



# International Conference of Agricultural Sciences

9<sup>th</sup>-10<sup>th</sup> January 2014

*"Perspectives for Contemporary Agriculture:  
Challenges and Future Directions"*

## **ABSTRACTS**



Faculty of Agricultural Sciences  
Sabaragamuwa University of Sri Lanka

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### **THEMATIC AREAS**

Agri and Food-business

Animal Bio-resource Management and Food Technology

Agro-environmental Resource Management

Crop Improvement and Production Technologies

Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka,  
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## MESSAGE FROM THE CHIEF GUEST

It affords me great pleasure to be associated with the International Conference on Agricultural Sciences organized by the Sabaragamuwa University of Sri Lanka. Since its establishment in 1996, SUSL has made great strides in teaching and research, and it has become not only a leader of higher education in Sri Lanka, but also a strategic partner in regional development. It is gratifying to note that the University has introduced several novel and innovative degree programmes in line with the needs and demands of the region in particular and country in general. The conference including contributions from home and abroad will contribute to advancing the frontiers of knowledge in agriculture and allied fields.

I am certain that the Sabaragamuwa University of Sri Lanka with many accomplishments to its credits will soon become a much sought-after university in the higher education landscape of the country.

I wish the conference all the success!

***Professor Ranjith Senaratne***

Vice Chairman

University Grants Commission

## MESSAGE FROM THE VICE CHANCELLOR

It is with great pleasure that I write this message for the International Conference organised by the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka. I am also happy to make known that our university has been organizing symposia regularly during the past. This conference offers a unique opportunity for scientists to present their research findings and discuss latest research in four thematic areas: Agri and Food Business, Animal Bio-resource Management and Food Technology, Agro-environmental Resource Management, and Crop Improvement and Production Technologies.

Sabaragamuwa University of Sri Lanka dedicated to its mission to nurture scholars by advancing knowledge and imparting it on new generations of students. At the attempt to be an internationally acclaimed centre of excellence in higher learning, our university strives to search for and disseminate knowledge, promote learning, research and training to produce professionals who are rich in knowledge, skills and right attitudes. This conference is a culmination of such academic attempts and I believe that it will provide an ideal forum for creating new knowledge through exchange of research ideas and outcomes among researchers from Sri Lanka and other countries. This conference will enable the delegates to make valuable networks among like-minded professionals who are working on challenging research projects.

I would like to express my thanks and appreciation to Dr HSR Rosairo; the Chairman and Dr HAD Ruwandeepika; the Coordinator of the conference, Dean and Heads of Departments of the Faculty of Agricultural Sciences, conference organizing committees, all the staff and students for their great effort in making this event successful.

I wish everyone a satisfying experience at this conference and a remarkably enjoyable stay in Belihuloya.

***Professor Mahinda S. Rupasinghe***  
Vice Chancellor  
Sabaragamuwa University of Sri Lanka



## MESSAGE FROM THE DEAN

It is a great pleasure and privilege for me to release this message as the Dean of the faculty on the occasion of 1<sup>st</sup> International Conference on Agricultural Sciences to be held on 9<sup>th</sup> & 10<sup>th</sup> January 2014 at the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka. This will be an another great milestone of the faculty by organizing such an international scientific forum making opportunity to undergraduates, academics and researchers to present their latest research findings in Agricultural Sciences, share the knowledge and experiences and interact with the experts in their relevant fields. I consider this will be a precious opportunity for our undergraduates, which gives them a confidence to enter into the research culture and enhancing the interest on exploring the universe of Agriculture.

In 2007 we held 1<sup>st</sup> symposium accommodating only for national researchers but this time we were successfully able to expand our horizon to the international community. That was our enormous achievement showing the unity of academics, non academics and students' of the faculty and the capability to organize such a massive forum. In the future, we expect to continue this academic gathering once in two years and welcome your novel findings in agriculture and allied fields to share with us.

Organizing an International Conference is not an easy task amidst the other ongoing academic activities in a University. As the Dean of the Faculty, I congratulate and appreciate the Chairman of the AgInsight – 2014 Dr. H.S.R. Rosairo and his team, referees and editors for their untiring effort to make this a grand success. I also take this opportunity to express my sincere gratitude to the sponsors and contributors to make this event a remarkable.

***Dr. Asanga D. Ampitiyawatta***

Dean

Faculty of Agricultural Sciences

Sabaragamuwa University of Sri Lanka

## MESSAGE FROM THE CHAIRMAN OF THE CONFERENCE SECRETARIAT

It is a great privilege to invite you to the International Conference of Agricultural Sciences 2014 held at the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka. It is with great pleasure to announce that the faculty organized its second conference as an international event. This year's conference endures the theme "Perspectives for Contemporary Agriculture: Challenges and Future Directions".

We believe that this conference offers a great opportunity for academics, researchers and students to present their research findings and discuss about their latest research in four thematic areas: Agri and Food Business, Animal Bio-resource Management and Food Technology, Agro-environmental Resource Management, and Crop Improvement and Production Technologies. This conference will also facilitate networking among scientists and the development of multidisciplinary and collaborative research. Interrelationships among institutions could also provide opportunities for young scientists. Abstracts presented have been selected through a strict editorial procedure and we sincerely thank all the researchers who submitted their abstracts for consideration. We would like to extend our thanks to the editorial board and the panel of reviewers for their meticulous work. Our sincere thanks also go to the chairmen/chairpersons for their professional input in the technical forums and our sponsors for their support.

We wish to thank the Vice Chancellor, Prof Mahinda S. Rupasinghe who always encourages us, the Dean of the faculty, Dr Asanga Ampitiyawatta for all his support and valuable comments and Dr Darshanee Ruwandeepika, the Coordinator of the conference for all her support. Our sincere thanks are also extended to the entire staff of the Faculty of Agricultural Sciences, the Registrar, Acting Bursar and all the administrative staff of the university for assistance in organizing this event. We also wish to thank all the students of the Faculty of Agricultural Sciences for their excellent support to make this event a success. We are extremely grateful to Professor Ranjith Senaratne, Vice Chairman of the University Grants Commission, Sri Lanka for accepting our invitation to be the Chief Guest of the conference, and Professor Sue Walker, the Research Theme Leader – Agrometeorology and Ecophysiology at the University of Nottingham Malaysia Campus for delivering the keynote address.

We wish everyone a satisfying experience at this conference.

***Dr. H S R Rosairo***

Chairman

International Conference of Agricultural Sciences 2014 – AgInsight 2014

Faculty of Agricultural Sciences

Sabaragamuwa University of Sri Lanka

## KEYNOTE ADDRESS OF THE INAUGURAL SESSION

### **Community Agromet Participatory Extension Service to Help Cope with Climate Change and Variability**

**Prof. Sue Walker**

*Crops for the Future Research Centre, University of Nottingham Malaysia Campus,  
Jalan Broga, Semenyih, Selangor, Malaysia and Department of Soil, Crop and Climate Sciences,  
University of the Free State, Bloemfontein, South Africa*

As all agricultural activities are affected by the weather and climate, it is important that this type of information is made available to farmers, despite the fact that they have a wealth of indigenous or local knowledge for making decisions about farming activities. Agrometeorologists have a crucial role to play in developing farmers friendly services to adapt and cope with climate change and variability. However, there are a number of barriers to overcome in addressing this task – including the fact that most weather and climate information use technical terms, are designed by the meteorological services and thus are difficult for the users to understand and apply. This paper considers the development of agrometeorological extension services, with examples from southern Africa, driven by the community need for information and applications. Agromet services are applications of weather and climate information in a practical way to meet farmers and other users' needs by addressing seasonal and operational planning by utilizing the available climate data and a range of analyses. Three levels of coping strategies are addressed namely operational, tactical and strategic. Agromet services for operational level decisions relate to daily or weekly short-term activities identified by weather sensitive on-farm operations and alternative interventions for which tailor-made forecasts can be developed. Tactical decisions are those taken when planning for the upcoming growing season and can be assisted by good seasonal outlooks to support wise decisions such as type of tillage, crop and cultivar choice, planting dates and rainwater harvesting. These first two categories are best developed in conjunction with the communities concerned in order to meet their felt needs. The strategic strategies are mainly for long-term planning by governments, such as developments of dams or selection of breeding lines or promoting alternative climate adapted crops. Crop-climate models can be useful when considering such decisions as crop production under long-term climate datasets (both past and GCM predicted) can be compared and used to develop advisories. Although a range of weather and climate forecasts are routinely available from National Meteorological Services, they seldom have added value to specifically address agricultural operations. Therefore, Agromet advisories need to be developed together with communities to address their operational and planning needs and then run routinely as agromet services. Crop-climate modelling is used to add value to

medium-term forecasts and seasonal climate outlooks using risk analysis from long-term climate data and GCM climate change scenarios. Information needs to be developed about alternative farming systems, including underutilised crop together with farming communities, to assess the acceptability and sustainability. Agrometeorologists can provide valuable information to add to currently available weather climate services to help farmers cope with climate change and variability.

**Keywords:** *agricultural meteorology services, operational decisions, weather forecasts, crop-climate modelling, southern Africa.*

**Corresponding author:** sue.walker@cffresearch.org

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**ORAL PRESENTATIONS**  
**AGRI AND FOOD-BUSINESS**

## INVITED PRESENTATION

### FIRMS' REALIZATION OF THEIR EXPECTATIONS OF ADOPTING FOOD SAFETY AND QUALITY METASYSTEMS: "FINAL CALL FOR AN EXTENSIVE ECONOMIC ASSESSMENT"

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Parallel to the reforms of public food safety regulations, both locally and globally, private enterprises themselves are working on advanced food safety metasystems such as HACCP and ISO 22000 in response to the demands of market and/or internal economic and management pressures. The decisions made by agri-food processing firms in this respect, however, depend on the perceptions of its management on internal costs and benefits associated with adoption versus non-adoption of such controls as well as the potential for improvements in industrial performance, for example market share, profitability etc. This, in turn, will reflect characteristics of the firm, its objectives, types of products the firm manufactures, and the environment in which firm operates. However, the same firm tends to evaluate, *ex-post*, whether those intended benefits of adoption have been realized against its *ex-ante* expectations. This evaluation and subsequent judgments are critical factors that will influence the firm's decision on whether to continue with the certification in the future. In light of this, it is of paramount importance to investigate empirically, the extent to which those agri-food processing firms involved with processing meat, fish, dairy, fruits and vegetables etc. in Sri Lanka have "*realized*" (i.e. firm's post-adoption experience) those "*intended*" (i.e. pre-adoption expectations) benefits upon having a food safety and quality metasystem such as HACCP in place. The lessons learnt from such empirical economic assessments will directly assist both industrialists and policy planners to identify and work on the "most realized expectations", the gaps between realizations and expectations, and in turn, use which to design an incentive-based regulatory framework for the Sri Lankan food processing sector in order to minimize potential failures in the market and policy.

**Keywords:** *agri-food businesses, economic incentives, food safety and quality, HACCP, regulation*

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## INVITED PRESENTATION

### AGRO TOURISM AS A COMPENSATING INCOME SOURCE TO THE RURAL AGRO ENTERPRISES

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Low farm gate prices of agricultural commodities along with rising input costs such as seeds & planting materials, fertilizer, agro chemicals and labour charges, etc are gradually increasing the cost of production of agriculture produce and subsequently decrease the profit margins of especially in the medium and small scale farms. Further, forces such as globalization, world trade agreement, agricultural policies in developed countries and bilateral & multilateral trade agreements are threatening small and medium scale farms in developing countries like Sri Lanka. As a result, especially young generation of farmer families are leaving their farms altogether in order to sustain their household incomes. In many regions in the world both developed and developing countries, farmers are recognizing the need and desire to diversifying their farm products and services in order to supplement their agricultural incomes. Therefore it is indispensable to introduce compensating income sources to enhance the profit margins of farming substantially, without further delays. Travel and tourism are big businesses across the world. Hence, a hybrid concept that merges elements of two complex industries “travel/tourism and agriculture” can be introduced to the medium and small farming sector/community to open up new profitable markets for their farm products and services. Agro tourism is the practice of attracting travelers and visitors to an area or areas used primarily for agricultural purposes. It is a subset of a larger industry of tourism. Agro-tourism is defined as “a commercial enterprise at a working farm, ranch, or agricultural plant conducted for the enjoyment of visitors that generates supplemental income for the owner”. Many agro tourism activities require only a small farm crew in order to be successful. For instance, farm tours, bed and breakfasts, pony rides, u pickups, petting zoos, and many other activities may be operated with little additional investment in physical and human resources in an existing farm. Finally, it can be concluded that agro tourism is a successful compensating income source to rural agro enterprises both in developed and developing countries.

**Keywords:** *agro tourism, compensating income source, agro enterprises*

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## PRELIMINARY RESULTS OF A THEMATIC ANALYSIS OF ONLINE AND MOBILE PHONE-BASED AGRICULTURAL INFORMATION SERVICES

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Their capacity to deliver information over distance and ability to facilitate interactive communication has meant that the role of online or mobile phone-based information services can play an important role in agricultural extension and rural development has long been recognised. This is reflected in the presence of numerous online and phone based agricultural information platforms and a significant literature on the subject. In this context, the development of effective tools to analyse such services is important if lessons are to be extracted concerning best practice in designing and delivering such services. While there has been considerable discussion concerning these questions, much of this literature has focussed on the development of research approaches which focus on the impact of these new technologies themselves. Less attention has been paid to analyze the content of these sites, thus a question arises concerning how, and to what extent, an examination of the content of such sites may have the capacity to inform us concerning the way in which they are currently designed and operated. The research is attempting to address this issue, by developing a framework for undertaking a qualitative content analysis of Information and Communication Technology (ICT) services and having done so, testing that approach through an examination of information provided online about such information services. The research employed a grounded theory approach to collect and analyse data. Data was gathered by reference to existing literature and internet searches employing relevant keywords. Sampled web pages were used to populate a database and content was analysed using NVIVO 10 in order to determine notable patterns and trends. Key findings of the research include the existence of significant discrepancies between the key issues, such services claimed to address and the services provided. It also reveals the retention of a top down approach to service delivery and a focus on agricultural extension.

**Keywords:** *extension, eAgriculture, agricultural information, ICT, decision support*

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## AN INVESTIGATION ON MANAGEMENT PERCEPTIONS OVER THE TRIPLE BOTTOM LINE (TBL) CONCEPT: A STUDY IN THE TEA PLANTATIONS INDUSTRY OF SRI LANKA

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Despite the growing international interest in this area, few empirical studies have been done from a Sri-Lankan tea plantations perspective. Considering this, a study was carried out with the principle objective of *identifying the associations among the independent variables: Awareness, Attitudes, Applications Knowledge on the dependent variable management perception over TBL concept and examining if Government intervention plays a moderating role between independent and dependent variables*. Research follows a deductive approach and predominantly a quantitative study. Population entails managers in the tea industry of the country overall. Data was collected from a total sample of 100 managers including 5 Regional Plantation Companies (10 each), 15 smallholders, 20 related institution managers and 15 industry professionals. The paper explores each dimension of the TBL concept separately (i.e., profit/planet/people). Results demonstrate *awareness* was significantly correlated with *perception people* plus *perception planet*. *Attitudes* were significantly correlated with *perception profitability* while *applications knowledge* was significantly correlated with *perception profitability* and *perception people*. *Government intervention* modified relationships between “Awareness and Perception People” (*interaction significance=0.001*) also “Attitudes and Perception Profitability” (*interaction significance=0.024*). Further, impact of independent variables on TBL approach differed among the target groups. Applications knowledge of the concept was lower across all categories. The conclusion noted that; associations differed depending on the dimension of the concept, portraying that TBL approach towards sustainability has to be conceptually based, with simplifications for practical application. Furthermore, suggesting government’s moderation towards TBL initiatives in the industry unsatisfactory. Since less knowledge exists from a Sri-Lankan plantations perspective, findings of this research will provide the ‘first-step’ in an unexplored area of Sri-Lankan academia. Key recommendations emphasize the importance of communication/positive perception of top management towards TBL approach, where government aid is mandatory in developing/retaining positive attitudes on managers/employees and surrounding communities.

**Keywords:** Sustainability, TBL, Tea Plantations Industry, Management Perception

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**IMPORTANCE OF UNDERUTILISED CROPS: A CASE STUDY IN  
MONARAGALA DISTRICT OF SRI LANKA**

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Today there is an increasing interest in underutilised or neglected crop species all over the world due to their importance for human beings as well as for the climate resilience. Underutilised crops are those species with under exploited potential for contributing to the food security, human health (especially nutritional and medicinal values), income generation and environmental services. Although Sri Lanka is an agricultural country, today there is no considerable level of awareness among the citizens about the importance of underutilised crops. Therefore, this research was conducted to study the importance of underutilised crops from the farmers' point of view. This study was carried out in Thanamalwila DS division of Monaragala District during January-October 2012. Two stage sampling technique was used to select the respondents. Data was collected from 120 farmers cultivating underutilised crop through a field survey with the help of a questionnaire. Furthermore, five group discussions were also conducted to collect in-depth information. Data was analyzed using MS Excel and MINITAB software. The result of the study revealed that a significant number of underutilised crop species are being cultivated by the farmers in the study area in small-scale mainly for the home consumption. However, Kurakkan, Meneri and Thala are cultivated for commercial purpose in chena lands. According to the farmers, the main goals of cultivation of underutilised crops are to contribute to the food requirement of the family, find extra income for the family and to use them as herbals for simple health disorders of family members and neighbors. When the attitudes of the farmers towards underutilised crops are taken into consideration, it is clear that they have positive attitude about some factors of underutilised crops such as economic benefits of cultivating underutilised crops, medicinal and nutritional values, the low cost of cultivation, less water requirements, less pests and disease problems. However, farmers have neither agreed nor disagreed upon three macro level importance of underutilised crops namely, contributing to the biodiversity, environmental protection and tolerance to climate changes.

**Keywords:** *underutilised crops, food security, biodiversity, environmental protection*

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## IMPACT OF BUSINESS PROCESS REENGINEERING (BPR) ON HUMAN CAPITAL PERFORMANCE: A CASE OF EXPORT PROCESSING INDUSTRY

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This research emphasizes how the Business Process Reengineering (BPR) impact on human capital performance of the organization. Principal focus of the study was to investigating the impact of BPR on human factor development. Knowledge and awareness, employee competencies, team work, attitudes towards change, knowledge dissemination, feedback, compensation and rewards, training and development, impact on personal life were treated as inputs for investigate the BPR impact on human factor development. Production departments of surf kite and windsurfing sail were selected using stratified sampling technique and the employees were selected by simple random sampling technique. Results of the human capital performance revealed that, BPR has a significant impact on knowledge and awareness, employee competencies, team work, compensation and rewards, knowledge dissemination and feedback of the individuals in the organization. But there was no significant impact of BPR on positive attitudes of the employees of the organization. Further, research revealed that only in windsurfing sail department, BPR has a significant impact on personal lives of the employees.

**Keywords:** *business process reengineering, human factor development, organizational performance*

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## ROLE OF REGULATION FOR SOLID WASTE MANAGEMENT IN AGRI-FOOD PROCESSING FIRMS IN SRI LANKA: A DISCRIMINANT ANALYSIS BASED ON PANEL DATA

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The purpose of this study was to examine extent to which the regulatory framework on environment in Sri Lanka triggers the private actions of agri-food processing firms towards adoption of solid waste management practices (SWMPs) recommended by the Ministry of Environment, where an emphasis was paid to examine the perceptual and behavioral changes occurred in the system over time using panel data. The data collected from a cross section of firms (n=146) operating in the Central, North-Western, Southern and Western provinces by means of a personal interview with environmental quality assurance manager/owner of the firm, supported by a structured questionnaire, during January to April 2013 (Stage II) were matched with corresponding data collected three years earlier, i.e. in 2010 (Stage I) from the same set of firms. An aggregate index, namely Environment Regulation Responsiveness Index (ERRI) derived to reflect the relative strength of a firm's perception on environmental regulation (i.e. 0 the "least" to 1 the "most" responsive) was taken up with Discriminant Analysis techniques to assess the relative importance of three facets of regulation, including: (1) existing regulation; (2) anticipated regulation, and (3) judicial/liability laws to differentiate "adopter" from a "non-adopter" of three SWMPs, including: 3R-system, Composting, and Good Manufacturing Practices (GMP). The outcome of analysis suggests that there is no significant change in the perception overtime, which is also evident by the low magnitude of ERRI (i.e. less than 0.5). Anticipated regulation was the most important incentive motivating adoption, while influence of judiciary was the least important implying that more localized, monitored, and futuristic regulatory strategies are needed to govern firms' environmental compliance.

**Keywords:** *agri-food processing sector, discriminant analysis, environmental regulation, solid waste management*

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## AN INVESTIGATION OF HUMAN RESOURCE MANAGEMENT PRACTICES AND ISSUES OF THE SMALL AND MEDIUM EXPORT PROCESSING FIRMS

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Proficient management of employees and their contribution to export processing business (EPB) is commonly accepted as contributing to Sri Lanka's future prosperity. The success of attempts to attract and select staff, as well as retain them, can be crucial to the success of manufacturing businesses in rural and regional areas. Principal focus of the study was to understand the variables and dynamics of employee recruitment, selection and retention process. The present study was mainly based on primary data and the principle data collection tools were interviewer administered pre tested structured questionnaires, focus group interviews and key informant interviews. Fourty export processing firms were selected using the simple random sample. Key analytical tool was the exploratory factor analysis in the form of principle component analysis. Seven constructs were identified for the further analysis. Research revealed that around half of the Sri Lankan export processing businesses utilize formal Human Resource Management (HRM) practices and about 49% employ a person to specifically look after Human Resource Management needs. Thus, it was also reported that Export Processing Businesses with a demographic trading type of 'Company Ltd.' utilized all of the characteristic constructs of Human Resource Planning practices. Sign in Shop/Business Front was the most valued method of recruitment while salary/wages package able to offer was the most important issues impacting on employee recruitment. Completing an application form was the most popular selection method and the most important strategy identified by Sri Lankan Export Processing Businesses in terms of retaining staff was financial benefits offered by the company.

**Keywords:** *export processing, recruitment, selection, retention*

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**FACTORS INFLUENCING THE ADOPTION OF FERTILIZER RECOMMENDATIONS  
IN THE TEA SMALLHOLDING SUB SECTOR IN SRI LANKA:  
A CASE STUDY IN THE MATARA DISTRICT**

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Tea smallholders in Sri Lanka make a significant contribution to the tea sector by accounting for 76% of the national tea production. However, during the past few years the growth of the tea smallholding sub sector has been sluggish, despite the fertilizer subsidy scheme in place since 2008. In this context, this study makes an attempt to analyse the fertiliser application pattern of the tea smallholders and its impact on green leaf productivity. For this purpose, a case study was conducted in the Matara district, which is a predominantly tea producing district in the country with a significant number of tea smallholders. The study used both primary and secondary data. Primary data was collected using a pre-tested interviewer administered structured questionnaire. The sample consisted of 120 tea smallholders selected from 17 GN divisions of the Pasgoda DS division using stratified simple random sampling technique. Descriptive statistics, cross tabulation chi-squared test and pooled t-test were used to analyze the data. The study revealed that the smallholders' most preferred method of determining fertilizer dosage was their own experience. Farmers mainly relied on neighbors as a source for fertilizer related information. Factors such as age of the smallholder, education level, extent of the tea land, plant density, fertilizer application frequency and participation in advisory services had statistically significant relationships with the propensity to adopt the recommended fertilizer dosage. The study revealed a strong relationship between the application of recommended fertilizer dosage and green leaf productivity. The study also revealed that the majority were not following the recommended dosage, instead applied excess fertilizer due to the availability of fertilizer at a subsidized price. Therefore, this study highlights the need for more research for better understanding of the impact of the fertilizer subsidy scheme on tea smallholders' productivity.

**Keywords:** *tea smallholders, fertilizer usage, green leaf productivity, fertilizer subsidy scheme.*

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## IMPACT OF SOCIOECONOMIC FACTORS ON SMALL HOLDER BLACK PEPPER PRODUCTION IN KURUNEGALA DISTRICT: ROBUST REGRESSION APPROACH

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Even though black pepper production in Sri Lanka contributes about four percent to the annual world production, black pepper cultivation in Sri Lanka has succumbed to a variety of issues and challenges relating to productivity, marketing, cultivation technology and institutional related constraints. This study was designed with the objectives of identifying the socio economic factors related with black pepper production and to examine the constraints which lead to unsustainability of the system in the Kurunegala district. Multi-stage sampling was used to select 57 small scale farmers in Kurunegala district. A pre-tested questionnaire was used to collect data related to socio-economic background, marketing methods and constraints related with black pepper production. As per the several numbers of outliers in the data set, Robust Regression analysis was carried out, since it is not as vulnerable as Least-Squares to unusual data. M-estimation of Robust Regression was applied to determine the relationship between productivity and socio economic factors. Results revealed that the productivity is significantly affected by farmer's age, pepper farming experience, management level and the value of the subsidy given by Department of Export Agriculture. Further, the constraint analysis revealed that lack of government subsidies, high cost of agro-chemicals and labor, poor marketing linkages and unfavorable weather at processing were the main constraints of the black pepper cultivation.

**Keywords:** *black pepper, constraints, robust regression, socioeconomic factors*

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**FACTORS AFFECTING THE PROFIT LEVEL OF MAIZE PRODUCTION  
IN SIYAMBALANDUWA AREA IN SRI LANKA**

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Maize is one of the most important cereal crops in Sri Lanka. Due to rapid expansion of the livestock industry within the last few years, the demand for maize has increased substantially in Sri Lanka. This study was conducted to study the factors affecting on low profit level of maize production in Siyambalanduwa area in Monaragala district in Sri Lanka. Data for the study were collected using structured questionnaire with face to face interview with farmers who cultivate in the Maha season 2012/2013. Seventy five farmers were selected using two stage probability sampling techniques and data were analyzed using descriptive statistics. Results showed that there are several constraints which affect to increase maize production such as cost of production, financial problems, marketing problems and labour shortage problems accordingly. The results revealed that total cost of maize cultivation by farmers was estimated at an average of Rs 62,789 per acre. Total return of the cultivation by farmers was revealed at an average of Rs 66,573 per acre and profit level was Rs 3517 per acre. According to the results of the study important factors affecting for the profit level were cost of production, selling price, fertilizer application, financial facilities, weather condition and farmer awareness of maize cultivation. The result also revealed that majority of farmers sell mature maize. Further, majority of the farmers in this area use local fair and village trader to sell their immature maize.

**Keywords:** *maize production, maize farmers in Sri Lanka. return from maize. maize markets.*

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**FARMERS' ATTITUDES ON PADDY MONO-CROPPING AND PROBLEMS ENCOUNTERED:  
A CASE STUDY IN DEHIATTAKANDIYA DIVISIONAL SECRETARIAT**

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The main purpose of the study was to assess the farmers' attitudes on paddy cultivation as a mono-crop and problem encountered due to paddy mono-cropping. Specific objectives were to investigate the paddy as a mono crop in Dehiattakandhiya divisional secretariat, factors affecting for farmers' motivation towards paddy mono cropping, attitudes on problems faced by famers and to evaluate capability of overcoming those problems. Data were collected from randomly selected 100 farmers in four GN divisions in Dehiattakandiya divisional secretariat using pre-tested interviewer administrated questionnaire. Majority of the respondents were old-aged male farmers having primary education level, low participation in training programme and long years of farming experience. The findings revealed that age, farmers' education, easy harvesting, less awareness of technology on other crops, less labour requirement, muddy soil condition, no hard practices during entire season and knowledge on paddy farming had a significant effect in motivation of farmers towards paddy mono-culture. Nevertheless, gender, family size, farming experience, satisfaction of credit facilities, and easy applicability of farm machinery and availability of input had no significant effect. Furthermore, findings revealed that, increasing crop vulnerability to insect and microorganism, damaging the soil ecology, more infestation of diseases, reducing the production, decreasing the quantity of beneficial organism and useful insects, reducing the biodiversity, increasing water pollution, lack of pure water level, high cost of production, reducing the market price, conflict between farmers for irrigation facilities, reducing the role of women in farming activities and bounding farmers to be unemployed several months were the problems arising due to paddy mono-cropping system. Farmers thought that paddy mono cropping is an economically inefficient system because of farmers' inability to get satisfactory harvest and profit due to problems arising from paddy mono cropping and continuous decreasing of the yield and their economic condition. Although paddy monoculture has created huge problems, farmers are interested to adopt it because it is the staple food crop, and bring more benefits than other competing crops and favourable alternative.

**Keywords:** *farmer attitudes, problems of, paddy mono-cropping*

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## INVESTIGATION OF THE APPLICATION OF PROPER SAMPLING TECHNIQUES IN PHYSIOTHERAPY STUDIES

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Sample design is the definite plan determined before any data are collected for obtaining a sample from a given population by the researcher. If the sampling technique is not appropriate, there is a risk of misinterpreting findings due to inappropriate, unrepresentative and biased samples. The aim of this study is to investigate whether the proper sampling techniques has been adopted in physiotherapy studies published. Twelve international full research articles published in English were selected for the study. Number of studies reviewed was not pre-decided and due to the time constraint review has included only 12 studies. Each article was then critically evaluated for its sampling technique. A checklist is made in order to verify the applicability of sampling techniques in the question in particular and in the field sample survey in general. Results indicated that the majority of the articles reviewed have not strictly adhered to the proper sampling technique. Awareness of researchers in the field of physiotherapy both at undergraduate and postgraduate levels is recommended. Further, at the initial stages of the research, researchers must concentrate on sampling techniques which they are going to use for their study. Journal editors, reviewers and other responsible personnel have to pay strict attention on the sampling technique used in the research before recommendation for publishing.

**Keywords:** *sampling techniques, physiotherapy studies, simple random sampling, stratified random sampling*

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**SOCIO ECONOMIC AND GEOGRAPHICAL EFFECTIVENESS OF DIVI NEGUMA REGIONAL  
DEVELOPMENT PROGRAM (SPECIAL REFERENCE TO BALANGODA, SRI LANKA)**

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Regional development is a strategy used to achieve development in any country. As a developing country, Sri Lanka implements several rural and regional development programs to increase the quality of life of people and growth of economy of country. *Divi Neguma* is one of the programs recently introduced by the government. This study mainly focused to identify the socio economic and geographical effectiveness of this program with special reference to Balangoda Divisional Secretariat in Rathnapura district. A survey was carried out to obtain primary data through a questionnaire, choosing a sample of 200 *divi naguma* beneficiaries in three selected Gama Niladari using purposive random sampling in Pettigala, Thumbagoda and Ampitiyawatta to represent urban, rural and estate sector respectively. Descriptive analysis including Self Sufficient Ratio and SWOT analysis were used. The study concluded that the total Self Sufficient Ratio was 19.8 percent and for urban, rural and estate sector was 16.2 percent 27.33 percent and 21.9 percent respectively. Therefore, it can be concluded that the self sufficiency of food conditions for households in rural and estate sectors are better than of urban households. The program has not identified the feasibility of the lands for distribution of crops and target groups. The program operates all round the area without focusing certain target group and it reduces the probability of success of the program. Further lack of the guidance and feed back is a weakness identified by the study. Further it can be developed as an extra income generating activity for unemployed especially in youth, house wives and economically inactive persons. The lack of knowledge of cultivation, contribution by the community due to competitive life style especially in urban area leads to reduce the efficiency and productivity of the *Divi naguma*. Reduction of household food expenditure, empowering the persons, developing as a leisure activity and achieving the self sufficiency are identified as strengths of this program.

**Keywords:** *community development, self sufficient ratio, divi neguma*

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**IMPACT OF SUPERVISOR'S GENDER ON ORGANIZATIONAL GOVERNANCE:  
A CASE OF EXPORT PROCESSING INDUSTRY IN SRI LANKA**

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Governance is the one of the most crucial factor which shapes the organization. Smooth governance caters high employee productivity. Supervisors are the immediate governors on down line employees and they have close relationship than the others. Relationship between supervisor and subordinate is critical component to the organization. This research investigates the gender impact of supervisors on supervisor-subordinate relationship. Research methodology was launched to achieve the broad objective; impact of Supervisors' gender on organization governance and specific objective which includes: the impact of supervisor's gender on supervisor-subordinate relationship. Stratified random sampling technique was used to select both supervisors and their subordinates. Thirty supervisors and 120 subordinates were participated in the study. The sample comprised with equal numbers in both sexes to maintain the gender balance. Subordinate's preference on Supervisors' governance was measured using eight factors. Careering and kindness of supervisor, emotional stability on decision making, prior identification of conflict situation and provide solutions to avoid, supporting behavior of supervisor, flexibility, personality, leadership and problem management were used to measure the strength of the relationship. The study revealed that, male subordinates were closer to male supervisors than the female supervisors on governance issues while female subordinates were maintain closer relationships with female supervisors than the male supervisors. Supervisor-Subordinates relationship was measured using five factors; co-cooperativeness and supportive behavior of supervisor, fairness, dignity and receptiveness of the supervisor, closeness of personal life of subordinator, establish and maintaining a good working relationship and productive rapport with employees. Results highlighted that strongest relationship exists between female subordinates and male supervisors. The relationship between male subordinates and female supervisors was weak.

**Keywords:** *supervisors' gender, organizational governance, supervisor-subordinate relationship*

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**WOMEN PERCEPTION ON PARTICIPATING IN URBAN AGRICULTURE:  
A CASE STUDY FROM SRI LANKA**

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Urban agriculture has been identified as one of the strategies to overcome the urban poverty and malnutrition while ensuring the food security. This incredible ability of urban agriculture on addressing burning global issues has made it one of the most vital discussion topics among experts in the field. The role of women is crucial in urban agriculture due to their contribution towards the urban food production at both household level and market economies at large. Nevertheless, the women participation in urban agriculture is significantly poor due to variances in the effect of socio-economic factors and diverse perceptions on urban agriculture among urban women farmers and urban women non-farmers. In view of investigating this issue, non-parametric Mann-Whitney test, multivariate factor analysis and cross tabulation tests were used on primary data which were collected by means of face to face interviews guided by a structured questionnaire. Stratified random sampling was used as the sampling technique. The results of the study confirm a significant difference in the perceptions of the two women groups. Moreover, the identified prominent external factors which affect the perception on urban agriculture are the differences in the levels of awareness about urban agriculture and the strong negative societal perception that the agriculture in urban areas is not productive. The results further reveal that the most influential socio-economic factors affecting the women perception in urban agriculture are age, level of education, number of members in the family and the total cultivable area. The findings of the study generate some important knowledge for policy making and strategic planning from micro level of household degree up to the macro level of aggregate economy.

**Keywords:** *urban agriculture, women, perception, socio-economic factors.*

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## THE PROBLEMS AND THE CHALLENGES FOR FARMERS TO USE THE MODERN MACHINERY FOR HARVESTING

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A great support can be acquired when farmers use modern technological skills in production of food for feeding the increasing population. The efficiency of harvesting can be increased through modern machinery systems. But, under the competitive commercial agriculture, the farmer has to face many difficulties in using modern technological skills. Such problems can be seen among the farmers in Kantale farming villages. A survey was conducted among 50 randomly selected farmers in Kanthale to collect data. The main objective of this survey was to identify the problems that the farmers have to face in using the modern machinery systems to harvest their crops. The co-objective was to find out the wastage during the harvesting by using these modern machinery. The primary field data were collected individually and the secondary data were received from the agricultural related institutions in the area. Statistical and non-statistical methods were used to analyze data. The main outcome of this survey can be summarized as harvesting wastage in using modern machinery, the soil of the paddy-fields become poor, a rapid growth of weeds which is not suitable for paddy cultivation and (a low demand for paddy as there is much moisture. To minimize the wastage during the harvesting, some programs have been implemented by the owners of the modern machines.

**Keywords:** *farmers, machinery, harvesting, problems*

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## CONSUMER PERCEPTION ON LABELING OF POULTRY PRODUCT IN THE BUYING PROCESS

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Vast amount of poultry product categories are available in the market and consumers face a problem on which criteria that they should rely on when purchasing a particular poultry product. "Label" is one of the available important criteria that helps consumer to ease their risk and reassure about the product that they are going to purchase. This paper examines the importance of use of labels in poultry products, such as meat balls, sausages, whole chicken and chicken parts in consumer decision making in buying process. Through an empirical study with a sample of 80 consumers determine the awareness and the perception towards the labels and the impact of label perception on the consumer's purchasing decision making of poultry products related to the Sri Lankan context. The sample was selected by using multistage sampling technique from Homagama divisional secretarial area. The results reveals that socio demographic factors such as age and education have a moderating effect on the label perception and they look at the label because for them it is a kind of an assurance to find information about the particular poultry product. Consumers are more concerned about the date of expire and manufacture that appears in the label than other information. Understanding consumer knowledge and their perception towards the label is decisive for the marketers to sustain in the high competitive market. Further it is identified by this study that the label remains a genuine tool of consumer motivation, a mirror that reflects the image of the company and a provide reasons for accounting high prices for products.

**Keywords:** *quality labels, poultry product, label perception, purchase intention, moderating effect*

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## STUDY ON THE NUTRITIONAL STATUS OF SECONDARY SCHOOL CHILDREN IN KARAVEDDY DIVISIONAL SECRETARIAT OF JAFFNA DISTRICT

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The nutrition and health of school-age children has been one of the concerns of the Government of Sri Lanka since its independence. Restructuring of the health programmes through school system was highlighted as a need. A nutrition survey was necessary to measure the extent and severity of under nutrition among children. This study was carried out with the objectives of identifying the current nutritional status of secondary school children in Karaveddy Divisional Secretariat between the age group of 11-12 years, identify the contributing factors to the poor nutritional status of school children and to find out the relationship between nutritional status and socio economic factors in Karaveddy Divisional Secretariat of Jaffna District. A cross-sectional rapid assessment was carried out within the study area using 300 school children aged 11-12 years from 25 randomly selected schools. Child's dietary and socio economic information were collected using pre-tested questionnaire and the height and the weight of the children were measured by using standard techniques. Of the study group 65 % were stunted, 61 % were wasted and 80 % were in the underweight category. There was a highly significant negative correlation ( $r = -0.902$ ) between monthly income and stunting percentage. Further, there was a significant positive correlation between family size and wasting percentage ( $r = 0.929$ ). The father's educational statuses were significantly associated with stunting ( $r = -0.809$ ) and wasting ( $r = -0.807$ ). Similarly, there were significant negative correlations between mothers' educational level and stunting percentages ( $r = -0.859$ ) and wasting percentages ( $r = -0.877$ ). To overcome these kinds of nutritional problems multitude factors including poor educational level of parents, consuming improper nutritious foods, poor water quality, poverty, and frequent infectious diseases should be concerned and corrected.

**Keywords:** *malnutrition, nutritional status, stunting, wasting*

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## IMPACT OF KNOWLEDGE MANAGEMENT ON PRODUCT INNOVATION: CASE OF DAIRY FOOD PROCESSING SECTOR IN COLOMBO AND KURUNEGALA DISTRICTS

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At present the dairy food processing sector in Sri Lanka is growing at an increasing rate continuously. In that, as a mode of reaping superior dairy firm performances Knowledge Management (KM) practices and Product Innovation (PI) are the major strategies need to be improved. The purpose of this study was to identify the KM practices in product innovations within the dairy food processing sector in Sri Lanka. Data were collected from top level management in forty one dairy food processing firms in Colombo and Kurunegala districts in Sri Lanka by using a pre tested questionnaire. The questionnaire consisted of forty questions which were mainly related to KM practices, product innovations and firm performances. KM was assessed on five major dimensions; knowledge generation, knowledge application, knowledge improvement, knowledge storage and knowledge share. Innovations were assessed on “New to the market”, “New to the firm” and “Improve or revise existing product” during the period from year 2009 to 2013. Pearson correlation technique was employed to identify the correlation among knowledge management, innovation and firm performances. Results show that among the KM practices, knowledge application, knowledge sharing and knowledge storage are strongly and positively relates to innovations and innovations positively relate to firms performances. The study strongly suggests that KM practices should effectively be adapted to improve innovations in dairy food processing sector to reach sustainable superior firm performances in future.

**Keywords:** *dairy firm performances, innovation, knowledge management*

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**FARMERS' SATISFACTION WITH DAIRY CATTLE FARMING AS A LIVELIHOOD SOURCE:  
CASE STUDIES IN BALANGODA AND KALTOTA VETERINARY DIVISIONS IN THE  
RATHNAPURA DISTRICT**

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Dairy cattle farming is one of the important agricultural activity among farmers in Sri Lanka because it's significant contribution towards poverty alleviation, self-employment, nutritional enhancement and agricultural resource development. Job satisfaction is the degree to which people like their jobs. Research has shown that there are important interactions between types of workplace structures and the kinds of subjective rewards that workers obtain as well as of the levels of satisfaction. The employment of farmers in the dairy cattle farming in Balangoda and Kaltota was investigated by using two stage cluster sampling method. There were 265 dairy cattle farmers in this population that represents 170 from Balangoda and rest from Kaltota. The sample size of 50 farmers has been chosen from two divisions and data on the demographic, educational, employment status, and income characteristics were collected through a questionnaire by allocating proportionally for each division. Also, data on the descriptive characteristics of the farms were collected. The response variable was consisted of three categories as the farmers which is highly satisfied, moderately satisfied and less satisfied. The data of the study was analyzed with descriptive statistical techniques, chi square test and cross-tabulations. The study revealed that, factors like level of education, support of the family, access to market, behavior of external society, and services provide by Veterinary Office had significant relationship with the job satisfaction. The overall level of job satisfaction of farmers was high. Further, study highlighted that gender, age, duration with farming and access to row materials (grass) had not significant relationship with job satisfaction. Finally, results of the study give an insight on the employment of farmers and the needs for future growth of this sector.

**Keywords:** *cattle farming, job satisfaction.*

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**FACTORS AFFECTING ON DEMAND AND CONSUMPTION OF DIFFERENT KINDS OF MEAT  
BY RURAL AND URBAN HOUSEHOLD; A STUDY IN HAMBANTOTA DISTRICT**

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The factors affecting demand and consumption of meat are varying according to number of factors. The objective of this study was to investigate the factors affecting on demand and consumption of different kinds of meat by rural and urban households in Hambantota District. Pre-tested structured questionnaire was employed to collect data from 120 consumers. All the respondents consumed at least one kind of meat out of four meat types namely chicken, beef, pork and mutton. There were significant relationships between demand for meat and household size, income and occupation but not with the locality, gender, age, religion and education. Meat purchasing frequency of consumers was once in two weeks. The most preferred meat types were chicken followed by, beef, pork and mutton. There was significant association between religion and preferable meat type. Chicken (66%) was the most preferable meat type among Buddhist and beef was the most preferable meat type among Muslims. Best taste of meat type (40%) and nutritional value of meat (28%) were the popular reasons for selecting most preferable meat type. Religious sentiment was a reason for not consuming both beef and pork and less availability of the market was the reason for not consuming mutton. Eventually findings of this study suggested meat retailers should draw and implement the strategies by considering the above key factors which determine the demand of meat in order to improve the status of meat industry as well as nutritional status of meat consumers

**Keywords:** *meat, consumption, house hold*

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## BUYING BEHAVIOR OF VALUE ADDED MILK PRODUCTS IN SUPER MARKETS IN KANDY MUNICIPAL COUNCIL IN SRI LANKA

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This paper aims to identify the buying behaviour of value added milk products in super markets of Kandy Municipal Council (KMC) area. Broad objective of this study was to analyze the factors affecting the buying behavior of value added milk products (especially yoghurt and bottled milk) available in the supermarkets. The specific objectives are to identify the main value added milk products and the highly preferred value added milk products available in super markets in KMC and to analyze factors affecting the buying behaviour of value added milk products. Systematic random sampling technique was applied to select the 100 respondents. Research was conducted in two outlets of Keels Super and Cargills Food City. The data were obtained through interviewer administered structured questionnaires and observations. The relationships between the factors and the purchasing decision of value added milk products were analyzed by Kruskal-Wallis test and Factor Analysis. According to the analysis factors, the highly affected buying behavior of yoghurt are product price, brand name, taste, health benefits, quality certifications, familiarity and the availability. Factors mostly affect the buying behavior of bottled milk are taste, and availability. The results revealed that seventy three percent of the respondents preferred to consume yoghurt than bottled milk. Eighty six percent of the respondents like to consume flavoured yoghurt being vanilla is the most preferred flavor. Forty nine percent of the respondents prefer to consume “Highland” brand than other brands. Fifty three percent of the respondents tend to buy yoghurt and thirty one percent tend to buy bottled milk weekly. Past experience of the product strongly affects the buying behavior of the value added milk products. According to this study, television has highly influenced in promoting bottled milk consumption. Therefore, the manufacturers have to consider only relevant factors when doing their marketing campaigns which differ from product to product.

**Keywords:** *buying behavior, value added milk products, yoghurt, bottled milk, super markets*

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## A STUDY ON CONSUMER PREFERENCE FOR DIFFERENT TEA BRANDS IN COLOMBO AREA

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Ceylon tea brings huge reputation to Sri Lanka as it is a sign of quality of our pure tea. The broad objective of this study was to study whether consumers prefer to buy local or multinational tea brands and how demographic and psychographic variables effect on consumer preference. The specific objectives were to find out the percentage of the consumers tend to buy branded tea, to find out the type of branded tea bought by the consumers, to study the attributes effect on brand preference, to determine most important parameters for brand preference and to determine relationship between psychographic variables. A Self-administered questionnaire was used to collect primary data. It was carried out in 3 Grama niladhari divisions in the Moratuwa Divisional Secretariat area. Consumer preferences for local and multinational tea brands were explored by using questions relating to demographic and psychographic variables. Wilcoxon sign rank test was carried out to find the most preferred and least preferred brand and attributes affect the consumer preference. The relationship between brand preferences and demographic variables was discovered by using chi-square test. The relationship between brand preferences with psychographic variables was discovered by using Mann-Whitney test separately for two brands. A correlation test was applied to ienitfy relationship between psychographic variables. Results indicated that 56% of the respondents prefer to buy local tea brands compared to 44% prefer to buy multinational brands. And also 81% of the respondents prefer to purchase branded tea rather than unbranded tea. It was revealed that the overall quality and taste were attributes affecting consumer preference. Ceylonta was the most preferred brand while Laoji was the least preferred brand. There was a significant relationship of level of education with brand preference. The main implication of this study is that the manufacturers need to consider both demographic and psychographic profile of consumers when promoting tea brands.

**Keywords:** *consumer preference, demographic variables, psychographic variables, local tea brands, multinational tea brands*

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## SOCIO ECONOMIC CHARACTERISTICS OF CATTLE AND GOAT KEEPERS IN RATNAPURA DISTRICT

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A survey was conducted in Ratnapura district to investigate the socio economic characters of the cattle and goat keepers. Data collection was performed by a face to face interview with the 78 farmers by using a standard questionnaire. This involved types of management system, ethnicity, income level, experience and application of bio-security measures. Data were descriptively analyzed by using Minitab 14.0. Multinational farmers were involved in cattle and goat management where Sinhalese contributed 75 percent, followed by Tamil (24%) and the lowest was Muslim (1.3%). Ninety percent of Sinhala farmers and 50% of Tamil farmers had more than 3 years experience in livestock management. Majority of farmers (45.33%) were engaged in semi intensive management system. Considerably, 24 percent farmers managed their herds in intensive system. Sixty nine percent of farmers carried out cattle and goat management as a part time business while 31 percent of farmers involved as their primary livelihood. Moreover, the farmers managed few other livestock species such as poultry (34.2%), buffalo (10.2%), swine (2.6%) and rabbit (1.3%) integrated with goat and cattle. Eighty seven percent of the full time engaged livestock farmers and 62 percent of the part time engaged farmers obtained assistance of the veterinary surgeon whenever required. 61 percent of the fulltime engaged farmers followed vaccination programs while it was 40 percent in part time engaged farmers. Farmers who managed herds to obtain additional income were highly concern on bio-security measures (70%) compared to the full time managed herds (57%). Cleaning of animals (50%), use of medicine to treat diseases (15.7%) and maintenance of sanitary conditions (13.1%) were the main identified bio-security measures. In overall, the survey showed that there is a possibility and need for the effective implementation of the policies on adequate financial aids and improved livestock extension services to popularize the cattle and goat management as a part time business in the area.

**Keywords:** *cattle, goat, management system, income*

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## CHANGES OF DOMESTIC CONSUMPTION TRENDS OF MILK CONSUMERS IN KEGALLE DISTRICT DUE TO DCD (DICYANDIAMIDE) PROBLEM IN MILK

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This study was designed to inquire Dicyandiamide (DCD) poisoning of imported milk and milk products and the consumer behavior at a shocking market impulse, whether the local consumers were well aware about this contamination of milk with DCD and if so, whether they have changed their milk consumption pattern or shifting into a substitute for milk and milk products. Primary data were collected through a pretested self-administered questionnaire and 300 households were selected by using multi stage random sampling technique. Analysis was based on descriptive statistics, graphical interpretation together with correlations. According to the depicted results, 71% of consumers prefer powdered milk and 22% of the sample prefers to consume fresh milk. Quality, taste, freshness and nutritional concerns were high priorities of the fresh milk consumers. Results further revealed that 77% of the respondents were daily milk consumers while 49% of respondents consume milk at least once. Moreover, the results further depicted that 44% of the sample has spent average Rs. 1000 monthly for purchasing the powdered milk. Of the sample, majority (94%) were well aware of the DCD contamination of the imported milk and milk products while 6% of the sample was unaware of the issue. Results revealed that, Brand shift was the sudden reaction of the consumers and majority (72%) of the consumers were shifted to a local milk brand and changed the product type from powdered milk to liquid milk. There was a relationship between the knowledge of DCD issue and the changes in pattern of milk powder consumption. Priority has been given to a selection of milk brands for the children compared to adults. DCD contamination has adversely affected the milk consumption of the local consumers where 20% of the sample has completely stopped the consumption of powdered milk and 25% of the sample has moved to the substitute products. Herbal drinks were the most widely used substitute in this regard.

**Keywords:** *milk, consumption pattern, DCD contamination*

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## LEVEL OF COMPETITION AND THE MARKET ADAPTABILITY OF DIFFERENT BRANDS OF COCONUT MILK POWDERS IN THE LOCAL MARKET OF SRI LANKA

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Coconut milk powder is one of the coconut based products produced and consumed in local market as well as available in foreign markets too. In order to develop the industry, it is vital for the producers to identify the market position, adaptability and the level of competitiveness of the product. Hence this study aims at examining the market adaptability through an index for different brands of coconut milk powders and natural coconuts in local market in Gampaha metropolitan area. Data were collected through a survey from the customers of five popular supermarkets in the area. The perception of consumers for two coconut milk powder brands (A and B) and the natural coconut were measured on a Likert scale through 20 distinct variables that constitute the marketing mix. The perception category convenience for the product purchasing determines the market type for purchasing the two types of coconut milk powders. Determination of market adaptability was done by analyzing the marketing mix of each product. Results of the study indicate that, natural coconut was best through the product mix and the price mix. Coconut milk powder of brand 'A' was best through place mix and brand 'B' was best through promotion mix. According to the market adaptability index relating to the marketing mix, coconut milk powder of brand 'B' was at the highest level followed by the brand 'A' and natural coconut on the adaptability index.

**Keywords:** *competitiveness, market adaptability index, marketing mix, product life cycle.*

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## SOCIAL CAPITAL IMPROVEMENT FOR FOREST MANAGEMENT: A CASE STUDY OF HURULU INTERNATIONAL BIOSPHERE RESERVE

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The knowledge and values of local communities play an important role in protected area management. Hence, social capital has been recognised as an effective tool for protected area management around the world in recent years. Social capital comprises relations of trust, reciprocity, common rules, norms and sanctions, and connectedness in institutions. It is also an important factor, influencing several issues both in individual and collective levels. This study investigated the existing social networks, to find out how social capital contributes to alleviate poverty and identify the issues related to social capital improvement related to peripheral communities in “Hurulu” forest reserve in Sri Lanka. Simple random sampling technique was used to collect data using pre-tested semi-structured questionnaire in *Habarana Grama Niladhari* (GN) division in *Polonnaruwa* district. Sample size was one hundred and fourteen. Informal discussions were also carried out with some officials of Forest Department (FD) and rural societies. Poverty index as well as social capital index were estimated. Results show that *Maranadara* society, Buddhist society, Farmer organization, and *Gamidiriya* are the most functioning societies out of 16 functioning societies in the area. Functions of these societies were to provide loans, act as an intermediate (for selling agricultural products etc), provide materials and trainings for social and livelihood development, help to funeral occasions, protect the “Hurulu” forest reserve, and maintaining community places. The poverty index for *Habarana* GN division was 24.79. Most of the organizations recorded high social capital index that vary from 85.95 to 89.12. Therefore, there is high potential for poverty alleviation using social capital of the study area. Moreover, age of respondents and health of the members were correlated with social capital. There were several obstacles for development of social capital such as lack of awareness about the importance of the rural societies, weak governance system, and bureaucratic nature of offices. Therefore, all these societies were useful to reduce the poverty of the respondent in peripheral of “Hurulu” forest area. Further, same societies can be utilized easily to protect the “Hurulu” forest. FD needs to be taken the leadership responsibility in this regard. This study suggests a need to blend social elements of conservation with protected area management.

**Keywords:** *social capital, poverty index, protected area*

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## INTELLECTUAL PROPERTY RIGHTS IN PROTECTING NEW PLANT VARIETIES: THE CASE OF SEED PADDY IN SRI LANKA

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In the face of growing scarcity of land in Sri Lanka, water and emerging challenges of climate change, productivity gain in agriculture will be the option available to increase agricultural output in the country. Productivity improvement should be achieved by introducing new technology generated through sustained investments. A well-established Intellectual Property Rights (IPRs) system will help to encourage innovations, technology transfers and product development. Being a signatory to the Trade Related Intellectual Property Rights (TRIPs) agreement, it was compulsory for Sri Lanka to formulate its intellectual property regulations to comply with TRIPs agreement and to provide legal protection to new plant varieties via patents or by an effective *sui generis* system or by both by 2006. Although Sri Lanka passed its Intellectual Property Rights Act in 2003 to comply with TRIPs agreement, it does not allow patenting of plants. Due to the inability of securing necessary protection, Sri Lankan agricultural sector had to face several difficulties in international trade and also it has lost a number of opportunities to use its own plant varieties for the benefit of future generation. Further, several cases of bio-piracy and loss of patentability of new plant varieties were encountered due to lack of effective IPRs system. Presently, Sri Lanka produces almost all its seed paddy requirement. Majority of farmers (90%) uses seed paddy produced by themselves from their previous crops or else they borrow from neighboring farmers. Thus, it is imperative to protect their inventions and knowledge in a systematic manner. The main objective of this study is to identify the best possible protection method for new plant varieties in Sri Lanka with a special reference to seed paddy. The methodology consisted with literature survey, key informant interviews, perception survey using a semi-structured questionnaire, focus group discussions with farmers and an expert consultation workshop. The main finding was that the *sui generis* system is the most appropriate protection method for Sri Lanka considering its economy, agricultural patterns and farming systems and also considering the existing IPR laws in Sri Lanka. Further, the study suggested several other techniques and methods such as a need of separate institute to monitor and documentation of existing knowledge of farmers to implement a strong IPRs system for Sri Lankan agricultural sector.

**Keywords:** *intellectual property, new plant varieties, seed paddy, TRIPs agreement, sui generis*

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**ORAL PRESENTATIONS**  
**ANIMAL BIO-RESOURCE MANAGEMENT**  
**AND FOOD TECHNOLOGY**

## INVITED PRASENTATION

### MONITORING OF HARMFUL ALGAE AND EUTROPHICATION IN THE BALTIC SEA AREA

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The study of phytoplankton in the Baltic Sea area have a long tradition and goes back to the end of the 19<sup>th</sup> century. Regular monitoring started in the 1970-ies and has developed since. All countries around the Baltic Sea cooperate in this effort and monitoring cruises are carried out at least monthly the year around. The problem of eutrophication in the coastal area of the Baltic Sea goes back to the early 20<sup>th</sup> century, but it is only about 50 years since it was shown that the open Baltic Sea might suffer from serious eutrophication. The connection between the increase in presence and blooms of both harmless and harmful phytoplankton and the increased eutrophication are nowadays given well-deserved attention. Whereas some of the toxic phytoplankton species thrive and develop blooms near the coast, in river mouths, harbour basins and close to big cities, there are also considerable blooms in the open Baltic Sea, mainly manifested by the annual surface accumulations of the cyanobacterium *Nodularia spumigena*. The connection between the increase in presence and blooms of harmful phytoplankton and the increased eutrophication is discussed using examples from different parts of the Baltic Sea. It includes blooms of *Nodularia spumigena*, *Prorocentrum minimum* and *Chrysochromulina polylepis*. While eutrophication in the Baltic Sea is expected to decrease in future, mainly because of the reduction of local nutrient discharge, there is a potential risk that the introduction of harmful phytoplankton species will increase, due to global warming and the increasing ship traffic into the Baltic.

**Keywords:** *harmful algae, eutrophication, Baltic Sea*

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## INVITED PRESENTATION

### GLOBAL DAIRY INDUSTRY AND ITS INFLUENCE ON DEVELOPING COUNTRIES

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Milk is one of the most volatile agricultural commodities today due to its short supply and increasing demand all over the world. The understanding of the global scenario is vital for the planning and implementation of dairy development strategies in developing countries (DC). Therefore, my presentation is to provide an overview of the global dairy sector and the forces influence its development with a focus on dairy farming in developing countries. The contribution of the milk and milk products to the world food basket is around 20% which is mainly dominated by the developed countries, such as USA and the countries of the European community. However, during recent times, the milk production in DCs has increased by 10% and at present contributes around 40% to the total milk production. The total farm households engaged in dairying in the world is estimated as 150 million and majority of them found in developing countries. Furthermore annual per capita consumption of milk is increasing by 3.5-4.0% in developing countries exceeding the annual growth rates of their staple food consumption by almost two fold. However, the per capita consumption of milk in developed countries is exceptionally high while many countries in the tropical region has very low per capita consumption. Therefore, the developed countries dominate the world market in dairying and milk prices in the developing countries are still controlled by them influencing local milk production. The animal feed price is a key determinant of milk prices, which contributes 65-70% of the total cost under any farming system. Demand for grain an ingredient for dairy ration, is driven by the need for food, feed and fuel of the growing world population. According to the Food and Agricultural policy Research Institutes (FAPR), feed prices will increase by 50% in near future, which directly influence the milk prices in the world market. Therefore, dairy sector development could serve as a powerful tool for reducing poverty in DCs. Devising a viable dairy development strategy for dairy farming systems is a timely need. Any dairy development strategy must be based on the principles of “creating value” in each and every segment of dairy chain, which is a very complex task which needs comprehensive analysis and continuous reassessment.

**Keywords:** *global dairy industry, developing countries, dairy development*

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## QUANTITATIVE RISK ASSESSMENT OF *Vibrio parahaemolyticus* IN CULTURED SHRIMPS *Penaeus monodon* BOUND-TO LOCAL MARKETS IN SRI LANKA

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*Vibrio parahaemolyticus* is a human pathogen of a significant health risk, causing gastroenteritis and other complications, ubiquitous in nature and also a part of natural and pathogenic flora in shrimps. Considering world-wide concern of the pathogen, its prevalence in cultured shrimps and lack of food safety management systems for local shrimp consumers in Sri Lanka, a risk assessment was performed for *V. parahaemolyticus* exposure of local populations that consume cultured shrimps in Sri Lanka. Available primary data, together with secondary data were simulated in probabilistic quantitative risk assessment model using @Risk program with 100,000 iterations. Model revealed that, about 5.313 % of the population has a risk of ingesting more than  $10^6$  *V. parahaemolyticus*, which according to known standards even exceed the level of infection. However, due to limited data availability, it is urged to validate the model with more ground level data, in order to be close enough to the real-life situation. These findings suggest a need of a basic food safety management system in grass root level and more vigilant approach for the pathogen in Sri Lankan conditions. Possible intervention methods are also discussed to mitigate the probable risk of illness from *V. parahaemolyticus*.

**Keywords:** *vibrio parahaemolyticus*, quantitative risk assessment, shrimps, food safety management

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**EFFECT OF AQUEOUS SOLUTION OF GARLIC (*Allium sativum*) ON REDUCTION OF *Salmonella* TYPHIMURIUM CONTAMINATION IN BROILER CHICKEN MEAT**

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Foodborne illness caused by consumption of contaminated foods with pathogenic bacteria or their toxins has been of great concern to public health. *Salmonella enteritica* serovar Typhimurium is a common food-borne pathogen that causes the deadly salmonellosis in human. Human acquires *S. Typhimurium* through consumption of contaminated animal products. Meat, dairy and poultry products are considered as principal reservoirs of *Salmonella* worldwide. As a substitute for chemicals, recently researchers have been looking to natural means of reducing microorganisms. Naturally occurring compounds such as, sulphur compounds, terpenes and terpene derivatives, phenols, esters, aldehydes, alcohols and glycosides in spices have shown antimicrobial functions. This study investigated the effect of garlic (*Allium sativum*) on reduction of *Salmonella* Typhimurium. Broiler chicken meat samples (n=9 per treatment) weighing  $25 \pm 0.3$ g were contaminated with *Salmonella* Typhimurium (ATCC 14028) at  $10^2$  and  $10^9$  CFU (Colony Forming Units) / g of meat. Subsequently the meat samples were dipped in 1% and 3% aqueous solutions of garlic (prepared with sterile distilled water followed by filter sterilization) for 10 and 30 seconds. Carcass rinse were obtained, serially diluted and plated on plate count agar and incubated at 37 °C overnight. Colonies were counted manually. Data were analyzed using SPSS and ANOVA followed by a Tukey's post-hoc test at 5% significance level. Compared to the untreated control samples, meat samples contaminated with  $10^2$  CFU/g and dipped in 3% garlic solutions indicated a significant reduction of *Salmonella* by 68% and 73%, at 10 and 30 seconds respectively. Meat samples that were contaminated with  $10^9$  CFU/g *Salmonella* and treated with 3% garlic exhibited a significant reduction by 52.4% and 73.1% at 10 and 30 seconds respectively. One percent garlic solution did not exert salmonella reduction effect in any sample. This study concluded that 3% garlic solution is an effective way of reducing *Salmonella* contamination in broiler meat. Further studies are crucial to standardize the optimum concentration of garlic solution in order to inhibit the growth of *Salmonella* completely.

**Keywords:** *salmonella, garlic aqueous, solution, broiler meat, foodborne illness*

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## PCR BASED DNA FINGERPRINTING FOR IDENTIFICATION OF FIVE CATTLE BREEDS USED AS MALE PARENTS IN ARTIFICIAL INSEMINATION PROGRAMS

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Cattle provide milk and meat which are important sources of high quality protein, minerals and vitamins. Breeding cattle for genetic improvement is essential in many perspectives for sustainable dairy and milk industry. In modern breeding programs, the importation of semen samples from superior stud bulls in different countries and distribution of semen samples from a local facility are routine practices. The availability of a robust DNA based method to identify cattle breeds used as parents in artificial insemination programs is very important to track parentage, avoid mix ups and ambiguities. Therefore, the present study was conducted to discriminate the five commonly used cattle breeds (Sahiwal, Jersey, Friesian, Ayrshire and Australian Friesian Sahiwal) in artificial insemination programs by using PCR based DNA fingerprinting with cattle specific microsatellite markers. Cattle semen samples were collected from Ambewela Dairy Farm (Ayrshire breed) and Artificial Insemination Center, Kundasale (Friesian, Jersey, Sahiwal and AFS breeds). DNA was extracted from semen samples and genotypic analysis was done using 14 different cattle specific DNA markers (*ETH152*, *ETH225*, *HEL1*, *CSSM66*, *RM180*, *RM011*, *RM192*, *BM6425*, *BMS1678*, *BMS1941*, *BM3517*, *TGLA304*, *BMS1747* and *ILSTS011*). A dendrogram was constructed for polymorphic band data using McQuitty Linkage and Square Pearson Distance, using the statistical package Minitab 16. Only four markers gave polymorphic bands (*ETH225*, *RM011*, *BM3517* and *BM6425*). Markers, *BM3517* and *BM6425* were selected to DNA fingerprint five breeds. *BM6425* generated two different bands; size ranging from 123-246 bp. Marker *BM3517* displayed four different bands; size ranging from 100-150bp. In combination these two markers can be clearly used to authenticate the exact breed of the germplasm.

**Keywords:** *DNA fingerprinting, cattle breeds, Sri Lanka*

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## EFFECT OF AGE AT WEANING ON POST-WEANING BEHAVIOUR OF NEW ZEALAND WHITE RABBIT KITS

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Under commercial animal production, the young animals are typically separated abruptly and permanently from their mothers at a relatively young age which could alter subsequent development of behaviour that can persist into adulthood. The purpose of this study was to examine whether there is a difference in behaviour among New Zealand White rabbits (n= 180) at age of 60-70 days, who were weaned at three different weaning ages of 21 days (T1), 35 days (T2) and 49 days (T3). Novel environment test, novel object test and aggression test were performed to detect behaviour differences. Behaviour observations were recorded according to the continuous recording methods following an ethogram. Data were analyzed by using General Linear Model (GLM) of SAS. Time taken for the first movement (latency) inside the novel cage was lowest ( $P < 0.05$ ) in T1 kits ( $10.9 \pm 1.9$  seconds) when compared to T2 ( $19.4 \pm 1.9$  seconds) and T3 kits ( $17.6 \pm 1.9$  seconds). T3 kits took longest ( $P < 0.05$ ) time ( $111.6 \pm 21.04$  seconds) to first sniffing of the novel object and interest of exploring was ( $P < 0.05$ ) persisted for a longer period of time ( $625.6 \pm 58.5$  seconds) while other two groups approached the object quicker ( $53.4 \pm 21.04$  and  $44.4 \pm 21.04$  seconds for T1 and T2 kits respectively) and sooner loosed their interest ( $403.3 \pm 58.5$  and  $475 \pm 58.5$  seconds for T1 and T2 kits respectively). During the pair-wise aggression test, longest ( $P < 0.05$ ) time duration ( $77.4 \pm 8.4$  seconds) was taken by T3 kits to reach and sniff the newly introduced kit when compared to T1 ( $34 \pm 8.4$  seconds) and T2 ( $13.1 \pm 8.4$  seconds) kits. It can be concluded that there are differences in behaviours of rabbit kits depending on the age at weaning.

**Keywords:** *behaviour, novel environment, novel object, rabbit kits, weaning*

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## SOCIO-ECONOMIC ROLE, FARMING SYSTEM AND PRODUCTIVE PERFORMANCE OF LOCAL CHICKEN IN THE EASTERN PROVINCE OF SRI LANKA

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Local chicken population plays a major role in socio-economic status of rural farmers in Sri Lanka. However, the productivity of local chicken is very low and some attempts have been made to improve this genetic group. In this context, a study was formulated to investigate the present status and productive performance of local chicken in the Eastern province of Sri Lanka. The findings will be used to plan different improvement programmes for local chicken. Pre-tested structured questionnaire was administered to gather information on socio-economic role, management system, nutrition, resources and productive traits of local chickens. Hundred and fifty farmers from each district were interviewed to gather information. Statistical Package for Social Sciences (SPSS) was used to analyze the data. The results of the study revealed that the local chicken population such as village chicken and naked-neck chicken were reared mainly under a resource-driven management system with commercial objectives. Among the farmers rearing local chicken, half was female with the average of 5.9 years experience in farming and 71% was young farmers of less than 40 years. Local chicken farming was a secondary income source among majority of the farm holdings (>80%). Predominant management system of local chicken was semi-intensive system with moderate management conditions and majority of the farms (69%) fallen into the small farm category according to the flock size less than 25 birds. Further the body weight of cockerel of village and naked-neck chicken at 7 months old was  $2.32 \pm 0.21$ kg and  $2.23 \pm 0.16$ kg respectively, while it was  $1.71 \pm 0.09$ kg and  $1.77 \pm 0.07$ kg for village chicken and naked-neck chicken respectively. Age at first lay, monthly egg production, egg weight, hatchability, productive period and life time of village chicken was  $6.14 \pm 0.21$  months,  $16.86 \pm 2.34$ ,  $46.31 \pm 2.11$ g,  $84.64 \pm 4.61$ %,  $21.64 \pm 0.21$  months and  $26.03 \pm 0.33$  months respectively, while these traits of naked-neck chicken were  $7.91 \pm 0.24$  months,  $18.72 \pm 2.64$ ,  $49.76 \pm 1.77$ g,  $90.01 \pm 6.24$ %,  $22.01 \pm 0.38$  months and  $24.97 \pm 0.24$  months respectively.

**Keywords:** *local chicken, naked-neck chicken, village chicken*

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## EFFECT OF DRIED GINGER ROOT POWDER (*Zingiber officinale* L.) SUPPLEMENTATION ON THE PERFORMANCE OF BROILER CHICKS

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The broiler farming in Sri Lanka is declining among small holders due to high cost of production. To reduce the feed cost it is necessary to maximize feed utilizing efficiency of broilers. At present some plant-based products are being used as feed additives. *Zingiber officinale* L is one of the natural plant products used to improve the feed efficiency. Three different levels of dried ginger; 1g/kg feed, 2g/kg feed and 3g/kg feed were included in broiler diet with a control treatment. The treatments were randomly allocated to thirty unisex broiler chicks of Cobb strain and was replicated thrice. The data was analyzed using Statistical Analysis Software (Version 9.0). The results of the study revealed that the feed intake ( $3140.0 \pm 62.6$  g/bird) was significantly higher ( $P < 0.05$ ) in broiler flock fed with dried ginger rhizome at the rate of 1g/kg feed when compared to other treatments. Body weight gain ( $1476.0 \pm 62.1$ g/bird), live weight at 45<sup>th</sup> day ( $2550.0 \pm 89.3$ g), carcass weight ( $1840.0 \pm 22.1$ g) and dressing percent ( $72.9 \pm 2.5\%$ ) were significantly higher ( $P < 0.05$ ) in broiler flocks treated with ginger at 3g/kg feed. There was no significant difference ( $P > 0.05$ ) for feed conversion ratio among different treatments. The zero percent mortality was observed in broiler flocks fed with ginger at the rates of 2 and 3g/kg feed. It was concluded that comparatively dried ginger at the rate of 3g/kg feed will have the potential of increasing the performance of broilers. However, further research related to mechanism of the action of dried ginger and its interaction with other factors of production is necessary.

**Keywords:** broiler, dried ginger, feed conversion efficiency, rhizome

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## DEVELOPMENT OF CHEESE WHEY BASED DRINKING YOGHURT INCORPORATED WITH PINEAPPLE (*Ananas comosus*)

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Cheese whey, an excellent source of protein, mineral and lactose, is a by-product of the manufacturing process of cheese. It has been estimated that 90% of total milk used in cheese manufacturing is discarded as whey. Recently, there is a growing interest in utilization of cheese whey as a functional component in the dairy product development. The present study was conducted to develop a drinking yoghurt using cheese whey with the pineapple pulp and artificial pineapple flavor. Different cheese whey levels, 80%, 90%, 100% and 85%, 90%, 95%, 100% were used to develop the drinking yoghurt using pineapple pulp and pineapple flavour respectively. Treatments were arranged in Completely Randomized Design (CRD) with five replicates. Parametric data were analyzed using SAS statistical package. Sensory data were analyzed by Friedman test using MINITAB statistical package. The shelf-life was determined for the product scored highest in sensory test. No significant changes found ( $P>0.05$ ) in pH, titratable acidity and Total Soluble Solids (TSS) among the treatments of the developed products. Cheese whey drinking yoghurt developed from pineapple pulp and flavour were significantly different ( $P<0.05$ ) for appearance, odour, taste, consistency and overall acceptability among treatments. The drinking yoghurts produced by adding 90% cheese whey using pineapple pulp and 95% cheese whey using pineapple flavours were selected as the best products. Both developed products could be kept for 15 days period at 4°C storage without any quality deterioration. Therefore, cheese whey could be effectively utilized for the production of drinking yoghurt with value addition.

**Keywords:** *cheese whey, drinking yoghurt, pineapple*

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**A STUDY ON MANAGEMENT PROFILE OF SMALLHOLDER DAIRY FARMS  
IN MONARAGALA DISTRICT**

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A field survey was conducted to study the management profile of smallholder dairy farms in Monaragala district to identify the areas for further improvement. One hundred cattle farms were studied representing all divisional secretariats of the district. Total number of animals used for the study was 948, of which, 402 indigenous and 546 crosses of indigenous and exotic breeds. Average herd size was  $9.48(\pm 1.06)$ . Majority (62%) of farms were managed semi-intensively, 35% were managed extensively and only 3% of farms managed intensively. Many farmers (59%) provide only grass for animals and the rest both grass and concentrates. None of the farmers considered body condition of animals in feeding. On average, a lactating cow and a pregnant cow received  $1.32(\pm 0.08)$  and  $1.26(\pm 0.11)$  kg of concentrates per day respectively. Mineral supplements were given by 55% farmers and none of the farmers practice pasture preservation. Majority of farmers (80%) use tethering and 17% and 3% use free grazing and zero grazing systems respectively. Sixty percent of farmers used artificial insemination (AI), 21% used only natural breeding and 19% used both natural breeding and AI for breeding. Rate of conception of the AI was  $1.75(\pm 0.078)$  and average cost per AI was Rs. 292.31( $\pm 12.04$ ). Average age at puberty and age at first calving were  $2.48(\pm 0.076)$  and  $3.48(\pm 0.75)$  years respectively. Average calving interval was  $1.16 (\pm 0.029)$  years. All the farmers use hand-milking method. Eighty three percent of farmers practice only morning milking whereas 15% of farmers milk twice a day. Teat dipping was practiced in 10% farms. In 42% of farms, whole milk production was sold, 2% consumed the total production at home and 53% used milk for both. Only 1% of farmers processed their milk. Average milk yield from an indigenous cow was  $1.9(\pm 0.19)$  litres and in crosses, it was  $4.98(\pm 0.21)$ . The average lactation period of a crossbred cow was  $6.96(\pm 0.38)$  month whereas in indigenous cow it was  $8.3(\pm 0.20)$  month. Average price per litre of milk was Rs. 52.86( $\pm 1.35$ ). The major constraints faced by farmers were inadequate scientific knowledge and lack of extension services.

**Keywords:** *cattle, management, milk, production*

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## DEVELOPMENT OF SPRAY-DRIED HERBAL PORRIDGE WITH COCONUT MILK

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Herbal porridge is an industry having good potential to be developed into commercial scale in Sri Lanka. Yet, it remains almost at cottage level due to the absence of successful preservation method. It is a fact that spray-drying is the most efficient and widely used preservation method which enables to produce powder out of liquids. But, herbal porridge is a bulk mixture having high fat content (15% - 25%) and previous studies are scanty on spray-drying of such a bulk solution. This study tests applying spray-drying technology to local herbal porridge mixture. The framework of this research was to investigate, the best formulation of herbal porridge for spray-drying selected based on sensory evaluation and performance during spray-drying; powder recovery, risk of clogging, stickiness in powder. Problems arising during spray-drying were controlled by maintaining total soluble solids at 20%, fat in feed solution at 4-4.5% and maintaining drying chamber at 165<sup>0</sup>C- 65<sup>0</sup>C, for inlet and outlet temperatures respectively. Then the developed product was subjected to proximate composition analysis, powder quality evaluation, sensory evaluation and shelf life evaluation. Shelf life evaluation was continuously done weekly for five weeks by packing in Triple Laminate sachets. At the same time the developed product was compared with a market available instant herbal porridge of same herb species. It was noticed that the developed product has a higher protein, minerals and fat content as well as better sensory properties than the market available product. In the evaluation of shelf life, the developed product did not show rapid change of free fatty acids, peroxide value, moisture, water activity, total plate count and yeast and mould count over the evaluation period of five weeks and all parameters were below the critical level ensuring that the developed product could be stored much longer without losing its quality. In conclusion, spray-drying technology could be applied to produce an instant herbal porridge successfully whereas making the storage easier and extending the shelf life.

**Keywords:** *herbal porridge, spray-drying, shelf life, sensory evaluation, proximate composition*

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## PRODUCTION AND EVALUATION OF SET TYPE LOW-FAT YOGHURT INCORPORATED WITH AYURVEDIC HERBS (PASPANGUWA WATER EXTRACTION)

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There has been increasing inclusion of natural food additives and health promoting substances into the diet because of various health benefits. “Paspanguwa” is an ancient ayurvedic formulation used to treat cold and cold related conditions and to reduce of body aches, enhance appetite and body immunity. Main ingredients of Paspanguwa are *Zingiber officinale* (Ginger), *Coriandrum sativum* (Coriander), *Solanum xanthocarpum* (Katuwelbatu), *Coscinium fenestratum* (Venivelgeta) and *Hedyotis corymbosa* (Pathpadagam). Considering the medicinal importance, present study was designed to produce new yoghurt (Paspanguwa low-fat yoghurt) incorporating Paspanguwa, to evaluate the functional properties and plausibility of its uses. Yoghurt was stored under refrigerated condition (4°C) for 21 days and proximate analyses were done at first week of storage. Keeping quality was evaluated for 21 days of storage life by analyzing microbiology and chemical components for three replicate samples from new yoghurt and plain yoghurt. Titratable acidity and pH values of Paspanguwa low-fat yoghurt and plain yoghurt were not significantly different ( $p > 0.51$  and  $p > 0.10$  respectively). However pH values were  $4.23 \pm 0.06$  and  $4.14 \pm 0.03$  respectively after 21 days. There was no significant difference between plain yoghurt and Paspanguwa yoghurt with regard to moisture content ( $p > 0.19$ ), total solid ( $p > 0.19$ ), ash ( $p > 0.08$ ), and fat content ( $p > 0.05$ ). Fat percentages of Paspanguwa and plain yoghurt were  $0.16 \pm 0.01$  and  $0.19 \pm 0.01$  respectively. Under same storage condition, higher microbial count were showed at 14 day;  $3.80 \times 10^6 \pm 0.65 \times 10^6$  and  $5.16 \times 10^6 \pm 0.41 \times 10^6$  respectively. In sensory evaluation, 15% of Paspanguwa yoghurt was selected as the most preferable one and consuming with honey increased the overall acceptability. Paspanguwa low-fat yoghurt is rich in both milk nutritive value as well as medicinal value. Further studies are required to detect activity of phytochemicals of the yoghurt.

**Keywords:** yoghurt, paspanguwa, ayurvedic

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**A STUDY ON GROWTH PERFORMANCES AND CARCASS QUALITY PARAMETERS IN  
BROILER CHICKEN FED WITH MAIZE AND SOYBEAN MEAL BASED DIET IN UP  
COUNTRY DRY ZONE, SRI LANKA**

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Success of the broiler industry vastly depends on the growth performances and the carcass quality parameters of birds. As the broiler chicken industry is the fastest growing livestock sector in Sri Lanka, it is important to be aware about the performance and quality parameters of broilers in different parts of the country. The knowledge about how the post mortem pH changes are taken place in broiler carcass would be of immense value to both the producer and the consumer to ensure proper keeping quality of meat. At present, soybean meal based diet is the most common type of broiler feed available in the market. A study on growth performances and carcass quality parameters in broiler chicken fed with maize and soybean meal based diet was conducted in up country dry zone in Sri Lanka with randomly selected 130 birds. Broiler performances were measured by average live weight, average net meat weight, average feed intake and average feed conversion ratio. Dressing percentage, average weight of different body organs and parts such as liver, heart, abdominal fat, head, feet and feathers were taken as carcass quality parameters of broilers. Post mortem pH changes of the liver were measured using a laboratory pH meter at 2 hr interval for 8 hrs. While the average live weight was 2.75 kg and the average feed intake was 3.8 kg/bird, the average feed conversion ratio was 1.38 showing better performances of broiler chicken in this area. The Dressing percentage of the broiler chicken (68%) was slightly below the standard value (72%), whereas the average weight of liver, heart, abdominal fat, head, feet and feathers were 35 g, 9.4g, 51g, 54 g, 68.9 g and 35.4 g respectively indicating normal developments of body parts. The pH of the liver showed a gradual decline with time and the average values at 2 hr intervals were 6.85, 6.76, 6.69, 6.64, and 6.54. It was suggested to conduct studies of this nature in different environmental conditions under various management systems to compare the production and quality parameters of broiler chicken in different parts of the country.

**Keywords:** *growth, parameters, broiler, liver pH, carcass, quality*

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**CONSUMER PREFERENCE ON GIANT FRESH WATER PRAWN  
(*Macrobrachium rosenbergii*), WITH REFERENCE TO DIFFERENT QUALITY  
CHARACTERISTICS OF THE FINAL PRODUCT:  
A CASE STUDY IN HAMBANTOTA DISTRICT**

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During the present investigation it was aimed to analyze the consumer preferences on giant fresh water prawn (*Macrobrachium rosenbergii*) with reference to the type of production and quality characteristics of the final product. Therefore, a questionnaire was prepared to collect data from the consumers representing individuals from local market, hotels and restaurants on consumer preference on *M. rosenbergii* in Hambantota district, Sri Lanka. Out of the total of thirty respondents, 80% of them have consumed fresh water prawns for their meal and 71% have no preference for the place of production while 17% prefer wild caught fresh water prawns and the rest (12%) have a preference on cultured prawns. Twelve percent and 42% of respondents consume freshwater prawns monthly and once in three months respectively. Forty six percent informed that they consume freshwater prawns very rarely. Out of total respondents, 83% claimed that the price of the prawn is too expensive while the others (17%) commented that the price is comparable to the marine prawns. The large size of the prawns is preferred by 73% while 27% respondents stated that the freshwater prawns are too large to add for their meal. Sixty percent of the respondents believe that the freshwater prawns contain high nutrition while 13% of the respondents have no idea on the nutritional status of the freshwater prawns. Fifty seven percent of the respondents informed that the availability of the prawns in the market is occasional while another 7% and 37% informed regarding the frequent and rare availability of freshwater prawns. Fifty three percent respondents claimed regarding the low edible portion of the freshwater prawns while 33% and 13% informed the satisfactory and high edible portion of the freshwater prawn respectively. Lower availability and high price have reduced the demand for the Giant fresh water prawn while it was further reduced due to mushiness and inferior taste. Therefore, a national programme can be suggested on enhancing the final product quality through best management practices during culturing, harvesting and post-harvest activities of giant fresh water prawn.

**Keywords:** *Macrobrachium rosenbergii*, consumer preference, quality characteristics

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**EFFECT OF PUMPKIN MEAL (*Cucurbita* SP.) ON COLOR ENHANCEMENT AND THE  
GROWTH PERFORMANCE OF BUENOS AIRES (B A) TETRA  
(*Hemmigrammus caudovittatus*)**

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The investigation was undertaken to determine the effects of dietary supplementation of different pigment sources on color enhancement, growth, feed conversion and survival of Buenos Aires (BA) tetra (*Hemmigrammus caudovittatus*). The fish (n=72) ( $0.69 \pm 0.02$ g) were fed with diets containing 3% pumpkin meal (PD) and commercial color feed “Super Red” (SR) to compare with the fish fed with a control diet without any pigments (CD) for 72 days. Daily food consumption and length, weight measurements of fish at two weeks interval were taken and at the end of the experiment, total carotenoid content of fish was measured. The fish fed with PD diets showed the highest total carotenoid content ( $6.36 \pm 1.16$  µg/g) in their skin, fins and flesh followed by the fish fed with SR feed ( $4.86 \pm 2.12$  µg/g) while the lowest carotenoid content was observed in the fish fed with CD diet ( $2.04 \pm 0.58$  µg/g). The carotenoid content was significantly different ( $p < 0.05$ ) among the fish fed with PD, SR, and CD diets. The dietary carotenoid sources did not significantly affect the growth performance while the percentage Specific Growth Rate ranged from  $0.92 \pm 0.02$  to  $1.27 \pm 0.05$  and feed conversion ranged from  $0.79 \pm 0.05$  to  $1.97 \pm 0.14$  of BA tetra fed with different diets ( $p > 0.05$ ). Survival rate of the fish was equal for all the treatments. The profit index of the preparation of PD diet ( $2.27 \pm 0.90$ ) was significantly higher than that of SR feed ( $0.88 \pm 0.36$ ) ( $p > 0.05$ ). According to the results, the pumpkin meal can be used as a natural pigment source for a low cost as it is not affecting the growth, feed conversion and survival of BA tetra.

**Keywords:** *ornamental fish, fish feeds, natural pigments, growth, total carotenoid content*

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## EFFECT OF REMOVING ADHESIVENESS OF COMMON CARP (*Cyprinus carpio*) EGGS ON HATCHABILITY AND LARVAL SURVIVAL

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The eggs of common carp, *Cyprinus carpio* is characterized by adhesive chorion. Due to this adhesiveness, eggs can be attached to any surface, rendering substantial amounts of eggs being unavailable to produce hatchlings. Therefore, removal of egg stickiness can be effective in increasing hatchability of common carp eggs and larval survival. Present study is aiming at removing adhesiveness of common carp eggs and evaluating its effects on hatchability and larval survival. Three males and three females of sexually matured common carps were acclimatized and breeding was induced by injecting Ovaprim hormone, followed by hand stripping. Fertilized eggs (4226 in number) were divided into three sub sample and kept one sub sample as a control (T<sub>1</sub>). Other sub samples were used for removing the adhesiveness of eggs by using two different treatments T<sub>2</sub> (24 g of milk powder + 1 g of NaCl in 1L of water) and T<sub>3</sub> (4 g urea + 1 g NaCl in 1L of water), which were proven to be effective elsewhere. Subsequently all sub samples were allowed to hatch and the hatchability and the larval survival were evaluated. Experiment was repeated thrice to verify the reproducibility. Results indicated that removing the stickiness of the eggs in both treatments increased both the hatchability of common carp eggs and the larval survival. As the removing agent of stickiness, milk powder + salt achieved the highest hatchability suggesting the best combination over the other treatments. In conclusion, adhesiveness of common carp eggs can effectively be removed by urea/milk powder + NaCl treatment and these resultant non adhesive eggs produced higher hatchlings and better survival.

**Keywords:** *Cyprinus carpio*, stickiness, hatchability, larval survival

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## FORMULATION AND QUALITY EVALUATION OF NATURAL VINEGAR BASED ON WASTE COCONUT WATER FROM THE DESICCATED COCONUT INDUSTRY

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The matured coconut water is an underutilized by product and problems are arisen due to direct disposal to the environment. This study was undertaken for the formulation and quality evaluation of natural vinegar based on waste coconut water from the desiccated coconut industry. Waste coconut water collected was filtered and total soluble solids (TSS) content were increased up to 15<sup>0</sup> brix by adding white-sugar. Pasteurization was carried out at 75<sup>0</sup>C for 10 minutes and allowed for alcoholic fermentation for one week by adding baker's yeast. Acetic acid fermentation was done in two vats; wooden and plastic, introducing 10% (v/v) of mother vinegar. Titrable acidity and pH were measured weekly until it reached an acidity level of four percent. Two end products were packed in sterilized bottles separately; subjected to evaluation of physiochemical, microbial and organoleptic qualities. Sensory results were collected through nine point hedonic scale and statistical analysis done by using Mini-tab 16 statistical software. An alcohol level of 9.1% was found in the product after eight days. The titrable acidity, TSS, pH value, total solids of the product in wooden vat were 4.92%, 6<sup>0</sup>brix, 2.89 and 2.05% respectively, the alcohol percentage before and after pasteurization was recorded as 0.4% and 0.0% respectively. The product contained in plastic vat was 4.31%, 6<sup>0</sup>brix, 2.86, 1.87%, 1.8% and 0.8% respectively. Both products were in accepted condition due to their physical and organoleptic qualities although vinegar in wooden vat received highest sum of rank as 78.0 and hence it was considered as the best product. The cost of production was Rupees 50 per liter and no product deterioration was seen during the three months of shelf life. It is revealed that waste coconut water from the desiccated coconut industry can be effectively utilized for the production of natural vinegar.

**Keywords:** *mature coconut water, byproduct, vinegar*

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## DEVELOPMENT OF FIBER AND IRON ENRICHED STIRRED YOGHURT INCORPORATING FINGER MILLET (*Eleusine coracana*)

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Dietary fiber and iron are important human nutrients. It has been found that daily intake of dietary fiber and iron by Sri Lankans are not sufficient for optimal health promotion and disease prevention. The present study was carried out to develop a fiber and iron enriched stirred yoghurt using dietary fiber and iron rich finger millet flour as a stabilizer. The levels of 4%, 6% and 8% finger millet flour were incorporated and yoghurt produced without finger millet was used as the control. The treatments were arranged in Completely Randomized Design (CRD) with four replicates. Acidity and pH were recorded 30 minutes intervals during incubation and 3 hours after incubation. Shelf-life of the best treatment was determined by microbiological, chemical and sensory evaluation tests at 0, 7 and 15 days of storage at 4°C. Citric acid was added at different stages of the manufacturing process to reduce pH to a safer level. Parametric data were analyzed using SAS statistical package. The organoleptic data were analyzed by Friedman test using MINITAB statistical package. Results revealed that the addition of citric acid before fermentation was not possible. However, addition of citric acid after incubation did not cause coagulation of the yoghurt mixture and was able to produce a safe product. There were significant differences ( $P < 0.05$ ) among four treatments at the sensory test for the attributes of appearance, odour, taste and overall acceptability. Yoghurt added with 8% finger millet flour was selected as the best product, which contained 4.9 g% crude protein, 1.2 g% fiber and 1.12mg% iron. The shelf life of the developed product was 12 days at refrigerated temperature. The yoghurt produced by adding 8% finger millet could be recommended as a fiber and iron enriched normal product for future needs.

**Keywords:** *finger millet, stirred yoghurt, fiber, iron*

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## FORMULATION AND DEVELOPMENT OF VEGGIE FINGER INCORPORATED WITH EGG WHITE POWDER

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Incorporation of plant based products as an alternative source for meat products is common and has increased to improve nutritional aspects in the human body. This study was carried out to develop a low fat veggie finger incorporated with egg white directly as binding agent with other ingredients. By trial and error methods, selected vegetables and egg white were incorporated in four treatments and prepared as T1 (13% egg white, 37% vegetable mixture), T2 (10% egg white, 40% vegetable mixture), T3 (7% egg white, 43% vegetable mixture) and T4 (4% egg white, 46% vegetable mixture). Sensory evaluation was conducted to select the best treatment and it was stored under freezing condition (-18°C) for two months. The pH and water holding capacity (WHC) of the developed product were determined. Total plate count (TPC), *E-coli*, *Salmonella* and *Staphylococcus* were determined with two weeks interval over two months. Parametric data were analyzed by SAS and sensory data were analyzed by Friedman test using MINITAB. Highest estimated rank was observed in T3 which contained 7% egg white and 43% of vegetable mixture. External appearance, smell, saltiness, spiciness, firmness were not significantly different ( $P>0.05$ ) while internal appearance, internal and external color, smoothness, juiciness and overall acceptability differed significantly ( $P<0.05$ ) among treatments. The pH and WHC were not significantly different ( $P>0.05$ ) with storage period. Developed product was negative for TPC, *E-coli*, *Salmonella* and *Staphylococcus* after storage period. Thus, the production of veggie fingers can be made with egg white powder and incorporation of 7% egg white with 43% vegetable mixture is the ideal ration for the production of veggie fingers.

**Keywords:** *veggie finger, egg white, vegetables, binder*

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## THE INFLUENCE OF STRAIN AND HOUSING SYSTEMS FOR BROILER PRODUCTIVITY

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Broiler industry is one of the fast food producing industries in Sri Lanka and it contributes to the livestock sector immensely. There is high consumer demand for separate broiler parts over the whole chicken. Hence poultry breeders pay attention to improve the yield of carcass and separate body parts. Therefore, this study was conducted to evaluate the effect of strain and housing systems on the broiler meat performance. Broiler strains Hubbard classic (HC), Hubbard Flex (HF), Hubbard 15 (H15) and Cobb 500 were used in the research. Hundred and sixty (160) birds which were fed with same formulated feed from two different housing conditions (open houses and Close houses) were selected, slaughtered, portioned and weighed at 38 days of age. The percentage of dressing, skin, fat, bone, muscle yield were taken and used to identify the effect of strain and housing system on the performance of them. The strain had significant effect on all the characteristics. Study showed that the housing systems affected on the yield variation except fat and bone percentage. Cobb 500 showed highest skin (7.4%), fat (4.1%) and bone (23.7%) percentages and resulted lower muscle yield, when compared with superior muscle yielder HC (38.6%). Cobb 500 was superior in DP and Hubbard classic was superior for meatiness in closed houses. According to the results, Cobb 500 has higher productivity to produce as full chicken not as skinless chicken. Also the Hubbard classic was superior for the production of boneless chicken under the closed house system.

**Keywords:** *age of slaughtering, broiler strain, housing systems, performance*

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**DEVELOPMENT AND QUALITY EVALUATION OF NEW BOTTLED MUSSEL BY USING  
LOCAL AVAILABLE MUSSEL SPECIES (*Perna viridis*)**

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*Perna* species (*Perna perna* and *Perna viridis*) are commonly found edible mussel species around the territorial sea of Sri Lanka. It is a seasonal seafood available only in few months per year and it has been cultured experimentally but not commercialized as a processed mussel product yet. This study was aimed at developing and evaluating the quality of bottled mussel using local available mussel species (*Perna viridis*). Mussels (*Perna viridis*) were harvested during three consecutive days and flesh extracted was stored at -10 °C until processed. Three mussel products (t<sub>1</sub>, t<sub>2</sub> and t<sub>3</sub>) were developed only changing the citric acid amount added (3g, 4g and 5g) to the recipe and subsequently organoleptic properties of three citric acid treated bottle mussel products were evaluated; nutritional and shelf-life were determined to find out the best product. During the processing, hot filling was done and stored in the room temperature. Semi trained 30 sensory panelist were used to determine the organoleptic qualities of the products subjectively and the best product was determined by using the Friedman non-parametric test. Three products showed significant difference ( $P < 0.05$ ) only for color and texture sensory attributes such as 0.001 and 0.035 respectively and there were no significant difference in other sensory attributes such as appearance, odor, taste, after taste and overall acceptability ( $P > 0.05$ ) such as 0.093, 0.152, 0.099, 0.850 and 0.106 respectively. The product t<sub>2</sub> has received the highest sum of rank in all sensory attributes and considered the best product. It had 6 months of expected shelf-life; no quality defects were recorded until 20<sup>th</sup> week of shelf-life and having 73.70%, 16.65% and 2.60% of moisture, crude-protein and crude-fat percentages respectively. This study concluded that the mussels can be processed thermally by incorporating citric acid without affecting its organoleptic and nutritional qualities.

**Keywords:** *bottled mussel, citric acid, shelf-life*

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## POTENTIAL APPLICATION OF PREBIOTIC INULIN AS A FAT REPLACER IN THE PRODUCTION OF CHICKEN SAUSAGE

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Sausages are popular traditional meat products in many countries and are of great importance to the meat industry. However, these products present some negative health effects because of their high fat and energy content. Inulin extracted from chicory (*Cichorium intybus*) plant was tested as an animal fat replacer in the production of chicken sausages. Five formulations of chicken sausage were prepared by replacing animal fat content with 25%, 50%, 75%, and 100% inulin. Physical, chemical, microbiological and sensory properties of the above formulations were tested to select the best level of inulin that can successfully replace the animal fat. The sensory evaluation of the chicken sausage was performed with 9 point hedonic scale. The results of sensory evaluation showed that samples produced by replacing 100% fat with inulin had significantly better texture, taste, juiciness, after taste and overall acceptability score ( $p < 0.05$ ). Total moisture, protein, fat and ash contents of the best prebiotic sausage (inulin added) were 63.4%, 12.6%, 4.3%, 3.5% respectively. Total replacement of fat with inulin had no influence on protein, moisture and ash content. But only fat content was reduced from 13.0% to 4.3%. This resulted in dramatic reduction of total caloric content (~ 27%) of the final product. Cooking yield, moisture retention, and fat retention of the final products were 98.6%, 40.4%, 88.0%, respectively. The addition of inulin had no influence on the microbiological parameters. This study revealed that prebiotic inulin can be used to produce low caloric healthy chicken sausage with high consumer acceptable attributes.

**Keywords:** chicken sausage, fat replacer, inulin, low caloric, low fat

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## DEVELOPMENT OF HIGH QUALITY CHICKEN MEAT BALLS BY INCORPORATING DIFFERENT TYPES OF FLOURS

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Meat balls are a popular food among consumers. There is a growing demand for high quality (nutritive and organoleptic) meat balls. This study aimed to produce high quality chicken meat balls by replacing bread rusk with three types of flours (cassava, rice and chick pea). Physicochemical and sensory properties of meat balls produced with cassava, chick pea and rice were investigated and compared. The sensory evaluation of chicken meat balls was performed using moderate score in a 9- point hedonic scale. Addition of flour did not affect total moisture content except for cassava. The highest protein content was observed in chick pea (14.77%) incorporated meat balls. Total ash content remained unchanged in all tested flour incorporated meat balls. The total carbohydrate content was significantly reduced after replacing bread rusk with chick pea flour. This reduction was more pronounced in chick pea added meat balls. The highest fat content (13.40%) was recorded in chick pea added meat balls, followed by rice (12.62%) and cassava (12.27%). The cooking yield significantly increased after incorporation of cassava (93.11%), whereas incorporation of rice (81.45%) and chick pea (86.05%) flours resulted in lower cooking yield. Moisture retention was increased in all tested flour incorporated meat balls. This was more in cassava incorporated meat balls. Addition of cassava flour significantly increased the fat retention, whereas, addition of chick pea flour reduced the fat retention. Incorporation of rice flour did not affect the fat retention. The sensory scores showed that cassava flour was the best alternative for the bread rusk in the manufacturing of meat balls.

**Keywords:** *cassava, chick pea, flour, meatball, rice*

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## EFFECT OF PROBIOTICS MIXTURE ON GROWTH PERFORMANCES AND WELL BEING OF AYRSHIRE-FRIESIAN CROSSBRED CALVES IN UP COUNTRY; SRI LANKA

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Sixteen Ayrshire-Friesian crossbred heifer calves were used in 75-day trial to study the effect of probiotic supplementation (*Lactobacillus acidophilus*, *Bacillus subtilis* and *Saccharomyces cerevisiae*) on growth performances and well being. Seven day old calves were divided in to two groups of eight calves in each. One group was fed with the probiotics supplement (100mg/calf/day) by mixing with milk replacer twice a day and the other group was fed only the milk replacer as the control. Calf starter was introduced on the 7<sup>th</sup> day and hay was introduced on the 46<sup>th</sup> day for the both groups. As growth performances average calf starter intake, average daily weight gain, heart girth gain, wither height gain, hip height gain and hip width gain were measured. Fecal fluidity scoring (1= Normal, 2=Soft, 3=Runny, 4=Watery) on weekly basis and fecal coliform count at the end of the experimental period were examined to detect the well being of the calves. Data were analyzed by multiple regression tests in MINITAB and fitted regression models were compared using two sample t-test. Starter intake was significantly ( $P<0.05$ ) higher in probiotics supplemented group. Average daily weight gain, wither height gain, heart girth gain, hip width and height gain were not affected by the treatment ( $P>0.05$ ). Significant ( $P<0.05$ ) treatment effects on decrease in fecal fluidity was observed. However, total fecal coliform count at the end of the experimental period was not affected ( $P>0.05$ ) by the treatment. In Overall, it can be concluded that, there are beneficial effects of the probiotics supplement on starter intake and decrease in fecal fluidity in Ayrshire-Friesian crossbred heifer calves.

**Keywords:** *heifer calves, probiotics, growth performances, fecal fluidity*

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## EFFECT OF ANTIOXIDANTS (BHT AND ETHOXYQUIN) ON SUPPRESSING RANCIDITY OF PLANT OIL AND TALLOW

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Lipid autoxidation is one of the major undesirable chemical changes occur in oil during the storage. The antioxidants can effectively be used to control the lipid autoxidation. This study aimed to investigate the effect of two different synthetic antioxidants (BHT and Ethoxyquin) on oxidative stability of plant oil and tallow during the storage. The influence of antioxidants in controlling lipid autoxidation was measured using peroxide value (PV) at 7 days interval for six weeks period. Free fatty acid content (FFAC) and Iodine value (IV) were measured. Without antioxidant (Blank samples) peroxide value was increased in both lipids as the time of storage was increased, but to a different extent. The peroxide value of plant oil was always higher than tallow. This indicated that plant oil was more susceptible to autoxidation than tallow. Both antioxidants significantly reduced the peroxide value in all tested samples compared to the blank samples. The PV results showed that Ethoxyquin had a greater effect in controlling autoxidation of plant oil than BHT. The initial iodine values of plant oil and tallow were 138.54 and 64.24 respectively. Iodine values of both samples were reduced during the storage. This was more pronounced in vegetable oil (from 138.54 to 24.32). These results further supported that the oxidative stability of plant oils are lower than that of tallow. Both antioxidants reduced the reduction of Iodine value during the storage, indicating that tested antioxidants increased the oxidative stability of plant oil and tallow. The results of FFA content showed that the FFA content increased in both tested lipids during the storage. FFA contents increased by 0.99 and 1.97 at the sixth week of storage in plant oil and tallow respectively. This reflected that tallow was more susceptible towards hydrolytic rancidity than plant oil. The formation of FFA in both oils reduced in the presence of antioxidants indicating that tested antioxidants can retard hydrolytic rancidity too.

**Keywords:** *rancidity, peroxide value, iodine value, free fatty acid value, antioxidant*

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## DEVELOPMENT OF A SAUSAGE USING A SHRIMP PROCESSING BY-PRODUCT; CHIN CUT

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Frozen, head-less shrimps are one of the highly demanded products exported from Sri Lanka in large quantities. During the process of removing the head, an abdominal muscle is protruding, which, only for the reason of appearance is removed as a “chin cut”. As for now, this substantial volume of chin cut does not produce any gain for processor. Therefore this study was aimed to add value to this chin cut to produce a shrimp sausage, preserving authentic shrimp flavour. To identify the initial problems arising in making the shrimp sausage, a preliminary study was conducted using a standard recipe of pork sausage. The main problem identified was the poor binding ability. To avoid that, Carboxy Methyl Cellulose (CMC) was used as a binder and wheat flour as a filler in the next stage of product development. Three different concentrations of shrimp meat were used (60%, 75%, 90%) to produce sausages with varying percentages of CMC (2.5%, 5%, 7.5%) in nine combinations. Sausage containing 60% shrimp meat did not have a strong shrimp flavour, while sausage containing 90% shrimp meat did not have proper binding ability. Therefore, 75% shrimp meat was used for further development. At the concentrations above 75%, no added colour enhancers were needed. Three best combinations among these were selected based on appearance, binding ability and the shrimp taste, and later evaluated by a sensory evaluation (7 point hedonic scale) alongside a standard pork sausage as a control and a spice added shrimp sausage. The shrimp sausage with 5% CMC and spices obtain significantly ( $P > 0.05$ ) higher consumer preference. The study proved that a shrimp meat (chin cut) can successfully use to develop a cost effective consumer acceptable sausage.

**Keywords:** *chin cut, shrimp sausage, carboxy methyl cellulose*

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## EFFECT OF FEEDING CURRY LEAVES (*Murraya koenigii*) ON GUT MICROFLORA OF BROILER CHICKEN

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Herbal medicines form an important part of health care system in humans because they are easily available, cheaper and safer than synthetic drugs. Plants produce a diverse array of bioactive molecules, making them a rich source of diverse types of medicines. In recent years, drug resistance to human pathogenic bacteria has been commonly reported from all over the world. Presently with the situation of emergence of multiple drug resistance to human pathogenic organisms, it has necessitated to search for new antimicrobial substances from natural sources including plants. Success of chemotherapy lies in the continuous search for new drugs to counter the challenge posed by resistant strains. With this background this experiment was conducted to assess the antibacterial effect of curry leaves (*Murraya koenigii*) on gut microflora of broiler chicken. Sixty, 28 day old broiler birds with similar body weight were divided into 12 groups of 5 and three treatments and a control group were assigned with 3 replicates per treatment according to complete randomized design (CRD). Test rations were prepared by incorporating 0.5%, 1% and 1.5% levels of curry leave to a commercial broiler finisher diet and the control was prepared without curry leave. On 42<sup>nd</sup> day, birds were slaughtered and 25 g of gut content was collected aseptically from each bird for microbiological investigation. Samples were homogenized, serially diluted in sterile distilled water and plated on standard plate count agar using spread plate method. Following incubation of plates at  $35 \pm 2^\circ\text{C}$ , colonies were counted manually and expressed as Colony Forming Units (CFU) / g of gut. Data were analyzed using SPSS and ANOVA followed by a Tukey's post-hoc test at 1% significance level. Results revealed a statistically significant reduction of gut microbes in broiler chicken fed with curry leaves diet. When compared to the microbial count of control ( $8.9 \times 10^8$  CFU /g), the count was reduced by 37.2% ( $5.6 \times 10^8$  CFU /g) in 1% group and by 49.1% ( $4.5 \times 10^8$  CFU /g) in 1.5% group. The reduction ( $8.5 \times 10^8$  CFU /g) was not significant in 0.5% curry leave treatment. It was concluded that there is a strong antibacterial effect in curry leaves which increases with the increase in curry leaf concentration.

**Keywords:** *curry leave, gut microbes, reduction, broilers*

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**EFFECT OF FEEDING CURRY LEAVES (*Murraya koenigii*) ON BLOOD GLUCOSE LEVEL  
AND THE LIPID PROFILE OF BROILER CHICKENS**

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Diabetes mellitus and cardiovascular diseases represent an enormous, medical, social and economic burden to the public and high cost of synthetic drugs used for these diseases have become unbearable. Attempts have been made to find alternatives with special attention to utilization of similar compounds of natural origin. Many studies have shown that curry leaves (*Murraya koenigii*) enclose various notable pharmacological activities such as anti-diabetic, hypocholesterolemic, antimicrobial, antiulcer, anti diarrhetic and vaso-relaxing in human. With that background, the effect of feeding curry leaves on blood glucose level and lipid profile was investigated using broiler chicken. Sixty, 28 days old broiler birds were randomly allocated to four dietary treatments with three replicates of five birds per each replicate in a completely randomized design. Maize and soybean meal based control feed and three test diets prepared from the control feed by incorporating curry leaves at 0.5 (T1), 1.0 (T2) and 1.5 (T3) % levels served as four dietary treatments. Feeding continued until slaughtering at 42 days of age. Feed intake was recorded at three day intervals and blood samples were collected at slaughtering by severing the jugular vein. Blood samples were subjected to lipid profile analysis (total cholesterol, high density lipoproteins (HDL), low density lipoproteins (LDL) and Triglycerides) and blood glucose analysis by enzymatic diagnostic kits (Diasys diagnostic kits). Feed intake was unaffected by curry leaves. Serum total cholesterol level was significantly ( $P < 0.05$ ) lowered by 6.0%, 12.4% and 15% in birds fed with 0.5% (T1), 1% (T2) and 1.5% (T3) curry leave diets respectively compared to the control. There was no significant difference in triglycerides and HDL levels among treatments. LDL level was significantly ( $P < 0.05$ ) lowered by 26.0, 30.7 and 34.6% respectively in birds fed with 0.5 (T1), 1.0 (T2) and 1.5 (T3) % curry leave levels. Curry leave significantly reduced the serum glucose level by 10, 13 and 16% in birds with 0.5 (T1), 1.0 (T2) and 1.5 (T3) % curry leave levels respectively. Results suggest that curry leaves exert a hypoglycaemic and hypocholesterolemic effects in broiler chicken.

**Keywords:** *curry leave, broilers, blood glucose, cholesterol*

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**EFFECT OF MARINATION AND COOKING METHODS ON NUTRITIONAL COMPOSITION  
AND EATING QUALITIES OF BROILER CHICKEN AND IMPACT OF MARINATION  
ON *Salmonella* TYPHIMURIUM**

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Effect of marination and cooking methods on nutritional composition and eating qualities of broiler chicken and impact of marination on *Salmonella* in meat were evaluated. Twelve chicken breast samples (n=12) were used and 6 samples were marinated using a traditional marinade. Three out of six samples were roasted and the rest were boiled. The unmarinated six samples were the control and three out of them were roasted and remaining were boiled. Cooking loss, moisture content, ash, fat, pH and water holding capacity (WHC) were measured in each sample. In a separate experiment, 14 breast meat samples were artificially contaminated with *Salmonella* Typhimurium (ATCC 14028) at two cell concentrations ( $10^2$  CFU /g and  $10^9$  CFU /g of meat) and marinated. Unmarinated artificially contaminated samples were taken as the control. Recovery of *Salmonella* Typhimurium was investigated following marination for 24 hrs by colony counting. Moisture content of roasted meat was significantly lesser than that of boiled meat in both marinated and unmarinated situations. Ash and fat contents were significantly higher in boiled meat compared to roast. There was no significant effect of marination on moisture, ash and fat content. The pH value of marinated meat was significantly lower than that of unmarinated. Roasted meat showed significantly higher pH than boiled meat. Boiled meat samples showed higher WHC than that of roasted. There was no significant effect of marination on WHC. Significantly higher cooking losses were reported from marinated roasted meat. Furthermore, the experiment showed significant reduction ( $P < 0.05$ ) in bacterial count in marinated meat samples ( $7.5 \text{ CFU/g} \pm 2.1$ ) compared to the unmarinated ( $87.5 \text{ CFU/g} \pm 3.1$ ) at  $10^2$  CFU /g bacterial concentration. Even at  $10^9$  CFU /g level, bacterial count of marinated meat ( $5.57 \text{ log CFU/g} \pm 0.02$ ) was significantly lower than that of unmarinated. ( $8.99 \text{ log CFU/g} \pm 0.0033$ ). Cooking methods affect on nutritional and eating qualities of meat while marination affects on pH and cooking loss in meat. Marination can be successfully used to reduce *Salmonella* Typhimurium in broiler chicken.

**Keywords:** *marination, broiler chicken, nutritional quality, eating qualities, Salmonella Typhimurium*

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**ORAL PRESENTATIONS**  
**AGRO-ENVIRONMENTAL RESOURCE MANAGEMENT**

## INVITED PRESENTATION

### THE NEED FOR INTEGRATED WATER RESOURCES MANAGEMENT FOR SUSTAINABLE AGRICULTURE

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The hydrological cycle binds together all components of the earth's various ecosystems, drives all natural (physical, biological and chemical) processes and sustain various organisms, plant and animal communities, humans and all life processes and activities. When ecosystems are classified based on dominant vegetation, we identify forests, grasslands, dessert and agricultural ecosystems. Therefore, the theme "Agro-environmental Resource Management" is a small component of the total ecosystem that we live and interact with. With increasing dependence of water, first for agriculture and domestic use, and later for industrial development, humans learned to manage the water resources, particularly in terms of their limited availability and extreme seasonal variability. In recent years, water managers are confronted with a new dimension of environmental consequences primarily due to the degradation of both water quality and quantity as a result of various anthropogenic activities. The agricultural sector which converts forest and grasslands to agricultural lands, abstract water both from surface and subsurface sources, apply excessive quantities of agrochemicals and discharge effluent generated from agro-processing industries to water bodies is largely responsible for this situation. The Integrated Water resources Management concept, defined as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" was put forward as a way forward to address these complex issues of addressing the problems with regard to the degradation of water resources. The presentation will focus on the status at present and what we need to do in future to sustain one of the key resources (water) required for agricultural production in Sri Lanka.

**Keywords:** *integrated water resources management, ecosystems, sustainability*

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## INVITED PRESENTATION

### AGRO ENVIRONMENTAL RESOURCE MANAGEMENT; IS IT DILEMMA IN SRI LANKAN CONTEXT?

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Ever increase in population and consumption levels demands exponential increase in food production and this has resulted in limited availability of natural resources making them economic commodities. Technological advancements in agriculture in recent past were more focused on high yields under monoculture system challenging the environmental integrity and its sustainability. Food security is considered to be the first most important component to maintain the stability of a country. Sri Lanka needs to produce more in agriculture with negative trade balance in this sector. True sustainability refers to zero negative impact to the environment; however in practice, cost on environment from agriculture is sought to be maintained at acceptable level. Environmental resources refer to natural capital and however in utilizing them in agriculture, holistic approach is to be taken with due consideration given to socio-cultural, political, economic and scientific aspects. Conflicts of interests have jeopardized most of agro based programmes with few success stories. Human-elephant conflict, Rajarata kidney disease problem and many such complications in the country are obviously associated with poor management of environmental resources. Being complexity, true impact assessment on environmental sustainability is rather difficult and methodologies are ever evolving. However, analytical techniques like lifecycle analyses, livelihood assessments and ecological, carbon and water footprint calculations facilitate to develop projects at near perfection. Note for concern; Sri Lankans have already consumed natural resources over the availability of the country though it is below the global average, according to ecological footprint calculation in 2010. Concepts like minimum tillage, intercropping/farming systems instead of monoculture systems, integration of different businesses to agriculture such as agro-tourism may be some tools for success.

**Keywords:** *sustainability, Sri Lankan agriculture, ecological footprint*

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**ASSESSING SUITABLE NURSERY TECHNIQUES FOR  
*Khaya senegalensis* (Desr.) A. JUSS.**

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*Khaya senegalensis* (Desr.) A. Juss, commonly known as African mahogany is becoming a priority species for forest plantation establishment in the dry zone of Sri Lanka, especially due to poor performance of *Eucalypts camaldulensis* as well as wild elephant's damage on *Tectona grandis*. Seed supply is one of the most critical factors limiting the *K. senegalensis* planting programmes. In addition, there is a high demand for seedlings from farmers and smaller growers in the country. This study was carried out at the central nursery of Forest Department in Polonnaruwa district to evaluate some selected shade types, establishment methods for raising nursery stocks, and potting mixtures on the performance of locally collected planting materials. Split-split plot design was applied while SAS software was used to analyze the data. The result revealed that the coconut fronds, which are easily available and inexpensive, have advantages over teak branches. As well, both planting materials of wildings as two-leaf and four-leaf stages seedlings were better options for scarcity of planting materials. Also, top soil; mixture of top soil, cow dung and sand (3: 1: 1); mixture of sub soil, cow dung and sand (2: 1: 2) can be used as a solution for scarcity of potting media. Every nursery has its own microenvironment, a unique target, planting sites, climate, or clients that require special seedling quality standards and standard nursery practices. Hence, site-specific research can be used to obtain better solution for the most of nursery constraints in efficiently and effectively.

**Keywords:** *planting materials, shade type, potting media, Khaya senegalensis, nursery techniques*

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## EXPLORING THE POTENTIAL OF THE DUALEM-1S SOIL SENSOR TO PREDICT SOIL QUALITY INDICATORS

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Proper characterization of the spatial variability of soil quality is essential to optimize soil management. Its characterization through manual soil sampling and subsequent analysis is time-consuming and less cost-effective. The DUALEM – 1S is an electromagnetic induction based proximal soil sensor which can be used to measure apparent soil electrical conductivity (ECa) on-the-go. As ECa is influenced by many soil properties, including soil quality indicators, DUALEM-1S sensor measurements can have a considerable potential for the spatial characterization of soil quality. The objectives of this study were to investigate the spatial variability of ECa, measured with the proximal soil sensor, and to explore the relationships between ECa data and selected soil quality indicators of an agricultural site. This study site (20 ha) is located in the Lunuwila area of the intermediate zone of Sri Lanka. Soil ECa was measured using the DUALEM-1S sensor attached to a sled. Thirty two topsoil (0-40 cm) and subsoil (40-80 cm) samples were collected using directed soil sampling. The soil quality indicators coarse gravel, sand, silt, and clay content, pH, electrical conductivity, cation exchange capacity and total exchangeable bases were determined. The ECa of the selected field was low compared to measurements obtained in moderately weathered soils of temperate regions. Mean ECa values of perpendicular geometry (PRP, i.e. ECa<sub>PRP</sub>) and horizontal co-planar geometry (HCP, i.e. ECa<sub>HCP</sub>) were 1.1 and 4.9 mS/m, respectively. Larger values of ECa<sub>HCP</sub> indicated the presence of a highly conductive subsoil compared to the top soil. The ECa<sub>PRP</sub> and ECa<sub>HCP</sub> maps revealed a considerable heterogeneity of the studied soil. A significant (0.05 significance-level) correlation was found between the ECa<sub>PRP</sub> and clay, sand and gravel (petroplinthite) content, pH and total exchangeable base cations. The correlations of the soil quality indicators with the ECa<sub>HCP</sub> were not significant. This study showed that soil ECa data obtained by the DUALEM-1S sensor has the potential to be used as secondary information to predict these soil quality indicators under Sri Lankan conditions, emphasizing the importance of further investigations.

**Keywords:** *DUALEM-1S sensor, apparent electrical conductivity, spatial characterization, soil quality indicators.*

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## ANALYSIS OF HISTORICAL AND PREDICTED TREND FOR RAINFALL AND TEMPERATURE IN SRI LANKA

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It is well known that the earth is under a pressure due to global climate change. The impact is worldwide and it has become a major concern to the society. Most obvious changes are rise of global temperature and alteration of temporal and spatial precipitation patterns. During the past decades, many researchers have identified changes in major climatic variables in many parts of the world and Sri Lanka, as well. Therefore, this study was carried out to investigate the trend distributions for historical and predicted rainfall and temperature time series. The objectives were to (1) analysis of both historical (1930 – 2000) and future (2000 – 2100) trends in rainfall and temperature in Sri Lanka, (2) spatial interpolation of temporal trends to the whole country and to (3) compare and discuss the difference in temporal trends and spatial distribution for historical and predicted rainfall and temperature time series. Monthly observed data from 1930 – 2000 were downloaded from Global Historical Climatological Network (GHCN) version 2.0. From 2001 to 2100 monthly rainfall and temperature values were simulated from General Circulation Model (GCMs) predictions by using Least Squares Support Vector Machine (LS-SVM). Simple linear regression and Mann-Kendall tests were used to detect the long term linear and non-linear trends, respectively. Annual and seasonal spatial distributions of trend statistics were mapped by inverse distance weighted interpolation method (IDW). Historical results show that there is no upward or downward significant trend for rainfall in most parts of Sri Lanka. Predicted rainfall trend distributions have a rich spatial pattern and significant upward trend for annual as well as seasonal. However, the North East Monsoon season will be a distinctly dry period for most parts of the country. South West Monsoon, First Inter Monsoon and Second Inter Monsoon may bring heavy rainfall in the future and may broaden the boundaries of the wet zone. There is a threat of developing a nearly semi-arid region around Batticaloa and the eastern coastal belt. Current semi-arid regions seem to be unchanged in the future scenario. Both historical and predicted temperature trend distribution results verify that whole country is undergoing an increasing threat of global warming.

**Keywords:** *climate change, trend analysis, rainfall, temperature, Sri Lanka*

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**ASSESSING AGRICULTURAL VULNERABILITY TO CLIMATE CHANGE IN SRI LANKA:  
APPLICATION OF THE IPCC METHOD**

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Climate change is a global phenomenon which reflects its impacts and consequences on environmental changes as well as livelihood adaptations. Vulnerability is defined as the degree to which a system is susceptible with adverse effects of climate change. The objective of the study was to improve understanding of the vulnerability to climate change that occurs spatially with time to make investment decisions. Analysis was undertaken for 22 Districts in Sri Lanka. Indexes were formulated based on indicators developed by the Inter governmental Panel on Climate Change (IPCC) for exposure, sensitivity and adaptive capacity. Identification of the functional relationships between indicators and vulnerability were done. All cross sectional data were collected from secondary sources for ten-year periods from 1977 to 2007. Districts were compared in terms of the vulnerability indexes. Chi-squares test was employed to find out associations. In 1977, Badulla was the most exposed District to climate related events and Nuwara-Eliya was the least. In 2007, Kurunegala was the most exposed District and the least was Matara. In 1977, Colombo revealed as the most sensitive District while Mannar as the least. In 2007, Gampaha was the most sensitive District and Trincomalee was the least. In 1977, Jaffna District had the highest adaptation capacity and Anuradhapura the lowest. In 2007, Batticaloa District had the highest adaptation capacity while Anuradhapura had the lowest. It was evident that in 1977, Colombo as the most vulnerable District and it remained as same over the period from 1977 to 2007. Nuwara Eliya and Polonnaruwa had emerged as the least vulnerable District in 1977 and 2007 respectively. The Chi-square test revealed that the ranking of Districts has no concordance with the overall vulnerability. Although the results were not statistically significant, this analysis has provided a sound theoretical base for analyzing vulnerability and its ranking. Availability of data for more indicators would have been resulted more precious judgments. However, it can be suggested that more attention has to be paid to most vulnerable areas by launching Government development programmes in livelihoods and infrastructure. Vulnerability status of Districts must be considered in future policy formulation of the Government.

**Keywords:** *climate change, vulnerability, exposure, sensitivity, adaptive capacity*

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## APPLICATION OF SEBAL MODEL FOR THE MAPPING OF EVAPOTRANSPIRATION POTENTIAL IN VAVUNIYA DISTRICT

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Evapotranspiration is of great importance to water resources management and a key process in land surface–atmosphere studies. It mainly depends on water availability and incoming solar radiation and reflects the interactions between surface water processes and climate. Evapotranspiration is an essential component for hydrological works & for the cultivation practices in which water loss from both top soil and plants. Evaporative fraction is an energy basis factor that determines the extent of evapotranspiration. This study aims to estimate the evaporative fraction spatially and temporally using remote sensing technology and to propose a simplified method to modify the traditional SEBAL (surface energy balance algorithm for land) model for mapping the evapotranspiration potential in Vavuniya district with the meteorological data for the period of January to June, 2013. SEBAL model was employed to estimate the evaporative fraction using sensible heat flux. This study revealed that the regions with high water availability reported a higher evaporative fraction. In contrast the regions with low water availability reported a lower evaporative fraction. Finally the simplified method enables the traditional SEBAL model to be applied to the vast area with limited availability of meteorological data. This approach could be recommended to identify the areas which necessitate water conservation strategies to be implemented.

**Keywords:** *SEBAL, evaporative fraction, evapotranspiration, remote sensing; sensible heat flux.*

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## MAPPING DISTRIBUTION PATTERNS OF POPULATION DENSITY IN GN DIVISIONS BASED ON LAND USE TYPE –ERAVUR PATTU DS DIVISION IN BATTICALOA DISTRICT

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Population density is widely used as an indicator in infrastructure planning and designing of urban and agricultural developments which are taking place especially based on the availability of the natural resources in the form of livelihood support. Unplanned developments and urbanization will create losses not only to the developers but also to the natural resources which are identified as scared resources. The study is mainly focuses on the distribution pattern of the population in the form of population density based on land use in the Eravur Pattu DS Division, Batticaloa. Residential potential method was adopted to calculate the land use based population density in this study. Land use details were obtained from 1:50000 scale topographical map sheets and Grama Niladari Division boundaries were used in the analysis. Population distribution in agricultural land use was calculated by cross calculation of population density multiplied by moderate value of residential potential of the land use. This was compared with the situation where the land use is not considered in calculating population density (flat rate). The comparison of the study revealed that it is important to include a small percentage of residential potential in vegetated land uses to get a good overview of the population density in an area. This shows a good picture of the population density in Eravur Pattu DS division, Batticaloa based on land use. This kind of updated digital data base on land use will give further information for the future researches where the agriculture is the main livelihood of the people.

**Keywords:** *Landuse, population density, digital database*

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## DEVELOPMENT OF A PORTABLE PAPER-BASED TOOL FOR THE ROUGH ESTIMATION OF SOIL PHOSPHORUS

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Farmers used to add recommended levels of fertilizers based on the field area regardless of available nutrients in the field. Excess fertilizers can leach in to ground water and excessive use of fertilizers may increase the price of final products. Estimation of nutrient levels in the field before applying the fertilizers will give an idea on the actual fertilizer requirements. Conventional methods that determine N, P and K levels are complex and require expensive instrumentations. A new portable paper-based micro fluidic device was developed for the determination of soil phosphorus level. This proposed paper-based method is capable of detecting up to 10 ppm phosphorus in soil. This new method requires no sample preparation, and the aqueous extraction can be directly applied to the micro fluidic paper-based device to determine the phosphorus level. Micro fluidic device consists of channels created with wax on a chromatographic paper, which are treated with a coloring agent. A mixture of antimony potassium tatarate and ammonium molybdate is used as the coloring reagent and in the presence of arsenic, coloring reagent produces a significant color change. After the color is developed, paper strip is scanned using an image scanner, then the color intensity is determined using an image editing software. A calibration plot is created using a series of standard phosphate solutions. This calibration plot is used to determine the concentration of unknown phosphate solutions. These paper-based micro fluidic devices can be considered as a new research area which has many advantages.

**Keywords:** *paper-based micro fluidic devices, portable tool, soil phosphate*

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## DEVELOPING IMPROVED CHEMICAL FERTILIZER AND BIOFILMED BIOFERTILIZER FORMULATIONS TO BE USED IN RATHNAPURA TEA ESTATES

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Combined application of biofilmed biofertilizers (BFBFs) and 50% of Tea Research Institute recommended chemical fertilizers for tea showed moderate yields in Rathnapura. Leaf analysis revealed that this was due to limited nitrogen supply in the soil. Therefore, present study was undertaken to improve mineralization of soil N with newly developed CF and BFBFs formulations to be used in Rathnapura. A soil leaching tube experiment was conducted under laboratory conditions with all possible combinations of existing and newly formulated CF, BFBFs and 50% or 100% CF alone or together with the BFBF. The BFBFs alone was also used as a reference treatment. Soil alone without amendments served as the control. All treatments were replicated three times in leaching tubes and arranged in a Complete Randomized Design. Mineral N was recovered by leaching with 100 ml of 0.01M CaCl<sub>2</sub> followed by a mineral solution in every two weeks. Organic matter content, microbial biomass C and N and soil texture were measured, before and after the experiment. Available N, phosphorous and exchangeable potassium contents in leachates were determined. When new BFBF having a newly isolated fast growing fungus was coupled with the new 50% CF formulation, it tended to establish a larger potentially mineralizable N pool with increased N and P mineralizations compared to existing formulations. Increased turnover rate of the microbial biomass established from the new BFBF having the new fungus may have enhanced N mineralization process, which led to improve N release. However, K release was not sufficient in the treatment. Thus, further studies are needed to increase K release by changing proportion of K in the new CF formulation.

**Keywords:** *biofilms, chemical fertilizer, microbial biomass, N mineralization*

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## IMPACT OF LOCALLY AVAILABLE ORGANIC AMENDMENTS WITH LEACHING ON RECLAIMING SALINE SOILS

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A leaching column study was conducted at Eastern University, Sri Lanka to study the impact of locally available organic amendments with leaching on reclaiming saline soils. Farmyard manure (FYM), gliricidia (G), partially burnt paddy husk (PBPH) and tank silt (TS) were used as soil amendments with leaching. All amendments were applied alone (4 treatments) and combination of farmyard manure with other amendments (3 treatments) at the recommended rate. The eight treatments including the control (simple leaching without amendments) were replicated three times in a complete randomized design. The amendments were added to saline soil from paddy land in Vaharai D.S. division, Batticaloa having the electrical conductivity (EC) and soil pH 13.1dSm<sup>-1</sup> and 7.8 respectively. Saline soils mixed with treatments were filled in each leaching column (5.4 cm internal diameter and 30cm height), and incubated in room temperature for three weeks. After incubation, columns were filled with distilled water up to their saturation point. Then once in two weeks 150 ml of distilled water was added to each leaching column and leachate was collected. Altogether four leaching cycles were completed during the study period. EC was measured in each leachate and in soil after whole leaching. There was a significant reduction in EC from 1<sup>st</sup> to 4<sup>th</sup> stage of leaching. The reduction may be due to the binding action of organic amendment and leaching water that dissolved and carried salts while passing through soils. At the final stage of leaching, the EC of leachate from TS was significantly higher among the amendments and was comparable to FYM+TS. In final leachate significantly least amount of EC was observed in G and was on par with PBPH and FYM+PBPH. This may be due to the impact of PBPH on ionic concentration. PBPH may function as salt ion binding agents which detoxify the toxic ions, thereby the EC may get reduced and significantly least EC was recorded in PBPH amended soil. This clearly indicates that PBPH is the best amendment to reduce salinity in soils.

**Keywords:** *electrical conductivity, organic amendments, saline soil*

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**A COMPARISON OF ACCUMULATION OF HEAVY METALS (Pb, Hg, Cd AND Cr) IN  
SOIL AND SELECTED VEGETABLES FROM KALUTHAWALAI FARMS  
IN BATTICALOA DISTRICT**

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During the last decades, the increasing demand for food safety has stimulated research regarding the risk associated with consumption of food contaminated with pesticides, heavy metals and toxin. Edible portion of four vegetables; Long bean (*Vigna unguiculata* subsp.), Onion (*Allium cepa*), Chilli (*Capsicum annum*.L) and Brinjal (*Solanum melongena*.L) were analyzed for heavy metals; Lead, Mercury, Cadmium and Chromium by using atomic absorption spectrometer. Concentration of Chromium is higher than the concentration of Lead, Mercury and Cadmium in the vegetables and soil samples. Chromium intake is higher by plants as reflected by high soil plant transfer coefficient. The heavy metal levels recorded in selected vegetables exceeded the maximum permissible levels (FAO/WHO Standards), indicating possible health hazards to consumers. Among the tested vegetables, Brinjal is more susceptible for heavy metal contamination than the others, as the total concentration of heavy metals is high in Brinjal than the other vegetables.

**Keywords:** *Heavy metals (Pb, Hg, Cd and Cr), Atomic absorption spectrometry, Vegetables (Long bean, Onion, Chilli and Brinjal) and Soil Plant Transfer Coefficient (SPTC)*

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**HOUSEHOLD WATER USE AND SANITATION OF RURAL COMMUNITY IN THE  
RESETTLEMENT AREAS OF THE ERAVUR PATTU DIVISIONAL SECRETARIAT  
IN BATTICALOA DISTRICT**

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An assessment of water use and sanitation of the rural community in Sri Lanka is a necessary investigation for the sustainable development. In this view, this study was conducted to find out the status of household water use, sanitation and hygiene of rural community in Eravur Pattu Divisional Secretariat Area of Batticaloa District. Two hundred households were selected by random sampling method. Questionnaire survey, field observation and group discussion were used to gather information. Collected data were statistically analyzed using SPSS. Results revealed that the socio-economic characteristics of households vary within the DS areas. About 60% of the people poses primary education and has a basic knowledge on water use, sanitation and hygiene. Most of the households had access to semi-protected wells (70%) as the main water source and use plastic jerry cans (42%), aluminum cans with lids (54%) and clay pots (4%) for water storage at houses. Sixty two percentage of the households reported that they get good quality water by adopting water treatment practices such as boiling (47%), filtering (52%) and chlorination (< 2%). Low level (about 14%) of water borne diseases was observed in this area. It is also observed that, 16% of them are washing the hands after defecation and 19% before eating. Soap/ash (91%) was the very common disinfectant material used to wash hands by households. Lack of water and poverty were the constraints for them to constructing and use latrine in their houses. Therefore, it is recommended to provide water through NWSDB to these area for domestic use and to aware on water use, sanitation and hygiene in order to solve their problems. Further, changing attitudes on waste management will contribute to the good sanitation and hygiene condition in this area.

**Keywords:** *sanitation, water shortage, water use, hygiene*

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## PHENOLOGY OF *Humboldtia laurifolia*: A POTENTIAL PLANT FOR LANDSCAPING

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*Humboldtia laurifolia* commonly known as Gal-Karanda is a native, wild plant belongs to the family Fabaceae. It is naturally distributed in lowland and upland forests of Sri Lanka. This plant has a potential ornamental use. Hence, the present study was conducted at Wayamba University of Sri Lanka, Makandura (Low country Intermediate Zone – IL1a) with the objective of investigating the flowering phenology and wildlife potential of this plant in view of promoting it in the landscape industry. Flowering phenology which includes time, duration and frequency of flowering and animal visitation and visitation pattern was observed. Flowering at population level was observed at Galagedara forest reserve, Kuliypitiya (IL1a) and individual flowering was recorded two plants raised at the faculty premises, Makandura. To monitor individual flowering, 20 inflorescences were tagged. Mass flowering was observed in *H. laurifolia* three times a year from January to February, April to May and August to September. During mass flowering 75-80% of the canopy was covered with flowers. Flowers started to bloom at 1.20 pm and a fragrance was present in fully bloomed flowers. The duration of an individual flower is 3 days. The corolla of the flower belongs to white group 155B and stigma is grayed red group 178 (RHS colour chart). Flowering initiated from the base of panicle and continued towards the top and the duration of an inflorescence was 10 days ( $\pm 2$ ). Pollen release observed at 3.20 pm and floral visitors viz. butterflies, bees, stingless bee and ants were observed from 6.00 am to 6.00 pm. Stingless bees were the most common visitor and two peak visitation patterns were observed in the morning (9.00 am) and afternoon (4.00 pm). This plant is smaller in size (about 5m) hence it has a potential to introduce into urban landscaping to fit into smaller spaces as there is a demand for native plants in the landscape industry. It produces attractive flowers and tree architecture is also attractive. Further, flowers attract insects hence can be promoted in wildlife gardening.

**Keywords:** *Humboldtia laurifolia*, landscaping, native, phenology, wildlife gardening

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## EFFECT OF SILANE COUPLING AGENT ON PROPERTIES OF NATURAL RUBBER/ SILICA/ NON-REINFORCING FILLER COMPOSITE

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Elastomers are not used alone for the manufacture of rubber products. They are generally compounded with many substances to improve their properties. Carbon black is the most widely used reinforcing filler in rubber compounds. This research was conducted to evaluate the reactivity of the silane coupling agent on different non-reinforcing filler composites. The compatibility of Natural Rubber (NR) with non-reinforcing fillers varies with the silane coupling agent; accordingly physico-mechanical properties of NR composites may vary. Four different filler composites were prepared with the fillers such as calcium carbonate, dolomite and kaolin. Control sample was prepared without any non-reinforcing filler. All the NR composites were analyzed using a rheometer, and were cured using the times obtained by rheograph analysis. The mechanical properties of those samples were tested with standard methods. According to the results from cure characteristics, dolomite is the more compatible non-reinforcing filler compared to other fillers. Abrasion volume loss is also minimum in the sample containing dolomite. Higher rebound resilience and hardness were shown by the sample containing kaolin. According to the results, optimum composite was the composite containing dolomite since it has higher scorch time, lower minimum torque, lower cure rate and higher tensile strength compared to other two non-reinforcing fillers. The compatibility of dolomite with NR was greater with the presence of silane coupling agent. More durable NR composite was formed with the coupling of NR with dolomite filler.

**Keywords:** *silane coupling agent, physico-mechanical properties, carbonate, dolomite, kaolin*

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**ORAL PRESENTATIONS**  
**CROP IMPROVEMENT AND PRODUCTION TECHNOLOGIES**

## INVITED PRESENTATION

### SUSTAINING AGRICULTURE AND FOOD SYSTEMS FOR SUSTAINABLE FOOD SECURITY

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Agriculture and food systems face many challenges, making it more difficult to achieve the primary objective of meeting the world food demand. An intimidating set of unprecedented challenges and risks including the increasing competition for land, water and other natural resources by non-agricultural sectors affect the food security of the current and future inhabitants of the world. Food security is multidimensional and the population growth and changes in consumption patterns associated with rising incomes drive greater demand for food and other agricultural products. Sustainability of food security should be achieved under a more extreme and also more uncertain future climate, too. This need is further exacerbated with the outcome of the Rio+20 conference on Sustainable Development held in 2012, initiating an inclusive intergovernmental process to prepare a set of Sustainable Development Goals (SDGs) in the post-2015 era. A new approach for long-term sustenance in food security is thus a necessity by effectively drawing in ecological principles to improve the productivity and efficiency of agriculture and food systems while reducing negative environmental impacts. Substantial gains in productivity in agriculture and food systems can be realized through investment, innovation, policy and other improvements. Advancements in the productivity frontier, transformations in production systems and enhanced food and environmental safety are three goals to achieve by countries, and Sri Lanka is not an exception. Realizing these goals will require an exceptional level of collaboration among stakeholders in the agricultural value chain including government, private sector, civil society groups, academia/scientists, farmers and consumers. Science and technological progression will make it possible for sustainable agriculture to become the new global standard, but the main factors resisting this change are political will, lack of policy coherence at many levels, financing, governance and human behavior.

**Keywords:** *agriculture and food systems, science and technology, sustainable food security,*

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## INVITED PRESENTATION

### RICE IMPROVEMENT IN SRI LANKA

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Rice production in Sri Lanka has tremendously increased over the past seven decades so that Sri Lanka has now become self-sufficient in rice. The major reason for this has been the sustainable increase in productivity of rice which can mainly be attributed to rice variety improvement. Rice varieties tolerant to major pests and diseases with a yield potential as high as 11t/ha have already been developed. Depending on the challenges in the rice sector, specific rice improvement objectives at present are sustainable yield increase at farmer level through further improving variety yield potential and reducing the yield gap at farmer level by improving varietal adaptability, improving grain quality to fit for the purpose and improving variety tolerance to biotic and abiotic stresses and variety fertilizer use efficiency. Strategies to improve yield potential up to 14t/ha would be the development of new plant type and hybrid rice. Subsequent development of hybrids on new plant type or super rice is expected to increase yield potential up to about 17t/ha. The use of quantitative trait loci may lead to small incremental yield improvement but not quantum jumps. Development of environment specific ideotypes considering plant architecture, maturity duration and tolerance to biotic and abiotic stresses would improve adaptability of rice varieties to specific environments and this may reduce the yield gap to an appreciable level. As country is self-sufficient in rice in terms of quantity at present, now the grain quality particularly eating & cooking and nutritional quality improvement is emphasized while maintaining the present yield level. Strategies to achieve this goal are not remote as no strong negative correlations among grain quality characteristics have been reported. Stabilizing yield and reduction in cost of cultivation are expected through the development of varieties that are resistant to comparatively a broader range of biotic and abiotic stresses along with increased fertilizer use efficiency. Existing genetic variability will be fully exploited in this respect and emphasis will be placed on the use of non-conventional breeding tools/techniques.

**Keywords:** *rice, Sri Lanka, variety improvement*

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## EFFECT OF HOT WATER SOAKING ON EFFLUENT CHARACTERISTICS OF PADDY PARBOILING PROCESS

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Sri Lanka is an Agriculture based country where paddy production plays a key role to gross domestic production. People in Sri Lanka consume rice as their staple food to keep their nutritional profile. Paddy grains can be processed by various methods. Parboiling is one of the pre treatment methods used to processing, which generally involves soaking, steaming and drying of grains. There are various methods available for soaking. Hot water soaking is one of the methods used for quick hydration at commercial level. However, it has not become an acceptable practice in Jaffna to process Nadu type long grains. Hence, an attempt was developed to study the effect of temperature on the effluent characteristics of paddy parboiling process. The hypothesis of the experiment was that an increase in water temperature would increase the effluent strength in terms of BOD value. An experiment was therefore developed at laboratory using thermo-stable water bath with selected temperatures 40, 50, 60, 70 and 80°C. Conventional cold soaking was carried out with same conditions for comparison. A kilogram of Nadu type long grains was taken and proportionate amount of water was used in all trials. After soaking, paddy samples were steamed and dried. The effluent samples at defined interval were taken for pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Bio-chemical Oxygen Demand (BOD) measurements. Results revealed that the increase in water temperature during soaking has increased EC, TDS and BOD of the effluent samples and decreased pH. Hot water soaking can therefore be practiced at commercial level as it reduces effluent quantity and soaking time significantly compared to cold soaking practiced commonly in Jaffna to process Nadu type long grains. However, the validation of this concept at commercial level will be a challenging task.

**Keywords:** *effect, effluent, hot water, parboiling, soaking*

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## SUITABILITY OF DOUBLE-LAYER EVAPORATIVE COOL CHAMBER FOR PRESERVATION OF SELECTED VEGETABLES IN JAFFNA PENINSULA

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Proper storage and transport facilities are to be made to minimize prevailing high postharvest losses of vegetables. Introduction of economically viable storage systems is essential to keep vegetables fresh until marketing and consumption. A double-layer evaporative cool-chamber would develop suitable conditions for preserving vegetables and minimize weight loss. Hence, an attempt was made to develop a double-layer evaporative cool-chamber for preservation of brinjal and carrot in Jaffna. A double layer evaporative cool chamber, which utilizes solar energy for evaporation, was made of bricks, concrete mixture and sand. Sand was filled in between two layers and saturated with water circulated from top to bottom. Internal and external temperatures of the chamber were measured. One kilogram of brinjal and carrot were selected for evaluation and placed inside and outside of the cool chamber. Weight loss was measured at 24 hours interval to check the effectiveness of the design. Sensory evaluation was also performed at the end using Friedman's test. Results revealed that around 4 - 7°C temperature difference (gradient) could be recorded between the external and internal environment. Physiological weight loss for selected vegetables was low for samples placed inside the cool-chamber than outside. However, sensory evaluation gave highest rank median for the samples placed inside the cool chamber in terms of colour, texture, appearance, freshness and overall acceptability. Designed cool chamber is therefore suitable for preserving vegetables in dry area. However, validation of this concept at farmers' level is a challenging task.

**Keywords:** *suitability, cool – chamber, preservation, vegetables*

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## DESIGN, DEVELOPMENT AND TESTING OF A MANUALLY OPERATED PINEAPPLE HARVESTER

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Pineapple (*Ananas comosus* (L.)) is a major fruit crop with four to eight years economical lifespan. It maintains as a ratoon crop to yield 4000 to 16,500 fruits per acre. There is no efficient method to harvest pineapple in Sri Lanka. The adoption of manual method is complex and labor intensive technique, increases injuries to laborers due to spines and the tips of the leaves. This study was aimed to develop a manually operated pineapple harvester. It was designed after investigating the possible maximum weight, dimensions of fruit and field conditions of pineapple. Major components of the pineapple harvester were handle, cutter and collector. The power was transmitted from handle to cutter by a lever with flat iron strips. The pineapple harvester was safe since the cutting blades are oriented to opposite side of the operator and it kept the pineapple spines away. The harvester was easy to operate because its light weight of 2.1 kg. The pineapple harvester was tested for the first, second and third ratoon stages to compare mechanical and manual methods, and received satisfactory results. The effective field capacities of the pineapple harvester for three consecutive harvesting stages were 0.03 hah<sup>-1</sup>, 0.03 hah<sup>-1</sup> and 0.03 hah<sup>-1</sup>. In sequence the field efficiencies were 80.51%, 69.03% and 75.38%. Damages to plant, leaves, fruit and operator were negligible. There was no significant difference ( $p > 0.05$ ) between performances of newly designed pineapple harvester and prevailing manual method, but the pineapple harvester was more safe in harvesting pineapple.

**Keywords:** *pineapple cultivation, pineapple harvester, fruit harvester*

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## EFFECT OF APPLICATION OF GIBBERELIC ACID (GA<sub>3</sub>) ON SHELF – LIFE OF BANANA CULTIVAR ‘KATHALI’

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*Kathali* (*Musa* sp) is the most promising banana cultivar grown by farmers in Jaffna. Post-harvest losses are very high in banana during transport and storage. Post-harvest losses could be reduced by extending green shelf-life of banana. A study was carried out to assess the effects of gibberellic acid (GA<sub>3</sub>) treatments on extending shelf-life of banana cultivar ‘*kathali*’. Four concentrations of GA<sub>3</sub> (250 ppm, 350 ppm, 500 ppm, 750 ppm) were applied by dipping method. The banana fruits were then packed in corrugated fibre boxes and kept at room temperature. Qualitative and quantitative data were obtained and used to analyze the shelf life of banana fruits. GA<sub>3</sub> treated fruits showed delayed peel colour development, total soluble solids accumulation, total sugar synthesis, decreased the rate of increasing pH and reduced cumulative weight loss during storage compared to control treatment significantly. Based on all the parameters, tested, 500 ppm and 750 ppm GA<sub>3</sub> levels significantly extended the shelf-life of *Kathali* cultivar of banana by 4 and 5 days, respectively. Increased concentration of GA<sub>3</sub> may result in extending shelf-life further. But cost effectiveness and effect on quality have to be evaluated before recommendation.

**Keywords:** *kathali, gibberellic (GA<sub>3</sub>) acid, dipping method, shelf-life*

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**EVALUATION OF STORABILITY OF BIG ONIONS (*DAMBULLA RED* SELECTION) UNDER  
CONTROLLED TEMPERATURE AND RH CONDITIONS FOR POSTHARVEST WASTE  
MINIMIZATION**

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The annual requirement of big onion in Sri Lanka is around 230,000 tonnes and only about 25% is locally produced at present. It is necessary to store mother bulbs harvested in September for about six months for seed production. Farmers can make significant profits by true seed production while satisfying their own seed requirements if they have a proper storage technology. However, the loss during long-term storage is greater than 50% at the farmer storage units due to bulb rot and germination. Therefore, the objectives of this study were to study the storage behaviour of big onions under different controlled environmental conditions and to assess the postharvest behaviour under selected optimum conditions in pilot scale controlled environmental storage. Storage behaviour of locally popular big onion cultivar, *Dambulla Red* selection was studied under two temperatures; 25°C and 30°C and three RH conditions; 60%, 75% and 90%, selected based on ten years of weakly weather data in *Dambulla*, using a lab scale locally fabricated environment controlled chambers. Both the temperature and RH effects were significant at  $\alpha = 0.05$  on the percentage losses. The combination of 75% RH and 25°C temperature was found to be the best among the tested conditions. Then the post harvest losses were assessed under selected optimum conditions in pilot-scale controlled environmental storage. The temperature (25°C) and the RH (75%) was controlled and monitored inside a 1000 kg capacity store with the recommended dimensions by the Department of Agriculture for storing mother bulbs for seed production. After six months, the percentage loss due to rotting, sprouting, moisture loss and physiological weight loss was 15% of the initial weight. The controlled environmental storage technology would ensure the reduction of postharvest losses of stored mother bulb onions and it would be technologically and economically feasible for storage of onion bulbs at farmer level.

**Keywords:** *big onion, bulb rot, controlled environment, Dambulla red selection, postharvest losses, long-term storage*

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**DETERMINATION OF APPROPRIATE STORAGE TECHNIQUES FOR FRESH GINGER**  
**(*Zingiber officinale*)**

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The objective of this study was to investigate on suitable storage techniques to store fresh ginger under ambient conditions. A complete randomized design (CRD) with six treatments and three replicates was used. Fresh ginger harvested three weeks before was stored for 90 days. The treatments were: storage in sealed packages made of low density polyethylene (LDPE) gauge 150 (T<sub>1</sub>), low density polyethylene gauge 300 (T<sub>2</sub>), polypropylene (PP) gauge 150 (T<sub>3</sub>), storage on the floor with sand in alternative layers (T<sub>4</sub>), storage with paddy husk in alternate layers (T<sub>5</sub>) and storing on the floor as a heap as the control (T<sub>6</sub>). Relative humidity and temperature of the storage environments were measured during the experiment period. Volatile oil content and moisture content as chemical parameters, and sprouting and weight loss percentage as physical parameters were determined at two-week intervals. An analysis of variance (ANOVA) with SAS statistical package was carried. Relative humidity and temperature of storage environment varied from 63% to 80% and from 23 °C to 26 °C respectively during the storage period. Ginger stored in packaging materials sprouted after 2<sup>nd</sup> week. Ginger stored as per traditional methods (T<sub>4</sub> and T<sub>5</sub>) and the control sprouted after 4<sup>th</sup> week. The oil and moisture contents decreased gradually with time. Significantly high oil and moisture contents were preserved in ginger stored in packaging materials than traditional methods (T<sub>4</sub> and T<sub>5</sub>) and the control. Weight loss of T<sub>4</sub> (46.58%), T<sub>5</sub> (33.47%) and T<sub>6</sub> (52.96%) were significantly higher (P < 0.05) than T<sub>1</sub> (2.49%), T<sub>2</sub> (2.18%) and T<sub>3</sub> (2.14%) after 03 months. Therefore, traditional storing techniques (T<sub>4</sub> and T<sub>5</sub>) are more effective storage methods for sprouting whereas other packaging methods were more effective against loss of weight, volatile oil and moisture three months after storage. Further studies are recommended with perforated packaging materials and without a delay after harvesting.

**Keywords:** *fresh ginger, storage techniques, sprouting, weight loss*

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## COMPARATIVE ANALYSIS OF ANTIOXIDANT ACTIVITY OF BLACK AND GREEN TEA INFUSIONS IN SRI LANKA

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Tea (*Camellia sinensis*) is the most widely consumed beverages in the world. Sri Lanka is the fourth largest tea producer and the second largest tea exporter in the world. Determination of antioxidant activity and the total content of antioxidants in foods, beverages, dietary supplements and herbal extracts like tea have gained much interest since antioxidants can prevent free radicals from damaging the human health. But little is known about antioxidant activities of tea produced in Sri Lanka. In this investigation the antioxidant activity of green tea {(Ceylon GT Special Hyson, Ceylon GT Fannings and Ceylon GT Gun Powder (GP) (Extra Spl))} and black tea {(Broken Orange Pekoe Fannings (BOPF), Dust and Broken Orange Pekoe (BOP))} samples of Sri Lanka was tested. Antioxidant activity was determined by Oxygen Radical Absorbance Capacity (ORAC) Assay. The ORAC values were calculated for tea infusions. The results were expressed as  $\mu\text{moles Trolox Equivalents (TE) mL}^{-1}$  of tea infusions. Green tea infusions showed the higher (11-12  $\mu\text{moles TE mL}^{-1}$ ) antioxidant activities than black tea (4-9  $\mu\text{moles TE mL}^{-1}$ ) infusions. Ceylon GT Fannings had  $12.26 \pm 0.73 \mu\text{moles TE mL}^{-1}$  ORAC value, which was the highest value out of the tested samples. Lowest value was  $4.26 \pm 0.72 \mu\text{moles TE mL}^{-1}$  for BOPF. According to the ORAC assay, all tested Sri Lankan green tea had high potential of antioxidant properties than black tea, although both categories were not significantly different at 5 % significant level. This should be further analyzed and confirmed by other antioxidant assays as well.

**Keywords:** *antioxidant properties, ORAC assay, green tea, black tea.*

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## EFFECT OF YELLOW STICKY TRAPS ON CABBAGE PESTS AND THEIR NATURAL ENEMIES

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Cabbage caterpillar complex is the major pest group of cabbage. Farmers heavily apply chemical insecticides to control their larval stages which damage the crop. To overcome the problems created by chemical pesticides, sticky traps which affect on their flying adult stages can be used as a mass trapping tool. A field study was carried out to determine the effect of sticky traps in controlling flying insect pests, to find the most effective sticky substance and to determine the effect of sticky traps on non target insects. Yellow colored buckets were used as the traps and Tangle foot, X-RAT – Rat glue, Grease, Castor oil, and used Motor oil were used as the sticky substances. Tangle foot which is a commercial sticky substance was used as the standard sticky substance. The treatments were completely randomized within eighteen plots to have three replicates from each. Once a week, sticky traps were examined directly, with a hand lens and under a microscope and the number of different insects stuck in each treatment were recorded. The duration of sticky substances actively available in the field, pest damages of the crops at the stage of maturity and harvesting, and the amount of Hymenopteran and Coleopteran insects stuck in each treatment were also recorded. Plots having sticky traps showed a grade two ( $0 < \text{Damage} \leq 20\%$ ) damage level which is very less compared to the control. Traps tested mainly trapped small Lepidopteran pests such as Diamondback moth and common flying insect pests such as Aphids, Whiteflies and Thrips. The numbers of insects stuck in each treatment were found to be significantly different when the data is statistically analyzed. Tangle foot, Grease and Castor oil were found as effective sticky substances. Grease was found as the best sticky substance by trapping the highest number of insects, being active in the field for the longest duration and being the most cost effective. In general of traps affect beneficial insect orders such as Hymenoptera and Coleoptera. These observations indicated that sticky traps can be used as an effective general trapping device and Grease is the best among the tested. As sticky traps adversely affect on non target insects, further modifications should be done make it more target specific.

**Keywords:** *cabbage pests, sticky traps, sticky substances, non target insects*

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**EFFICIENCY OF AGRICULTURAL BYPRODUCTS AS SUBSTRATES FOR MASS  
PRODUCTION OF ENTOMOPATHOGENIC FUNGUS *Beauveria bassiana* (BALSAMO)  
VUILLEMIN FOR CONTROLLING COFFEE BERRY BORER  
(*Hypothenemus hampei*) (FERRARI)**

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Coffee berry borer (*Hypothenemus hampei* (Ferrari)) is the most frequently occurring and destructive pest of coffee (*Coffea* spp.) in Sri Lanka. *Beauveria bassiana* (Balsamo) Vuillemin is an entomopathogenic fungus that has a great potential as a biological control agent for the control of coffee berry borer. This fungus is found naturally infecting coffee berry borer in Sri Lanka. In the large scale application, mass production of the fungal pathogen is essential. An experiment was carried out to investigate the effect of different agricultural byproducts which are freely available in Sri Lanka, including five solid substrates [coir dust, saw dust, refuse tea, disposable part of maize cob (pith + chaff + woody ring) and oil cake] and two liquid substrates (coconut water and molasses). Mass production was done under two temperature levels (room temperature  $30 \pm 2$  °C and incubator temperature  $25 \pm 2$  °C). Fungal pathogen was isolated from the infected coffee berries and pure cultured fungus was inoculated in to sterilized solid and liquid substrates at equal concentration. Inoculated substrates were placed in the incubator under room temperature and the experiment was continued for 8 weeks. The highest numbers of spores were observed in molasses ( $6.9475 \times 10^{13}$  spores/ml) among all the tested liquid and solid substrates in both temperature levels and it was significantly higher than number of spores produced in all other substrates. However, there was no significant difference ( $p = 0.2552$ ) with respect to the spore production in all substrates at room and incubator temperatures. Optimum spore production was achieved 42 days after inoculation of the fungus in all the substrates irrespective of the temperature.

**Keywords:** *Beauveria bassiana, coffee berry borer, entomopathogenic fungi, mass production, biological control*

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**CHARACTERIZATION OF SOME NEWLY IMPROVED TEA CULTIVARS;  
*Camellia sinensis* (L.). O. KUNTZE. USING MORPHOLOGICAL DESCRIPTORS**

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Morphological characterization is important for plant breeders to identify accessions with genetic variability to utilize them in future hybridization programmes. In addition, the exceptional characteristics and character combinations which distinguish accessions from each other would be useful in cultivar identification purpose, also which has become one of the most demanding needs among tea growers after the introduction of new improved cultivars. In this study, ten newly improved promising tea cultivars along with two standard cultivars were characterized using 22 standardized morphological descriptors. Principle Component Analysis (PCA) using the 22 morphological descriptors and clustering on the first six principles component (PC) scores accounted for about 87% of the total variation delineate the 12 cultivars into 3 well defined clusters. Although all 22 morphological descriptors found to be important in principle component analysis, three of them were found most deviating in grouping the accessions after cluster analysis. These descriptors were leaf shape, leaf apex shape and leaf apex habit. The study enables separating the cultivars into groups and confirmed to a reasonable extent using the information available on origin and progeny trials, and this would provide a reasonable foundation for future biochemical and molecular studies to use them effectively in future tea breeding and hybridization programmes. The cultivar identification guide prepared using the information gathered in the study could be utilized for future cultivar identification programmes.

**Keywords:** *tea cultivars, morphological characterization, principle component analysis, descriptors.*

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**ADAPTABILITY TESTING AND PERFORMANCE EVALUATION OF EXOTIC TOMATO  
VARIETIES (*Lycopersicon esculentum* L.) UNDER MID COUNTRY WET ZONE  
CONDITIONS IN SRI LANKA**

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A Randomized Complete Block Design experiment with two replicates was established at the research fields of Horticultural Crops Research and Development Institute, Gannoruwa (Mid country wet zone) to study the adaptability and agronomic performance of fifteen exotic varieties of tomato and one local hybrid variety Bathiya as standard variety. Plant height, days to flowering, number of fruits per plant, marketable and non-marketable yield (t/ha), fruit qualities, pest and disease incidences were recorded. Growth habit of variety Bathiya was indeterminate while others showed determinate or semi- determinate growth. Maximum plant height at first flowering and first harvesting were recorded by the varieties Milinda and Bathiya respectively. Variety E 15 M 00025 took lowest days (31 days) to 50% flowering. The variety 10 T 1320 produced highest number of fruits (62) per plant. Highest marketable yield (t/ha) was recorded by the check variety Bathiya (51 t/ha). The varieties 10 T 1320 and Misora were susceptible to bacterial wilt showing 42.2% and 34.2 %, respectively. The maximum plant stand was recorded by the variety E 15 M 00024 (100%) while the minimum plant stand was recorded by the variety 10 T 1320 (47%). The marketable yield of the varieties TO 1458, NS 4012 and Sonia produced significantly similar yield compared to the check variety Bathiya. Also, the bacterial wilt incidences of those three varieties were lower when compared to the other varieties and not susceptible for diseases. Hence, the varieties TO 1458, NS 4012 and Sonia are the potential recommendations for commercial cultivation in mid country wet zone.

**Keywords:** *exotic tomato, mid country wet zone, yield potential, bacterial wilt*

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## DNA BASED AUTHENTICATION OF SATINWOOD (*Chloroxylon swietenia*) FROM POSSIBLE CHEAP ADULTERATIONS IN FURNITURE INDUSTRY OF SRI LANKA

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*Chloroxylon swietenia* (Satinwood) is a valuable timber source in Sri Lanka. Satinwood is hard, heavy, durable and gorgeous in color and figure patterns. Because of these features and strict conservation measures, satinwood timber is very expensive. The carpenters blend or counterfeit satinwood with other low quality cheap timber species such as *Hevea brasiliensis* (Rubber) and *Michelia champaca* (Sapu) after spraying with dyes which provides the appearance of satinwood. However, a considerable attention has not been paid to identify the timber adulterations in Sri Lanka which is a huge violation of consumer rights. Therefore this research study was conducted to establish a DNA fingerprinting method to accurately identify satinwood from its possible adulterations in Sri Lankan furniture industry. Timber samples from the species of Satinwood, Rubber and Sapu were collected from reliable sources. Saw dust was obtained separately from each wood piece to fresh Eppendorf tubes by using three new sterile steel piles. The collected saw dust was ground with liquid nitrogen into a finer powder by using a mortar and a pestle. DNA was extracted from fine wood powder by using NucleoSpin Plant II kit. Seven random decamer primers were tested for PCR amplification and band polymorphism PCR products were sized separated on 1% agarose gel electrophoresis. The PCR was repeated three times for the primer which provided polymorphic bands. The primer OPA 02 generated specific polymorphic DNA banding patterns for all three species. The results were consistent for all three separate independent PCR runs. Other primers yielded non informative/ monomorphic or no bands. Satinwood can be distinguished from Rubber and Sapu based on polymorphic DNA banding patterns generated by marker OPA 02. According to our knowledge this is the first time of using DNA fingerprinting to detect timber adulterations. More over the proposed test uses DNA extracted from a tiny amount of saw dust (~0.1g) in which no damage is causing on furniture.

**Keywords:** *Chloroxylon swietenia*, timber adulteration, DNA fingerprinting

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## ANALYSIS OF THE LEAF COLOUR AND SHOOT DRY WEIGHT VARIATIONS DUE TO PHOSPHATE DEFICIENCY TOLERANCE IN RICE

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Phosphate is an essential macronutrient for profitable rice farming. Phosphate fertilizer is very expensive and are causing environmental pollution and health hazards. Therefore, development of rice varieties with phosphate deficiency tolerance (PDT) would be a promising solution. The objective of this study was to identify the segregation pattern of leaf colour variation and the correlation between leaf colour variation and shoot dry weight due to PDT in rice. The F<sub>2</sub> seeds of the four rice populations (Mas×Bg352, H4×Bg352, Suduheenati×Bg352 and Suduheenati×Bg357) and seeds of the parents obtained from a previously conducted research were established in a greenhouse at Peradeniya with each population having 75 individuals. As the potting medium, soil was collected from a field at RRDI, Bathalagoda where no fertilizer has been applied for last 30 years. For F<sub>2</sub> populations and parents, leaf colour measurements; L\*, a\* and b\* were recorded after six weeks of planting using a spectrophotometer. Plant dry weights were measured by collecting above ground portions of plants at the flowering stage. F<sub>2</sub> plant means for L\*, a\* and b\* were calculated and subjected to frequency distribution curve fitting and K-means clustering using the statistical package, MINITAB 14. The chi test for goodness of fit for the closest dihybrid ratio for the number of individuals in each cluster was conducted. The correlations between the color; L\*, a\* and b\* data of F<sub>2</sub> plants with shoot dry weight was tested. L\*, a\*, b\* and dry weight parameters are quantitative variables. When L\*, a\* and b were subjected to K-means clustering, three significant clusters were apparent for all four F<sub>2</sub> populations. The ratio of the number of individuals in three clusters of each F<sub>2</sub> population was following the dihybrid ratios of either 9:3:4 (Mas×Bg352) or 9:6:1 (H4×Bg352, Suduheenati×Bg352 and Suduheenati×Bg357). The observation of modified dihybrid ratios such as 9:3:4 and 9:6:1 indicates the occurrence of epistasis between two genes that have bigger effects. There was no correlation between shoot dry weight and L\*, a\* and b\*. Extremely sensitive and tolerant individuals of the four F<sub>2</sub> populations were selected for identification of molecular markers associated with PDT using bulk segregant analysis which is currently underway.

**Keywords:** *phosphate deficiency tolerance, L\*, a\*, b\*, Oryza sativa*

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## MARKER ASSISTED FOREGROUND SELECTION FOR IRON TOXICITY TOLERANT IN RICE (*Oryza sativa* L.)

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Iron toxicity is one of the major problems of rice production in low country wet zone and a minor problem in dry and intermediate zones of Sri Lanka. Thus, breeding of rice varieties having iron toxicity tolerance is considered as a national requirement. In the Sri Lankan iron toxicity tolerant rice breeding program, six backcross lines have been developed by using Bw-367, Bw-361, Kahata wee and 03-1198 as donor parents and Bw-272-6b and Ld-3-12-50 as recurrent parents at Regional Rice Research Station, Bombuwela. Plant selection of those breeding programme have been performed by using morphological markers. Therefore, three molecular marker was used to screen those population to increase the precision of the breeding programme. In this research, those parents were tested by using RM6, RM315, and RM252 SSR markers which are (located on chromosome 2,1 and 4 respectively) linked with Leaf Bronzing Index control QTLs under ferrous ion stress condition. Thirty five PCR cycles were performed to amplify the each SSR locus. Agarose gel electrophoresis (3%) and Polyacrylamide Gel Electrophoresis (7%) was used to check the polymorphism between the parents. RM6 marker showed polymorphism in both gel electrophoresis between line 1 parents (Bw-367,Bw 272-6b) and line 2 parents (03-1198 line, Ld 3-12-50). Hence, RM6 marker was used to screen the BC<sub>3</sub>F<sub>1</sub> and BC<sub>2</sub>F<sub>2</sub> population of line 1 and BC<sub>2</sub>F<sub>2</sub> population of line 2. Agarose gel electrophoresis (3%) was used to screen those populations. Seven heterozygous individuals from BC<sub>3</sub>F<sub>1</sub>, nine heterozygous individuals from BC<sub>2</sub>F<sub>2</sub> of line 1 and one heterozygous plant from BC<sub>2</sub>F<sub>2</sub> of line 2 were selected from molecular screening. Molecular screening was useful to select the best iron toxicity tolerant genotype. Hence, Plant selection for further advancement was done by based on result of the both morphological and molecular screening. Finally, it was helped to increase the precision of plant selection because, selected plants showed high degree of tolerant in the iron toxicity affected fields.

**Keywords:** *iron toxicity tolerant. molecular markers, rice microsatellites, molecular screening*

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## MORPHOMETRIC PARAMETER ANALYSIS OF PUTATIVE RICE HYBRIDS TO CONFIRM THE HYBRIDITY

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Rice (*Oryza sativa*) is the staple food in Sri Lanka. Improving the crop yield is a major problem in Sri Lankan rice industry. The present day production of rice has to be increased to meet the demand of the increasing population. It is difficult to achieve this target with the present day inbred varieties. Hybridization is fundamental importance in improving rice as a crop. Rice hybridization is done by using two methods: clipping method and hot water method, emasculation by immersing pollen source panicles in hot water (55 °C). After getting hybrids, It is difficult to say that the F<sub>1</sub> seeds are 100% hybrids because of the predominantly selfing nature of rice. Therefore, the confirmation of the hybridity of rice plant is very important because true hybrids should be used for the required purposes. Therefore the present study was conducted to identify the percentage of hybridity of F<sub>1</sub> seeds made using hot water or clipping methods by using morphological parameters. A morphological analysis was carried out between five traditional varieties, namely Murungakayan, suduheenati, kaluheenati, mas, suwadal and four improved varieties H4, Bg352, Bg357, Bg358 and subsequent F<sub>1</sub> progenies. Traditional varieties and H4 were used as maternal parents whereas, Bg varieties were used as paternal parents. Hot water method and clipping methods were used to generate F<sub>1</sub> Hybrids via emasculation to promote cross pollination. Difference in height, number of tillers and leaf color were used to evaluate the morphological deviations between parental varieties and their F<sub>1</sub> progenies. Measurements were taken every week. Statistical analysis was carried out to confirm the hybridity. Leaf Color and tiller number obtained from both parents and F<sub>1</sub> hybrids for each cross showed no significant difference. Statistical analysis for height measurements claimed that F<sub>1</sub> progenies are much similar to their male parent. Therefore, at this stage it seems morphometric parameters are not suitable to confirm the hybridity though it is the popular practice among hybrid seed producers and breeders. The present study shows the importance of having molecular marker based genotyping to confirm the hybridity which is currently being tested in our laboratory.

**Keywords:** rice hybrids, hybridization, *Oryza sativa*, hybridity testing

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## IDENTIFICATION OF PROMISING TWO- LINE RICE (*Oryza sativa* L.) HYBRIDS WITH ATTRACTIVE GRAIN QUALITY TRAITS FOR THE TROPICS

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Sixty two- line rice hybrids of Temperature Genic Male Sterile (TGMS) origin were developed and these hybrids were subjected for agronomic evaluation to select promising hybrids with attractive grain quality traits. Best performing ten hybrids were analyzed for their six physical quality traits and nine cooking quality characters along with their parents. Quality analysis was followed according to the standard procedures. The results indicated that there were hybrids which showed better performance over their parents with desirable kernel length and shape. Seven of ten hybrids yielded more head rice recovery than their parents and the eight of which were categorized as medium slender. Linear expansion ratios were significantly higher in three hybrids whereas another three hybrids expressed the intermediate gelatinization temperature. Two hybrids had intermediate amylose content whereas two hybrids and six hybrids had high and low amylose content respectively. When all these hybrids were rated using IRRI score of quality analysis, four hybrids namely TNAU 60 S X CB-09-106, TS-150-GY X CB-09-106, TNAU 60 S X IET 21493 and TNAU18 S X IET 20921 received higher scores of 46.42 and 43 points respectively. These hybrids were identified as promising two-line rice hybrids with attractive grain quality traits for the tropics.

**Keywords;** *two-line rice hybrids, grain quality, temperature genic male sterile, quality traits*

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**STRESS TOLERANCE OF RHIZOBIUM STRAINS ISOLATED FROM  
*Psophocarpus tetragonolobus* (WINGED BEAN) ROOT NODULES**

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Fixation of atmospheric nitrogen by symbiotic microorganisms such as *Rhizobium* is known as biological nitrogen fixation (BNF). This requires a survival of bacteria under stress such as salinity, acidity and heat. *Psophocarpus tetragonolobus* (winged bean) shows a ferocious growth and that could partly be attributed to its BNF making an ideal candidate legume to look for more tolerant strains of *Rhizobium*. This study was conducted to isolate *Rhizobium* strains from winged bean grown in four different habitats and to characterize their stress tolerance to identify highly tolerant strains. Nodules were collected from winged bean vines grown in four locations (Kandy, Kurunegala, Dambulla and Anuradhapura) in Sri Lanka. Selected nodules were sterilized and crushed. The extracted inocula were streaked on ½ Lupin Agar (½ LA) medium. Series of re-streaking were conducted until pure colonies of *Rhizobium* were obtained. Tubes with ½ LA broth (without congo red) having salt concentrations of 0.5%, 1%, 2% were prepared. Another set of tubes were prepared for different levels of pH as 5, 7 and 9. The selected temperature variations were 15°C, 25°C and 35°C. The culture tubes with medium were inoculated with the selected pure Rhizobial cultures and incubated for three days. The cell density was measured as optical density at 600 nm using spectrophotometer. The absorbance values were statistically analyzed using SAS 9.1. When all the isolates were compared for tolerance to salt, pH and temperature stresses, isolates from Kurunegala showed the highest tolerance. The isolates from Kandy showed the next highest tolerance whereas the isolates from Dambulla and Anuradhapura showed the least tolerance (P<0.05). The higher tolerance of Rhizobial isolates from Kurunegala and Kandy could be due to limited application of artificial nitrogenous fertilizer to winged bean in these areas. Genetic characterizations are currently conducted to further validate these inferences.

**Keywords:** – *rhizobium, winged bean, stress tolerance, cell density*

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**DNA FINGERPRINTING FOR PRECISE IDENTIFICATION OF COMMONLY GROWN  
*Fragaria × ananassa* (STRAWBERRY) VARIETIES IN SRI LANKA**

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Strawberry (*Fragaria × ananassa* Duch.) is an introduced crop in Sri Lanka. The unavailability of suitable varieties and varietal identification through morphological characteristics which is often leading to mix ups are the major problems in the Sri Lankan strawberry industry. The present study was focused on identifying the strawberry varieties in Sri Lanka using DNA fingerprinting. The study was carried out using 16 strawberry cultivars; 'Cambridge', 'Kendal', 'Sweet charlie', 'Chandler', 'Aoriar', 'Floriar', 'Mignonette', 'Mignonette sp.', 'Elsantha', 'Cambridge vigor', 'Festiva', 'Tamar', 'Longconic', 'Camarosa', 'Variety X' and a wild variety grown in Sri Lanka. Immature strawberry leaves were obtained from strawberry farms in Nuwara-Eliya, Sita-Eliya Agricultural Research Station, surroundings of Ambewela dairy farm and Gannoruwa. Genomic DNA was purified using the DNeasy Plant Mini Kit. PCR was performed using four SSR markers; ChFaM031, ChFaM035, EMFn117 and UAFv8216 and the PCR products were separated according to size using agarose gel electrophoresis. Alleles were scored as present (1) or absent (0) for each marker and a binary data matrix was created and analyzed for genetic similarity using the statistical package Minitab 14. All SSR markers showed polymorphism, producing two bands per marker and produced a total of 128 alleles for 16 strawberry cultivars. The cluster analysis revealed that the varieties that come from the same nursery or farm appeared in the same cluster with slight variations implying the mix ups. It is apparent from the results that the varieties are mixed up. Therefore, it would be advisable to initiate with a good set of germplasm and establish a proper place as the repository for mother plant stock. Then tissue culture procedures can be followed to propagate the plants and molecular markers can be used to authenticate micropropagated plant varieties.

**Keywords:** *strawberry, Fragaria × ananassa, Cultivar identification, DNA fingerprinting*

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## EVALUATION OF ALLELOPATHIC POTENTIAL OF SOME SELECTED TRADITIONAL RICE CULTIVARS USING RADISH (*Raphanus sativus*) AS TEST CROP

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An allelopathic property of rice is a viable component of integrated weed management as eco friendly and sustainable approach. This strategy provide practical tool to avoid the hazardous use of chemicals. Allelopathic property of rice shows huge variation among rice accessions. Therefore, relay seeding technique was conducted under laboratory condition to observe the allelopathic properties of 9 traditional rice cultivars on seed germination, shoot and root length and dry matter production of radish as a phytochemical sensitive test crop. Average inhibition in radish growth was calculated to assess the overall allelopathic effect of respective rice cultivars. Significant differences ( $p \leq 0.05$ ) were observed among different rice cultivars in terms of inhibition of measured parameters. Overall, variety Herathbanda showed the highest average inhibitory effects on radish seedling growth (37.6%), closely followed by Murungakayan (27.83%). In contrast, Suwadal had the lowest inhibition which is 15.3%. The highest inhibition percentage on radish shoot length, root length and dry weight also recorded in Herathbanda cultivar ie. 52.4%, and 40.6% and 54.2% respectively. Rice cultivar Suwadal showed the lowest inhibition of shoot length (6.0%) and germination (2%), but Pokkali indicated that lowest inhibition of root length (5.0%) and dry weight (16.0%) Two varieties including Herathbanda and Murungakayan had total inhibition rates over 25.0%. Measured parameters varied in a very broad range when considered discretely. As examples inhibition of shoot length vary from 6-52 %, root length from 5-40% , dry weight from 16-54% . Furthermore, suppression of dry weight was higher than the other measured variables. Moreover none of these cultivars showed stimulation effect on radish seed germination and seedling growth in this experiment. These results revealed that the allelopathic potential of traditional rice cultivars varies in a very broad range and out of cultivars tested Herathbanda showed highest allelopathic potential against radish growth.

**Keywords:** *traditional rice, test crop, allelopathy, radish, inhibition.*

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**INHIBITORY EFFECT OF SELECTED MEDICINAL PLANT EXTRACTS ON  
PHYTOPATHOGENIC FUNGUS *Fusarium oxysporum***

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*Fusarium* wilt (FW) caused by *F. oxysporum* is one of the most destructive disease which has wide variety of hosts of economic value. The massive uses of synthetic fungicides in crop defense from FW have severe environmental impact and health hazards. In search for environmental friendly control measures for FW disease, the antifungal activity of the methanol extracts of six medicinal plants; *Oxalis corniculata*, *Ocimum gratissimum*, *Tithonia diversifolia*, *Azadirachta indica*, *Acorus calamus* and *Zingiber officinale* used in native medicine were screened. The media amended with methanol extracts of different concentrations (25%, 12.5%, 6.25%, 3.12%) of tested plants were inoculated with mycelia discs (4 mm diameter) taken from the advancing edges of 10 day-old pure cultures of *F. oxysporum* and incubated for 7 days. The fungicidal activity of the minimal inhibitory dilution (MID) of methanol extracts were studied after immersing fungal discs (4 mm diameter) in solution for 1, 3, 6, 9, 12 and 24 hours. The media amended with methanol and recommended fungicide for *F. oxysporum* were considered as negative and positive control respectively. All the data were subjected to analysis of variance followed by mean separation through Duncan's Multiple Range Tests (DMRT) using SAS software. Results showed that radial growth of *F. oxysporum* was significantly impaired ( $P = 0.05$ ) by methanol extracts except *O. corniculata*, *O. gratissimum* and *T. diversifolia*. At 25 %, the most active extracts were *A. calamus*, *O. gratissimum* and *A. indica*, which showed inhibition values of 91%, 89% and 83% for *F. oxysporum* respectively. MID was 3.12 % (v/v) for *O. gratissimum* and *A. calamus* and 6.25% (v/v) for *A. indica*. Out of six plants extracts screened, *O. gratissimum*, *A. calamus* and *A. indica* showed more than 80% fungal inhibition after 6 hour immersion and other extracts could not exceed 60% inhibition after any exposure time. The study revealed that methanol extract of *O. gratissimum*, *A. calamus* and *A. indica* exhibit strong fungistatic and fungicidal activity against *F. oxysporum*, confirming the potential use of these plants extracts in the management of FW.

**Keywords:** *antifungal activity, Fusarium oxysporum, fungistatic, fungicidal, plant extracts*

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**EFFECT OF PLANT SPACING AND NUMBER OF PLANT PER HILL ON GROWTH AND YIELD  
OF RICE (*Oryza sativa* L.) VARIETY BG - 359 UNDER THE SYSTEM OF RICE  
INTENSIFICATION (SRI) IN DRY ZONE OF SRI LANKA**

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The System of Rice Intensification (SRI) is a possible alternative for the rice production with high chemical and water use in Sri Lanka. Though SRI was already introduced to Sri Lanka in early 90s, still it has not been accepted by Sri Lankan rice farmers. Lack of field proven research findings is one of the reasons. Therefore, an experiment was conducted at Rajarata University of Sri Lanka to evaluate the effect of plant spacing and number of plants per hill on growth and yield of rice (*Oryza sativa* L. variety BG 359) under SRI during *Maha* season (2012/ 2013). Six treatments namely, 1 plant (pt)/ hill by 25 x 25 cm spacing (T1), 1 pt/ hill by 30 x 30 cm spacing (T2), 1 pt/ hill by 35 x 35 cm spacing (T3), 2 pts/ hill by 25 x 25 cm spacing (T4), 2 pts/ hill by 30 x 30 cm spacing (T5) and 2 pts/ hill by 35 x 35 cm spacing (T6) were arranged in a RCBD with three replicates in a factorial experiment. The highest number of tillers/ hill was observed in T5 (16) at PI stage and T6 (18) at 50 % flowering stage. At both stages the highest shoot to root ratio were recorded with T5. At PI stage, the highest root depth was recorded with T5 (24.85 cm) and at 50 % flowering with T3 (29.47 cm). The highest yield was reported in T4 ( $0.51 \pm 0.09$  kg/ m<sup>2</sup>) followed by T5 ( $0.48 \pm 0.08$  kg/ m<sup>2</sup>) at  $P < 0.05$  while showing no significant yield difference between T4 and T5 (LSD = 0.38). The study indicated the higher possibility of enhancing the growth and yield of rice using 2 pts/ hill with 30 x 30 cm plant spacing in comparison to other treatment combinations under SRI in dry zone of Sri Lanka than the normally accepted 1 plant/ hill by 25 x 25 cm spacing.

**Keywords:** *plant spacing, plant number per hill, spacing, SRI, Oryza sativa*

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## EVALUATION OF RHEOLOGICAL, PHYSICO-MECHANICAL PROPERTIES OF PALMYRAH FIBRE AND CARBON BLACK (N660) FILLED NATURAL RUBBER COMPOSITES

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Natural fibres are generally lignocellulose in nature, consisting of helically wound cellulose microfibrils in a matrix of lignin and hemicellulose. Many types of natural fibres such as coconut fibre, wood fibre, sisal, banana fibre, have been incorporated in rubber and plastics. Further, natural fibres degrade faster than synthetic fibres in normal environmental conditions, minimizing environmental pollution. However, biodegradation of natural fibre can decrease the durability of the product. The main objective of this study was to evaluate cure characteristics and physico-mechanical properties of Natural rubber composites prepared with Palmyrah fibre and carbon black (N660). The effect of different amounts of palmyrah fibre on physico-mechanical properties of natural rubber compounds was investigated and the properties were compared with those of carbon black (N660) filled rubber compound. The cure characteristics and physico-mechanical properties of the rubber composites prepared with different loadings of palmyrah fibre were investigated. Palmyra fibre containing composites exhibited lower minimum torque, higher maximum torque, higher scorch time and shorter cure time. Further, incorporation of palmyra fibre into rubber compounds improved hardness, tensile modulus, elongation at break and tear strength, but decreased tensile strength and abrasion resistance. In overall, results indicated that palmyrah fibre containing, carbon black filled natural rubber composites exhibit improved cure and physico-mechanical properties in comparison to carbon black (N660) filled natural rubber composites. Based on ANOVA, there was a significant difference ( $P < 0.05$ ) between palmyrah fibre, carbon black (N660) filled natural rubber composites and only carbon black (N660) filled natural rubber composite.

**Keywords:** *palmyrah fibre, cure characteristics, physico-mechanical properties, reinforcing filler, carbon black*

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## RHEOLOGICAL AND FT-IR SPECTRAL ANALYSIS OF NATURAL OIL USED AS A REPLACEMENT FOR AROMATIC OIL IN DRY RUBBER COMPOUNDING

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Processing oils play a major role in rubber industry. It is very important to add processing oils for the purpose of proper mixing of the ingredients in the preparation of rubber materials. Processing oils support the mixing process by distributing the filler particles evenly throughout the mixture. This implies that the processing oils should be compatible with the filler. Viscosity, molecular weight, molecular structures are the important factors that affect the compatibility of the processing oil. In this research, carbon black was used as the filler. Therefore, the processing oil should contain aromatic compounds with simple structures. The main objective of this research is to evaluate a natural-oil which is more compatible with the existing processing oils and to develop the properties of that natural oil by treating with aniline, phenol and a combination of both reagents. Another aspect of this research is to study the properties of the rubber materials prepared using the natural oil. Statistical analysis of data obtained showed that the aniline treated natural oil gives best qualities compared to the others. The data showed the possibility of using a plant based oil as a processing oil.

**Keywords:** *natural rubber, processing oils, rheological properties, FT-IR spectroscopy, rubber compounding*

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## A FORWARD REDUCTION ROTATION SAMPLING DESIGN FOR ESTIMATING THE PADDY YIELD

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A simplified version of a rotation sampling design has been proposed in order to ease the estimation task of paddy statistics of Sri Lanka. The approach of forward reduction would reduce the administrative and respondent burdens and response biasness through the sampling process. The correlation structure of observations in consecutive time periods would be used without sacrificing the precision of estimates in order to reduce the sample size in future samplings until a full rotation is complete. The best combined estimate of average paddy yield at each consecutive period is obtained by weighing the independent estimates inversely as their variances. The complete estimation procedure due to the proposed rotation sampling design is presented in this paper. The rotation scheme is recommended for the estimation of national average and the total paddy production in Sri Lanka.

**Keywords:** *rotation sampling, forward reduction, best combined estimates, average paddy yield*

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