp, 2 table spoons of olive oil, salt and water were added and cooked for 10 min at 20P pressure. The same procedure was followed for fish without head (C2).

Traditional curry was prepared by adding one tea spoon of chili, salt, 3-4 carpels of garcinia, garlic, turmeric and one cup of coconut milk to the clean fish and cooked for 10-15 minutes.

Preference test was done using hedonic scales consisting of five levels with 1 represent

extreme dislike and 5 representing highest satisfaction. Turkey's range test used to compare nutritional values, Kruskal- Wallies test for consumer preference and Chi square test to determine the effect of each attributes on preference of particular product.

## Results and Discussions

The study revealed that the MSR is nutritionally richer than MSB in ash and protein but not in lipid (Table 01).

**Table 01: Proximate composition of flesh of *Ehiravafluviatilis***

Location	Nutrient composition (mean $\pm$ SD) (g/g)			
	Moisture	Ash	Lipid	Protein
Bolgoda	10.98 $\pm$ 0.03 <sup>b</sup>	10.10 $\pm$ 0.78 <sup>b</sup>	21.32 $\pm$ 0.18 <sup>a</sup>	10.79 $\pm$ 0.39 <sup>b</sup>
Rajanganaya	12.86 $\pm$ 0.21 <sup>a</sup>	12.16 $\pm$ 0.04 <sup>a</sup>	17.23 $\pm$ 0.48 <sup>b</sup>	12.83 $\pm$ 0.17 <sup>a</sup>

Means in the same column with different superscript (a,b) differ significantly (P< 0.05)

Variation in available foods for fish at different localities may result such alternations. It has revealed previously that MSB mainly feed on copepods (Amarasinghe and Sriya, 2002)and MSR feed on diatoms (Mihindukulasooriya and Amarasinghe, 2014).

There was no significant difference among the smoked fish products (p>0.05). According to the Kruskal- Wallis test, the preference to product S2 which has seasoned with pepper and salt is higher than other three products. Willingness of Asians including Sri Lankans to have piquant flavored foods may be the reason for this.

There was a significant difference between two types of canned fish (p< 0.05). C2 canned fish was preferred by community involved for sensory evaluation than C1 canned fish. Sandy nature of “with head” product may have created a repulsive action to the particular product.

However, there was a significant difference among the most preferred smoked fish S2, canned fish C2 and traditional curry (p<0.05).

Canned fish “without head” C2 was the most preferred food item. It was preferred than the traditional curry too.

## Conclusions

*E. fluviatilis* in Rajanganaya is a nutritionally rich fish .Especially in ash and protein. So, it can be used as a low cost source of protein and ash to the Rajanganaya villagers especially for growing children where particular fish is abundant.

As canned fish product is preferred by over 80% of consumers than smoked fish and traditional curry, production of canned fish using *E. fluviatilis* suitable method to develop a postharvest product. As the bones of sprat become soften during cooking under pressure it could be suited for small children.

## References

- Amarasinghe, U.S., Sriya, I.P.D. (2002). Aspects of the biology and fishery of Malabar sprat *Ehiravafluviatilis* (Osteichthys: Clupeidae) in Bolgoda lake, Sri Lanka. *Asian fisheries science*. 15, 215-228.
- Mihindukulasooriya, I.D., Amarasingha, U.S., (2014). Food and feeding of *Ehiravafluviatilis* (Osteichthys: Clupeidae) in Rajanganaya reservoir, Sri Lanka. *Sri Lanka journal of aquatic science*. 19, 31-39.
- Newrkla, P and Duncan, A. (1984). The biology and density of *Ehiravafluviatilis* (Clupeoid) in Parakrama Samudra, Sri Lanka. *Verhhandlungen der Internattional Vereinigung für theoretische und angewandte Limnologie*, 22, 1572-1578.
- Schiemer, F. and R. Hofer. (1983). A contribution to the ecology of fish fauna of Parakrama Samudra reservoir. In: *Limnology of Parakrama Samudra, Sri Lanka, A case study of an ancient man-made lake in the tropics* (ed. F. Schiemer). 135-140. Dr. W. Junk Publishers, The Hague.



# Effect of Different Heat Treatment Methods on the Nutritional Value and Microbiological Safety of Rice Bran Incorporated Poultry Feed

K.I.S. Senadheera\* and P.N. Yapa

*Department of Biological Sciences, Faculty of Applied Sciences,  
Rajarata University of Sri Lanka.*

*\* Corresponding Author: sandamalisendeera90@gmail.com*

## Introduction and Objectives

Rice bran, a byproduct of rice milling industry is used for poultry feeding in Sri Lanka as it is a highly available, low cost, highly nutritious feed ingredient (Atapattu and Madushanka, 2015). But, some factors present in rice bran, such as high phytate content, rancidity development, enzyme inhibitors, high fiber content, high mold growth and palatability problems limit its potential use as a poultry feed ingredient (Ersin *et al.*, 2006). Therefore, elimination of those limiting factors and stabilization of rice bran is necessary. As a highly available feed resource, it is critical to focus the attention towards the development of suitable heat treatments to stabilize the rice bran which is incorporate into poultry feed. So, the aim of this study was to investigate the effect of different heat treatments on the nutritional value and microbiological safety of rice bran incorporated poultry feed.

## Research Methods

In this study, two types of rice varieties were collected namely BG 358 as the improved rice variety and '(1)' and Gonabaru as the traditional rice variety '(2)'. A part of traditional and improved paddy was parboiled to collect parboiled rice bran prior to milling process and the other part of two rice varieties was used to collect crude rice bran. All parboiled and crude paddy were freshly milled to collect rice bran. Crude rice bran was subjected to one of either heat treatments namely autoclaving, microwave heating and hot air oven heating. Prior to addition of rice bran poultry feed was prepared using the formulation of corn (53.5%), rice bran (10.0%), full-fat soybean (9.2%), soybean meal (13.3%), gluten meal (2.0%), fish meal (1.0%), limestone (9.3%), mono calcium phosphate (0.95%), salt (0.22%),  $\text{NaHCO}_3$  (0.10%), vitamin and mineral mix (0.25%), DL-methionine (0.12%) and phytase (0.02%). Then ten types of poultry feed were prepared by incorporating heat treated and non-heat treated rice brans from two rice varieties. Five different treatments were consisted by inclusion of rice variety '(1)':  $T_1$ : crude rice bran from rice variety '(1)' incorporated poultry feed (control),  $T_2$ : parboiled rice bran from rice variety '(1)' incorporated poultry feed,  $T_3$ : autoclaved rice bran from rice variety '(1)' incorporated poultry feed,  $T_4$ : oven heated rice bran from rice variety '(1)' incorporated poultry feed,  $T_5$ : microwave heated rice bran from rice variety '(1)' incorporated poultry feed. These treatments were repeated for rice variety '(2)' also. The experiment was set up in a completely randomized design, assigned ten treatments with twelve replicates in each. Sampling was done in first, second and fourth week of storage from three replicates from each treatments. Changes of nutrient quality with different heat treatments were compared by analyzing crude

protein content, crude lipid content and crude fiber contents. Storage life of poultry feed containing heat treated rice bran was also compared by estimating total fungal and total bacterial counts. Moisture content was measured in prepared poultry feeds. The data were analyzed as a completely randomized design using the GLM procedure of SAS software. Mean separation was performed using the Dunnett method and 95.0% confidence level as used to compare treatment means with the control mean at a significance level  $p < 0.05$ .

## Results and Discussion

Analysis revealed that the crude protein content was significantly reduced ( $p < 0.05$ ) with any of heat treated rice bran incorporated poultry feed of both two tested rice varieties, than the non-heated control. However, there was significantly a high lipid content ( $p < 0.05$ ) shown in microwave heated rice bran applied feed and was independent from the tested rice variety. Lipid preservation implies the reduction of rancidity development in heat treated rice bran. And also heat treatments were effective in reducing the high fiber content which is considered as an anti-nutritional factor of rice bran. Further, heat treated rice bran incorporated poultry feeds from both two tested rice varieties were exhibited significantly less ( $p < 0.05$ ) fungal count and bacterial count than the control ( $T_1$ ) for storage periods tested. Among them microwave heated rice bran from both rice varieties added feed was shown the lowest fungal and bacterial counts. Results revealed that parboiled, microwave heated, autoclaved and oven heated rice bran incorporated poultry feeds were shown high microbiological safety than the control. Moisture contents of heat treated rice bran incorporated poultry feeds were reduced during storage and it influences the stability of bran by reducing bacterial and fungal contamination.

## Conclusion

Although the protein content has been reduced in heat treated rice bran incorporated poultry feeds, lipid content has been preserved. Heat treatments of rice bran were effective in reducing the high fiber content. Heat treatments were effective in lowering the presence of bacteria and fungi in rice bran incorporated poultry feed. Microwave heat treatment is the most effective among other heat treatments to stabilize the rice bran. Heat treatments on the nutritional quality and microbiological safety of rice bran incorporated poultry feed has affected similarly in two tested rice varieties.

## References

- Atapattu I, N.S.B.M. and Madushanka K.P.K. (2015). Effects of heating of dietary rice bran on growth performance and serum cholesterol levels of broiler chicken. *Journal of Agricultural Sciences* 10, 151 – 157.
- Ersin, S., Nizamettin, S., Hasan, A. and Aylin, A., (2006). Using rice bran in laying hen diets. *Central European Agriculture*, 135-140.

# Development of a Probiotic Cereal Bar using Fermented Rice Bran with *Lactobacillus delbrueckii* subsp. *bulgaricus*

P.A.H.N. Wijesinghe\* and P.N. Yapa

Department of Biological Sciences, Faculty of Applied Sciences,  
Rajarata University of Sri Lanka.

\* Corresponding Author: hasaraneelangirusl@gmail.com

## Introduction and Objectives

Functional foods are the foods that have health benefits beyond their normal nutrition. Development of new healthy food products is rapidly growing due to the increasing demand for healthy, high quality foods associated with changes in consumer's lifestyle. Incorporation of probiotics into cereal based products is desirable, as it can provide prebiotic ingredients and the beneficial effects of the probiotic bacteria together in to the food. And also by incorporating rice bran in to cereal bars, can enhance the health benefits of the food as well as its nutritional value. The main objective of this study was to develop a probiotic cereal bar using fermented rice bran with *Lactobacillus delbrueckii* subsp. *bulgaricus*. And the specific objectives were to compare the nutritional value and shelf life of fermented cereal bars and estimate the *Lactobacillus* sp. count of the cereal bars with the time. Further, consumer preference of the produced cereal bars was also compared.

## Research Methods

Bran of two rice varieties was used for the study, including a traditional rice (Pachcha perumal) variety and an improved rice variety (BG 300). Six types of cereal bars were prepared with following treatment combinations. T<sub>1</sub>: cereal bars without rice bran (control), T<sub>2</sub>: 5% non-fermented rice bran from rice variety 01, T<sub>3</sub>: 5% rice bran fermented with *Lactobacillus* sp. from rice variety 01, T<sub>4</sub>: 5% non-fermented rice bran from rice variety 02, T<sub>5</sub>: 5% rice bran fermented with *Lactobacillus* sp. from rice variety 02, T<sub>6</sub>: 5% fermented rice bran from rice variety 01 and 5% fermented rice bran from rice variety 02. Before incorporating to the cereal bar and fermentation, rice bran was heat stabilized using microwave heat for two minutes to prevent bran from becoming rancid (Hamid *et al.*, 2007). Fermentation was followed by adding 2ml of *L. delbrueckii* subsp. *bulgaricus* inoculum suspension containing  $1.5 \times 10^8$  CFU/ mL to a 10g of heat stabilized rice bran with 1g of skimmed milk powder. Cereal bars were produced according to two formulations. The first formulation was puffed rice (20%), corn flakes (10%), rice bran (5%), dried grapes (10%), cashew (10%), sugar (10%), treacle (33%), and cinnamon (2%). In the second formulation bee honey was used instead of treacle.

## Results and Discussion

Statistical analysis revealed that the crude protein level, total lipids and the dietary fiber contents were significantly higher (at the 0.05% probability level ANOVA) in fermented rice bran incorporated cereal bars than non-fermented rice bran incorporated

cereal bars and the control. So incorporation of fermented rice bran with *Lactobacillus delbrueckii* subsp. *bulgaricus*, in to cereal bars has affected to enhance the nutritional quality. The initial moisture contents of the cereal bar formulations were around 11-15%. The moisture contents of the formulations were close to that of the moisture content of traditional cereal bars. (Loverday *et al*, 2009). And the moisture content of the cereal bars were reduced with the time. There was a greater variation in protein content between 7.79-10.95%. Cereal bar formulations had a high carbohydrate content than other nutrients due to high percentage of starch in the cereals and corn glucose in the formulations. In this study the carbohydrate amount has ranged between 44.2 and 51.66 g.100 g<sup>-1</sup>. Among them fermented rice bran incorporated cereal bars had a significantly (at the 0.05% probability level ANOVA) lower carbohydrate content than the control and non-fermented rice bran incorporated cereal bars. The Lipid contents were between 6.5 and 7.71 g.100 g<sup>-1</sup> in this study. In previous studies lipid content of roasted rice bran incorporated cereal bars had between 7.43 to 9.57 g.100 g<sup>-1</sup> ( Marina *et al.*, 2012). The dietary fiber content of cereal bars were between 3.45 and 6.46% in this study.

## Conclusions

Finally, fermentation of rice bran with *Lactobacillus delbrueckii* subsp. *bulgaricus*, significantly affects the enhancement of crude protein, total lipids and dietary fiber contents. At the time of consumption, *Lactobacillus* sp. count was around 1x10<sup>4</sup> CFU/g and the count was viable throughout the shelf life of the food. Due to the increment of the total fungal count and reduction of moisture content with the time, the shelf life of the product is less than four weeks. And the Consumer preference was enhanced with the addition of bee honey in to cereal bars instead of sugar and treacle. This research is valuable to food manufactures and consumers who seek a quick diet and a nutrient rich diet together with health benefits.

## References

- Hamid, A. A., Sulaiman, R. R. R., Osman, A., Saari, N. (2007). Preliminary study of the chemical composition of rice milling fractions stabilized by microwave heating. *Journal of Food Composition and Analysis* 20, 627-637.
- Loverday, S. M., Hindmarsh, J. P., Creamer, L. K., Singh, H. (2009). Physicochemical changes in a model protein bar during storage. *Food Research International*, 42, 798-806.
- Marina, C. G., Lobato, L. P., Benassi, M. D. T. (2012). Application of roasted rice bran in cereal bars. *Food science and technology*, 32 (4), 234-240.

**AgInsight 2016, Faculty of Agricultural Sciences,  
Sabaragamuwa University of Sri Lanka, PO Box 02,  
Belihuloya, Sri Lanka. 70140**