A Best Practice Reference Model for Agricultural Supply Chain for Rice

W.M.S.K.Weerabahu
Department of Industrial Management
Faculty of Science
University of Kelaniya
Sri Lanka
samanthiw@kln.ac.lk

L.D.J.F.Nanayakkara
Department of Industrial Management
Faculty of Science
University of Kelaniya
Sri Lanka
julian@kln.ac.lk

Abstract

In order to cater to the increasing demand of rice, it is necessary to raise the average yield of paddy and quality of paddy significantly through best practices in planning, sourcing and delivery stages of the rice supply chain activities. The choice of reference processes during the design phase is of utmost importance for a paddy supply chains‟ overall performance. Applicability of various supply chain reference models in the agriculture domain will be discussed for the purpose of presenting a reference model for the rice sector with existing best practice related to the seed, fertilizer, water, labour and technology factors. In this research main objective is to identify planning and sourcing best practice of the rice supply chain and create best practice reference model as a collaborative tool for the rice sector. The survey was conducted in "Pollonnaruwa district" with the participants of farmers and agriculture officers to identify current best practices. The result indicate the presence of key success factor of the rice supply chain still in the initial stage and needs of the operational strategy for fulfillment of the existing gaps of the rice supply chain with best practices.

Keywords

Rice supply chain, Best practice, Reference model

1. Introduction

Rice is the staple food of Sri Lanka and the most important agriculture sub-sector in the country. It occupies 28% of the arable land and provides 25% employment for the total labor force. Rice contributes 17.5% to agriculture gross domestic production (GDP). Rice is grown almost all the district in Sri Lanka but five districts contribute more than 60% of the total rice production. Almost all major rice-production areas are located in the dry zone. Ampara, Pollonnaruwa, Kurunegala, Anurahpura and Hambamthota are the main granary area and they are in the dry zone. In these areas we can clearly identified effective network with integrated supply chain. For example, rice processing villages established in dry zone enhance the supply chain performance. Sri Lanka has just achieved near self-sufficiency in rice. Thus the rice sector, including both production and consumption, is still plagued with a multitude of economic and social problems [Samaratunga, 2011].

Analyzed the demand conditions through the rice supply chain is necessary to measure whether there is a surplus or shortage. However, in the current scenario there is no comprehensive method for measuring supply chain performance and productivity. Sri Lankan rural economies face several shortcomings in terms of farm to market roads, market facilities, and access to electricity, telecommunication, and financial services. Poor infrastructure and lack of access to enabling facilities have increased operating costs, and reduced the competitiveness of both farmers and rural enterprises. For example, post–harvest losses due to mishandling, storage, and transport have accounted for 25 to 40% of losses for perishable items [Jayawardena ,2003].Agriculture plays a crucial role in linking rural areas to the broader rural and national economy. Sri Lankan rice sector needs some established policies and methods to proactively manage factor market, demand condition and supporting industries related to the rice sector supply chains. In order to face these challenges in supply chain, it is important to have a thorough understanding about world and Sri Lankan best practices in the supply chain management. The agricultural sector needs qualitative improvement for the sustainability in long term.

The application of Supply Chain Management best practices in the agricultural sector of Sri Lanka has had relatively little research conducted to date. Supply chain management Best practices which are used in manufacturing and service sectors can be directly interpreted in to agricultural sector as well. Extracting and interpreting supply chain best practice into agricultural domain will lead collaborative improvement of the Agri-supply chains.

Thus, considering the above discussion, problem of the research can be presented as follows.

How supply chain planning and sourcing related best practices can lead to better supply chain performance of agriculture sector in Sri Lanka?

The purpose of this research is to conduct a study in the field of supply chain management in Agriculture sector in Sri Lanka and enhancing the competitiveness of entire sector performances by creating best practice supply chain model in order to reduce the existing gaps of current supply chain. This will lead to identifying the planning and sourcing best practices of the rice supply chain for enhancing efficiency and effectiveness of the entire paddy value chain.

2. Review of Literature

2.1. Past Researches of Supply chain models

Supply Chain Management (SCM) is increasingly being recognized an important for business competitiveness. SCM offers the opportunity to capture the synergy of intra-and intercompany integration and management [Lambert et.al., 2000]. Supply chain networks comprise of both "upstream" network of suppliers and "downstream" network of distributors and customers. For example, in agriculture supply chain networks comprise with fertilizer suppliers, seed paddy manufacturer and suppliers, etc in upstream and wholesalers, retailers and rice consumers in downstream.

Global Supply Chain Forum (GSCF) defines SCM as: *"Supply Chain Management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customer and other stakeholders*". The Global Supply Chain Framework (GSCF) model originally presented by [Cooper et.al., 1997] and later modified by [Croxton, 2001] identifies eight key supply chain management processes which cut across the supply chain namely Customer Relationship Management, Customer Service Management, Demand Management, Order Fulfillment, Manufacturing Flow Management, Supplier Relationship Management, Product Development and Commercialization and Returns. Management of all firms in each supply chain should consider these eight processes, the relative importance of each process and the specific activities included may vary. Each process is described at *strategic and operational levels*.

One of the Conceptual frameworks of SCM was presented by [Cooper et.al.,1997]. The conceptual framework emphasizes the interrelated nature of SCM and the need to proceed through several steps to design and successfully manage a supply chain. The SCM framework consists of three closely interrelated elements: the supply chain network structure, the supply chain business processes, and the supply chain management components.

The supply chain operations reference-model (SCOR) has been developed and endorsed by the Supply-Chain Council (SCC) as the cross-industry standard for supply chain management. The five SCOR processes are Plan, Source, Make, Delivery and Return (Supply-Chain Council ,2003). The SCOR model aims to integrate well-known concepts such as business process reengineering, benchmarking, and process measurement into a cross-functional framework. SCOR, a flexible framework and a common language that can be improve SC internally and externally by evaluating the objectives, effectiveness of reengineering, performance, quantification, testing and future planning of the agriculture sector. There are some limitations in SCOR model. SCOR does not

attempt to describe every business process or activity, including Sales and marketing, Research and technology development, Product development and some elements of post-delivery customer support. SCOR assumes but does not explicitly address training, quality, information technology and administration functions.
The GSCF and SCOR frameworks are based on the implementation of business processes that are meant to connect customers and suppliers, and integrate activities across corporate functions [Croxton K.L.2004]. Each of the GSCF processes is aligned with the corporate strategy and the appropriate functional strategies either directly or indirectly through the customer relationship and supplier relationship management processes. In the SCOR model the processes are linked with the operations strategy which is a derivative of the corporate strategy but not clearly consider the other functional strategies or corporate strategies.
SCOR provides list of best practices that includes tools primarily aimed at improving transactional efficiency in the supply chain. These best practices can be implemented even within the GCSF framework in the context of the Process to improve the process efficiency. According to the SCOR model, *Best Practices* is a current, structured, proven and repeatable method for making a positive impact on desired operation results. Example for best practice: - Collaborative Planning, Forecasting and Replenishment(CPFR)can be used as a tool for demand management process. Along with that Supply chain performance measurement systems examine specific performance along the entire supply chain and among all partners to ensure that supply chain strategy can contribute to value creation for end customers [Wisner, 2005]. The world-class performance measurement system was adopted from the Supply Chain Operational Reference (SCOR) model. SCOR model takes into account the performance of the overall supply chain in multiple dimensions. But it does not attempt to describe every business process or activity and does not explicitly address training, quality, information technology or administration. Key performance indicators (KPIs) for agri-food supply chains are similar to generic supply chains.
Sri Lankan rice supply chain needs cross functional integration and input in order to implementing best practices within the overall sector. Integration among universities, research institutes and industries and taking demand patterns and customer requirements as input for the new rice varieties development and paddy cultivation will lead effective supply chain strategies.

2.2. Best value supply chains

Best value supply chains are used by organizations as a central element of strategy, not simply as a means to move materials. Best value supply chains are designed to deliver superior total value to the customer in terms of speed, cost, quality, and flexibility. Best value supply chain differs from traditional supply chains in at least four key areas: Strategic sourcing, logistic management, supply chain information systems, and relationship management [Ketchen et.al., 2008]. In Sri Lankan agriculture domain irrigation, seed management and fertilizer management practices, etc. need to be involved early in rice varieties development and throughout the supply chain. Positioning inventory to achieve the desired time, place, and possession benefits at the lowest practical cost is a key feature of best value supply chain. All the critical operations include order processing, inventory, transportation, warehousing, material handling, packaging and facility networks of the paddy supply chain must be integrated. Best value supply chains find the optimal balance between maintaining comprehensive supply chain information on one hand and cost considerations on the other.

2.3. Agricultural sector in Sri Lanka

The agriculture sector in the country requires special attention in several areas to accelerate its growth. Measures to increase the competitiveness of the Agriculture sector through improvement in the productivity and increase in value addition in both domestic and export agriculture are necessary in anticipation of further integration of the country with the world through trade agreements in future. In this regard, the adoption of improved agriculture and manufacture practices, the adoption of capital intensive methods where possible, the reduction of post-harvest losses and the provision of appropriate technical services could be identified as areas for improvement. Moreover, it is imperative to introduce measures to encourage private sector investment in large scale farming, which would also promote investments in the food processing industry [Central Bank, Annual report 2010]. In this study mainly focus on agriculture best practice in order to increase the competitiveness of the sector through improvement of productivity and value addition.

2.4. Sri Lankan Rice supply chain

Rice staple to the 19.8 million inhabitants in Sri Lanka where people used to consume minimum two rice based meals per day. Of the total cultivable land (2.9 mn ha), 65% (1.9 mn ha) is cultivated with agricultural crops. Paddy occupies 40% of the agricultural land. According to the projections of Ministry of Agriculture, the demand for rice will increase at 1.1% year and to meet this rice production should grow at the rate of 2.9%/year. Current cost of production of rough paddy is about Rs. 8.57/Kg. The cost of labor, farm power and tradable inputs consists of 55%, 23% and 23% respectively in total rice production [Central Bank, Annual report 2010].

Paddy cluster is a network of farmers, government organizations, companies, their customers, and suppliers of all relevant factors, including materials and components, equipment, training, finance and so on. With the approach of self-sufficiency, farmers will be more vulnerable to market shocks in the form of unanticipated price slumps due to production gluts. There will be a room for the rice supply chain collaborative planning and integration tool with best practices to overcome existing gaps of the supply chain.

Through the comparison of the SCOR model and GSCF model, most suitable supply chain reference model for the agricultural sector was identified. Based on the literature SCOR operational reference model is used as a theoretical framework for the further research analysis in this study.

3. Methodology

3.1. Data Collection

This study mainly focuses on developing best practice reference model for rice supply chain in Sri Lanka. The main research questions to be answered were as follows:

1. What are the core management processes within rice supply chains?
2. What are the key processes and strategies in planning and sourcing of rice supply chain?
3. What are the possible supply chain practices that can achieve rice supply chain performance in most effective way?
4. What are the needs of the farmers and agricultural officers in order to enhance the rice supply chain performance?
5. What are the world class best practices in supply chain management?

The research process is inductive rather than deductive. Also exploratory and descriptive research is used because research questions provide in-depth analysis for understanding research problem. The exploratory part in the study, analyzes the best practices and performance enhancement of the rice supply chain. Based on the past researches and other requirements acknowledged Supply Chain Operations Reference Model is more appropriate for the rice supply chain with a higher focus on operational efficiency. Therefore, SCOR model is selected for the validation process in rice supply chain. This research considers plan and source areas and their best practices.

In order to identify the key processes and strategies related to planning and sourcing areas of the rice supply chain expert survey was conducted. Experts from agricultural domain were selected based on the snowball sampling. A detailed discussion was conducted with these experts to gather their views and opinions and more data on additional factors were gathered through some published reports. Based on the literature review SCOR model performance attributes are suitable to address the structure of the supply chain reference model. Therefore, Cost, Quality, Time and Flexibility are used as performance attribute. Among those cost is the main crucial performance attribute in rice supply chain. Preliminary survey is carried out to identify the major needs and suggestion of the farmers about the current process.

In this study a preliminary survey was conducted for 6 farmers and 1 agriculture officers to test the questionnaire and data gathering was started with the pilot survey. The objective of the pilot was to assess the efficiency of the research instrument.An exploratory survey (Figure 1) was conducted in the Pollonaruwa district with 50 farmers randomly selected from a group of 380 in the Polonnaruwa district Atharagallewa agriculture instructor division and 8 agriculture officers in order to identify current performance and operational strategies in the supply chains of the rice production sector. Most common problems related to planning and sourcing processes will be sorted to a structured questionnaire where the farmers can rank each of the requirements. These requirements will be prioritized based on the ranks allocated by farmers.

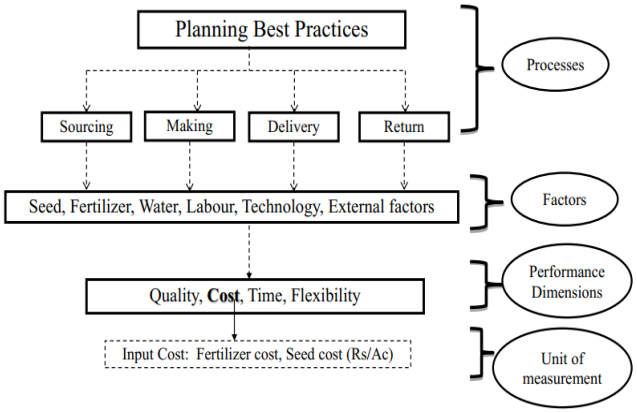

Figure 1: Structure of the Survey questionnaire

Main Factors Considered for the survey questionnaire design
Cost
Quality
Storage
Demanding varieties
Sustainability
Information availability and accessibility
water management practical knowledge
Infrastructure
Knowledge
Availability of labour force
Training
Knowledge sharing/communication
Information technology
Extension
Market information
Profit expectation
Delivery cost
marketing network
pre planning/crop plan
Branding
Government policy
Risk management
Flexibility
Maintenance

Interviews were conducted to identify best practices and gaps of the existing supply chain. Among representative sample of 50 farmers' best performers (e.g.: best farmers of the year, farmers who were selected for the "Soora goviya" programme) were selected for the interviews based on the agriculture officers‟ opinion. Expert interview and agriculture officer interviews were used for further identification of the best practices and gaps. According to the survey, identified best practices filtered using key words and categorized under the seed management, fertilizer management, water management, skill and knowledge management and technology management processes.

3.2. Data Analysis

The feedback from the experts were scaled and analyzed using (Figure 2). Based on the expert opinion planning and sourcing are the critical areas which need to be focus through this research.

Process	Expert‟s Rank						Total rank
	Expert1	Expert2	Expert3	Expert4	Expert5	Expert 6	
Plan	5	5	5	4	5	5	29
Source	4	3	4	3	4	4	22
Make	3	4	3	5	3	3	21
Delivery	1	2	1	2	2	2	10
Return	2	1	2	1	1	1	8

Figure 2: Expert Opinion Analysis

Wilcoxon rank sum test was carried out to see whether there is a significant difference between farmers‟ opinion and agriculture officer opinion.
H0 = There is no significant difference between farmer opinion and agriculture officer opinion
H1 = There is significant difference between farmer opinion and agriculture officer opinion
Z test statistic is 1.647 and p-value is 0.0994.Therefore do not reject the null hypothesis. This conveys that the farmer opinion and the agriculture officer opinions were very similar and there is no significant difference among those opinions. Therefore, the needs expressed by the above farmer group was taken for further validation of the research findings and farmers and needs of the agriculture officers were used for the further validation and identification of the farmers needs and best practices and supply chain gaps.
After reviewing the interview discussion with key informants (best farmers, expert), a content analysis was done to identify the best practices under the main themes for the purpose of developing best practice reference model. First the audio recorded interviews were transcribed into word format and words that captures the key thought or the concept were highlighted. Then the codes or the themes were derived based on the highlighted sections and the codes were

sorted into broad domains based on different attentions of the study and how the different codes are related and linked. The emergent categories were used to organize and group the codes into meaningful clusters.

4. Results and Discussion

4.1. Survey Findings and Discussion

First an expert survey was carried out among a group of experts in the rice production domain to identify the most important paddy supply chain processes, key success factors and the operational strategy. Agriculture domain experts who involves in policy making and researches with proven knowledge of the rice sector were interviewed to get their expert opinion. Mechanization, Knowledge and skill development, Quality improvement, Risk management, Information availability, Branding, Marketing *n*etwork, Market information generation, Effective Storage facility/methods, Government policy implementation, Cost reduction, Flexibility of the chain, Training and knowledge, Pre Planning, Information technology, Infrastructure development, Extension, Sustainability, Communication, Water management practices and rice varieties are the key success factors of rice supply chain which identified through supply chain stakeholders and literature review for further analysis. Moreover, key processes generated as a result of content analysis based on in depth interviews are seed management, fertilizer management, water management, labor management, technology management and climate uncertainty management.

The needs of the farmers and agriculture officers of the rice supply chain will be collected through survey questionnaire based on the key success factors identified via expert survey and past literature review. Data collected from the survey are of qualitative nature. Maximum 5 point Likert scale was used to rank the answers for the questions in the questionnaire. Responses based on the Likert scale ranks from farmers and Agriculture officers (AO) averaged and calculated the total farmer and AO score separately for each and every factor (Figure 3).

	Farmer score	AO score
Cost	2.37	1.81
Quality	2.39	2.19
Storage	2.69	2.19
Demanding varieties	3.14	3.13
Sustainability	3.13	3.25
Information availability and accessibility	3.14	3.25
water management practical knowledge	3.48	3.50
Infrastructures	3.16	2.25
Knowledge	3.40	3.06
Availability of labour force	2.36	1.63
Training	2.38	3.25
Knowledge sharing/communication	3.32	3.38
Information technology	3.12	2.13
Extension	3.10	3.56
Market information	2.40	2.88
Profit expectation	2.32	2.63
Delivery cost	2.44	1.88
marketing network	2.74	2.25
pre planning/crop plan	3.20	2.54
Branding	1.86	1.50
Government policy	2.36	2.13
Risk management	2.10	2.25
Flexibility	1.90	2.00
Maintenance and mechanization	3.44	2.88

Figure 3: Key success factors of rice supply chain

Total scores of the both farmers and Agriculture officer's surveys categorized under the key criteria were compared via two by two matrix (Figure 4). According to the matrix (Figure 4) considering factors and measurements categorized under the four key areas.

A. Quality, storage (post and pre harvesting storage), cost, delivery cost, flexibility, Branding, labour availability, market information availability, marketing network, ability of getting profit (return on investment), Government policy implementation are the key areas with lower performances. Both agriculture officers and farmers emphasized above mentioned factors with lower performance construct existing gaps within rice supply chain.

B. Training and development is the factor under this area which has low performance from farmer's perspective and slightly high in agriculture officers‟ perspectives. Therefore, it can be considered as need of the farmers to be competitive in the market place. Each and every farmer is unable to get equal opportunity for training and development due some constraints (such as inappropriate training method, lack of trainers and resource persons, lack of training materials, etc…). But selected study sample of agriculture officers thought that they were facilitating sufficient

C. training opportunities for the farmers. According to the interviews conducted with agriculture officers they were commented that with the available facilities they attempt to facilitating equal opportunities for all farmers. Therefore, they ranked training as above the average point.

D. Extension, Sustainability, Information availability, Knowledge sharing and communication, availability of demanding rice varieties, knowledge and water management practices are the areas at the current level both farmers and agricultural officers had higher satisfaction.

E. Pre planning, Information technology, infrastructure and maintenance are some controversial factors where farmers score is higher than officers score. Farmers‟ opinion based on the existing practical situation and they made judgment based on the narrower scope than agriculture officers. For example, they compare their infrastructure facilities with other nearby areas and made conclusion compare to that which is not 100% accurate. Due to experience and exposure of the broader agricultural domain agriculture officers‟ expectation was higher and they are expecting operational and strategic improvement of above areas.

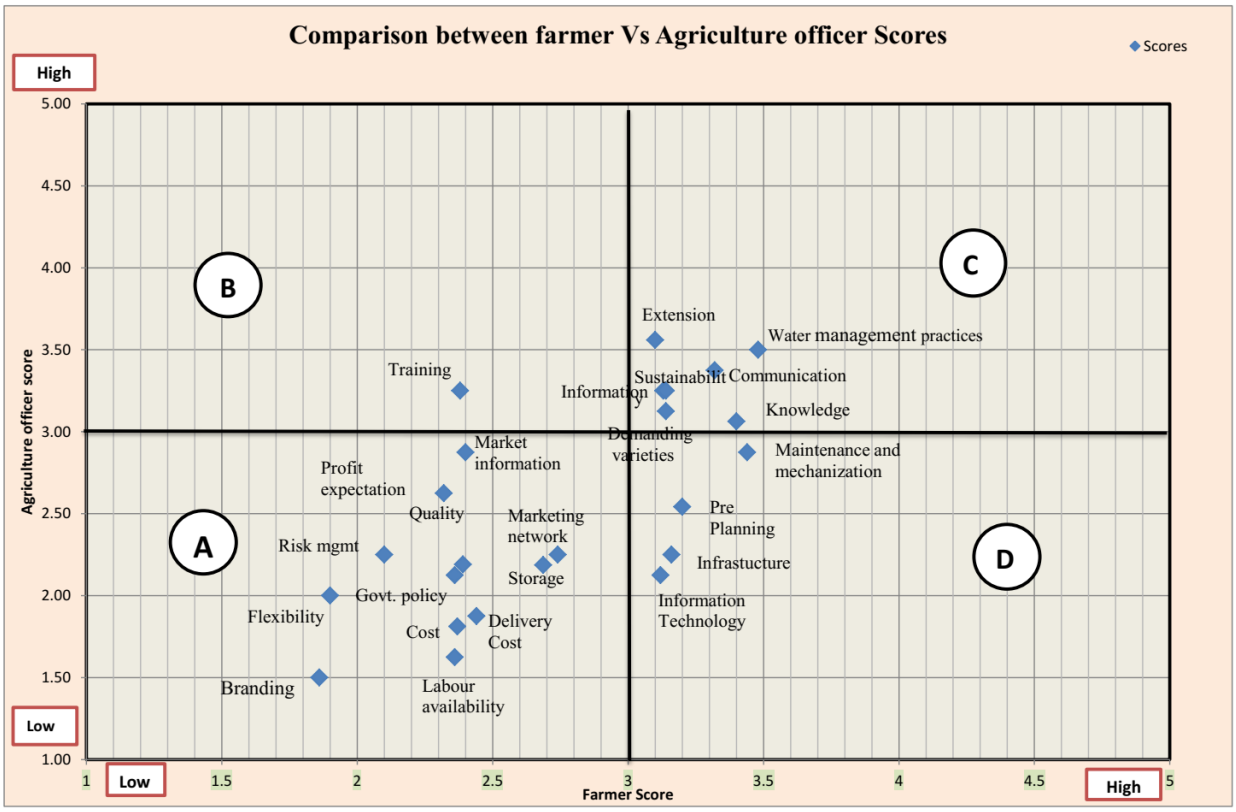

Figure 4: Comparison between farmer vs agriculture officer scores

4.2. Rice Supply Chain Best Practice Reference Model process overview

After analyzing the quantitative and qualitative facts, rice supply chain best practice reference model with special reference to planning and sourcing processes is developed to summarized the all study findings. Figure 5 shows the rice supply chain best practice reference model processes, the highest level of analysis. This process included a detailed review of process definition as well.

Process	Definition
Seed Management	Planning for source, make, delivery and return of good quality seed paddy
Fertilizer Management	Planning for source, make, delivery and return of fertilizer
Water Management	Planning for source, use, delivery and storage of water for paddy cultivation
Skill and Knowledge Management	Planning for improve the knowledge level and skill of labour force
Technology Management	Planning for source, use, delivery and maintenance of technological equipment and machineries
Climate uncertainty Management	Planning for mitigate risk occurs due to climate uncertainty

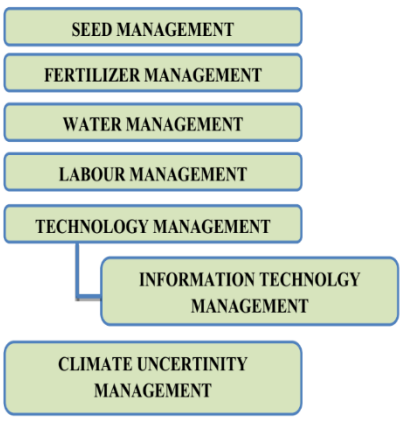

Figure 5: Rice Supply Chain Best Practice Reference Model

Each key process related best practices are representing in graphical form in Figure 6.

Process 1: Seed Management
Best Practices:
Seed certification programme to improve quality
Self-seed production within farmer association under the guidance of agriculture officers
Integration of research institute and field Seed testing plots
Integrated seed distribution network (research institute to paddy field)
Collaborative planning through " Kanna Resweema"
Using Proper seed storage method

Process 2: Fertilizer Management
Best Practices:
Giving Fertilizer subsidiary for farming
Use fertilizer recommendation
Organic fertilizer usage and team based organic fertilizer production units
Fertilized distribution network (government involvement)
Keep remaining fertilizer for the next season with proper storage mechanism

Process 3: Water Management
Best Practices:
Instruction to match available water capacity with cultivated areas
Water management operational best practice with new technology
Development of infrastructure for water distribution
Selection of crop based on the water availability and type of soil

Process 4: Skill and knowledge Management
Best Practices:
Training programme and skill development programme for farmers
Improved communication -video tutorial about best practice
Knowledge sharing: best performers share the knowledge among others
Keeping records and updates
Controlling mechanism to improve the extension services

Process 5: Technology Management
Best Practices:
Training for mechanization -selection and use of rice processing machinery for small and medium scale rice processing
Establish agri technology testing and quality certification centers-Institute of post-harvest technology
Establishment of rice processing families-farmer can process paddy into rice and sell rice in the market instead of paddy
Outsourcing
Maintain machinery and equipment
Information technology management
Create Marketing information system to improve the accessibility of market related information to the paddy farmers
Maintaining/updating farmers database or Data warehouse

Process 6: Climate uncertainty management
Best Practices:
Forecasting weather patterns
Collaborative planning and scheduling (creating crop plan)

Figure 6: Best Practices related to key processes

5. Conclusions

Supply chains not only benefit the sector directly involved, they also stimulate social, economic and environmental sustainable development within a region or country. Supply chain collaboration is of utmost importance for the connection with profitable markets and consumer's demands, the flow of information, goods, technology and capital and to limit transaction costs. Despite there were few studies of agricultural supply chain networking and collaboration, the planning and sourcing best practices analysis is still not in focus.
In this study analysis the current processes of planning and sourcing related to rice supply chain and identify process failure modes and their cause of failure related to Sri Lankan context are tested and discussed the solutions for preventing those failure as planning and sourcing best practices of the rice supply chain. Even though few previous studies are available on this topic this knowledge will be highly useful for farmers, millers, rice consumers, supplier, policy makers and planners in making their decisions.
At present, rice sector in Sri Lanka faces a number of constraints related to production, socio economic and policy, technical, institutional and natural resource base. For Sri Lanka to reach, maintain, and even surpass self-sufficiency in rice production, a long term vision, careful planning, innovative research, best management practices, and efficient extension services will be needed.
The vertical and horizontal integration and transparency among farmers, millers, researchers, and the government are key features of the rice sectors and shortage of these driving forces for the impressive competitiveness in rice sector generates negative impact for the counties economy. The well-integrated structure of the supply chain means completes and up-to-date information about supply and demand, well-defined rice quality standards, active

participation of supply chain players for their own role and research goal and the collaboration with different supply chain players. Innovation is another key area which gives value addition to the rice sector. Private sector, government, research institutes and operational level player such as farmers" millers align with new product development to outfit boosting opportunities.
Linkage of best practice and strategies for accomplishing goals and objective of the rice sector should integrate with agricultural policy development and implementation. The need of strategic national agricultural policy with controlling and monitoring mechanisms is key requirement for the future of rice sector development.

Acknowledgements

Special thanks go to the farmers and agriculture officers of Pollonnaruwa district, Atharagallewa Grama Niladhari division for their contribution to the survey conducted for this research.

References

Samaratunga, P, Sri Lanka as a Rice Exporting Country: Possibilities and Problems, Available: http://ipslk.blogspot.com/2011/12/sri-lanka-as-rice exporting-country.html, 2011

Jayawardena, S.S.B.D.G., Past, present, future of the golden grain rice in Sri Lanka, International Rice Research Institute, Los Banos, Philippines.19- 23pp,2003

Lambert, Douglas.M. and Cooper, M.C., Issues in Supply Chain Management*, Industrial Marketing Management*,2000

Lambert, Douglas m.and Renan Burduroglu, Measuring and selling the value of logistic, The International Journal of Logistic Management, Vol. 11, No. 1, pp. 1- 17, 2000

Cooper, Martha C., Douglas M. L., and Janus D. Pagh D.J., Supply Chain Management: More than a New Name for Logistics,*The International Journal of Logistics Management,*Vol. 8, No. 1, pp. 1-14,1997

Central Bank of Sri Lanka (2010) .Annual Report. Central Bank of Sri Lanka: Colombo

Croxton, Keely L., Sebastin J. Garca-Dastugue, Douglas M. Lambert, and Dale S. Rogers,The Supply Chain Management Processes, *The International Journal of Logistics Management*, Vol. 12, No. 2, pp. 13-36, 2001

Wisner, J.D., Principles of Supply Chain Management: A Balanced Approach, South-western, Mason,OH,2005

Ketchen, D.J., Rebarick, W., Tomas, M.H., Meyer, D., Best value supply chains: A key competitive weapon for the 21st century, 2008

Biographies

W.M.S.K. Weerabahu is currently a fulltime lecturer in Department of Industrial Management, University of Kelaniya, Sri Lanka.She obtained her MBA in Management of Technology from University of Moratuwa in 2016.Her first degree was in Management and Information Technology, graduating with first class honors from University of Kelaniya in 2013. After finishing her first degree she worked in the industry for about four years as a SAP functional consultant for Camso GIT(pvt) Ltd, Associated Motorways (pvt) Ltd and Printcare PLC. She has gained expertise in material management, SAP workflow, Plant maintenance modules. She is also a visiting lecturer to other institutions in Sri Lanka. Her research interests include, Business Process Management, Process automation with Enterprise Resource Planning systems, Management of technology and supply chain management.

L.D.J.F.Nanayakkara , graduated in the field of Mechanical Engineering with B.Sc. Eng. (Hon) degree in 1974 from the University of Moratuwa, Sri Lanka. Qualified with Ph.D. in 1983 in the area of Production Management and Manufacturing Technology from the University of Strathclyde, U.K. Worked as lecturer, researcher and consultant to

industry for over 35 years out of which initial 26 years were in the Department Mechanical Engineering, Faculty of Engineering, University of Moratuwa. Presently, a Senior Lecturer at the Department of Industrial Management, Faculty of Science, University of Kelaniya. Involved in the development and delivery of curricula at undergraduate, postgraduate and school levels in the field of engineering, technology and management. Designs and delivers customized industrial training programmes in the area of operations management and industrial engineering specializing in the management of manufacturing. Has publications in the areas of production operations improvement, modelling and management. Worked as consultant for Production Technology in the Technical Education Development Project (TEDP) of the Technical and Vocational Education Commission (TVEC) of Sri Lanka, and consultant for curricula in Practical and Technical Skills (PTS) programme for education reforms in Sri Lankan schools