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PROCEEDING
International Seminar
on Horticulture to Support Food Security 2010

June 22-23, 2010
Bandar Lampung, INDONESIA

Editors:
Soesiladi Esti Widodo
Siti Nurdjanah
Darwin H. Pangaribuan

Organized by:

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PREFACE

Growing populations across the world, economic growth and changes in dietary patterns have caused both the production and consumption of horticultural produce, mainly fruit and vegetables, increasingly important. Horticulture, which includes the production of fruits, vegetables, flowers, spices, medicinal and aromatic plants and plantation crops, has a vital role in farm income enhancement, poverty alleviation, food security, as well as sustainable agriculture. However, this sector severely suffers from postharvest losses. Some estimates suggest that about 30–40% of fruit and vegetables are lost or abandoned after being harvested. Huge postharvest losses result in diminished returns for producers, and reduced food availability.

It is very clear that postharvest management determines food quality and safety, competitiveness in the market, and the profits earned by producers. However, the postharvest management of fruit and vegetables in most developing countries is very poor.

The major constraints include inefficient handling and transportation; poor technologies for storage, processing, and packaging; and poor infrastructure.

In order to overcome the incidence of the huge postharvest losses in the region and new challenges faced under trade liberalization and globalization, serious efforts are needed to reduce postharvest losses of horticultural produce, and to support food security.

Therefore, the University of Lampung in collaboration with the Government of Lampung Province as well as the University of Kentucky USA has organized this seminar with the objectives: 1) to discuss recent developments in postharvest handling, processing and marketing of horticultural produce, 2) to identify issues and constrains to reduce postharvest losses, 3) to define strategies and measures to reduce such losses in order to support food security, 4) to discuss marketing and food security issues, and challenges in the postharvest management of horticultural produce, issues and obstacles to improve the marketing and safety of postharvest handling and processing of horticultural produce.

It is our hope that serious consideration will be given to the recommendations of International Seminar on Horticulture to Support Food Security in shaping the future development of the production, postharvest handling, processing and marketing of horticultural produce.

June 22, 2010

Organizing Committee
International Seminar for Horticulture to Support Food Security 2010
Bandar Lampung - Indonesia

Website: http://www.ishsfs2010.unila.ac.id/
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WELCOMING ADDRESS FROM THE ORGANIZING COMMITTEE

(Sandi Asmara)
Chairman

Good Morning, ladies and gentlemen.

First, let us praise our gratitude to God Almighty, who has given us all an opportunity to be present this morning to attend the "International Seminar on Horticulture to Support Food Security in 2010.

I'm, as a Chairman of the Committee, would like to thank our colleagues who I could not mention their names one by one, who have worked very hard to bring this conference in front all of us.

In addition, the committee must also express our gratitude for the support provided by the University of Lampung, Lampung Province Local Government, University of Kentucky, the Ministry of Agriculture; in this case represented by the Directorate General of Horticulture and Directorate General Processing and Marketing of Agricultural Products, as well as the Sponsors who have helped so that this conference can be held.

Until last night, ISHSFS2010 participants who have registered were approximately 250 people. Among them, 130 are speakers, both local participants, and others who came from various provinces in Indonesia, from Aceh, South Sumatra, West Sumatra, Bengkulu, Riau, Jambi, Sulawesi, Kalimantan, Ternate, West Java, Jakarta, Central Java, East Java, Bali to Papua. These Participants came from various Universities, other Government Agencies and also Private Companies.

Once again I extend many thanks to the committees of ISHSFS2010 who have worked tirelessly so that this conference can be held, and to all the ISHSFS2010 participants who have taken the time to be present and take part in this conference room.

May the Almighty God, give love and guidance so that we can achieve the goal of this conference.

WELCOMING ADDRESS FROM RECTOR OF LAMPUNG UNIVERSITY

(Satria Bangsawan)
Vice Rector for International Collaboration Affair

Assalamu'alaikum wr. wb.

Honorable Dr. Ahmad Dimyati, The Director General Horticulture from Agriculture Ministry, Mr. Syachruddin Z. P., the Governor of Lampung, Prof. Dr. Douglas Archbold from University of Kentucky, Mr. Bihikmi, the Head Office of Agriculture and Food Crops, Lampung, scientists from Lampung and outside Lampung, students, horticulture growers and traders, members of media, ladies and gentlemen.

It is my proud privilege, and on behalf of Rector Lampung University, to extend heartiest welcome to you all to this International Seminar on "Horticulture to Support Food Security 2010". This seminar is also one of the events which is aimed to commemorate the 45th anniversary University of Lampung.

We feel extremely honored by the presence of The Director General of Horticulture, Dr. Ahmad Dimyati, and the Governor of Lampung Mr Syachrudin Z.P., on this occasion as Chief Guests. It is a matter of great pleasure for all of us that they could find time to be with us in spite of their occupations. This shows their interest in academic and scientific pursuits. Their presence here this morning is a source of inspiration for us and a great moral booster to the entire scientific community. I also take this opportunity to welcome Prof. Dr. Douglas Archbold from College of Agriculture University of Kentucky who have come to be one of Keynote speakers in the seminar. I understand that more than 125 research papers shall be presented during the two day seminar and hope that the deliberations will result in fruitful recommendations, and to be able establish future collaboration between partners.

Finally, I wish you all pleasant stay in Lampung and may you have a very successfull conference.

Thank you.

Wassalamu'alaikum wr. wb.

EVENT SCHEDULE

TIME		MODERATOR	SPEAKERS
Tuesday - June 22, 2010			
08.00–08.30	Registration		
	Opening Ceremony		
08.30–08.40	Report from ISHSFS's Chairman		Sandi Asmara, M.Si.
08.40–09.00	Speech from Rector of University of Lampung		Prof. Dr. Ir. Sugeng P. Harianto, M.S.
09.00–09.30	Speech and Event Opening Governor of Lampung's Province		Drs. Hi. Sjachroedin S.Z.P., S.H.
09.30–09.40	Prayer		Dr. Ir. Hi. M.A. Syamsul Arif, M.Sc.
09.40–10.00	Break		
10.00–12.00	Key Note Speakers 1. Directorate General of Horticulture, Department of Agriculture Republic of Indonesia 2. Horticulture Department, College of Agriculture University of Kentucky, USA	Prof. Dr. Ir. Tirza Hanum, M.S.	Dr. Ir. Ahmad Dimyati Prof. Douglas Archbold, Ph.D.
12.00–13.00	Lunch and Prayer		
13.00–15.00	Plenary Speakers :	Prof. Dr. Ir. Bustanul Arifin, M.Sc.	Ir. Bihikmi Soefian, M.M Prof. Dr. Ir. S. Esti Widodo Hasan J. Widjaja, M.Engr Ir. Nurjaya, M.M. Ir. I Made Donny Waspada
15.40–17.00	Parallel Seminar		

	Group A: Horticultural Biology and Physiology	Group B: Horticultural Postharvest Handling and Processing Technology	Group C: Horticultural Pests and Diseases & Horticultural Postharvest Handling and Processing Technology	Group D: Economy of Horticulture of Food Security
15.40-16.20	Session 1	Session 1	Session 1	Session 1
16.20-17.00	Session 2	Session 2	Session 2	Session 2
Wednesday - June 23, 2010				
08.00-14.00	Parallel Seminar			
	Group A: Horticultural Biology and Physiology	Group B: Horticultural Postharvest Handling and Processing Technology	Group C: Horticultural Pests and Diseases & Horticultural Postharvest Handling and Processing Technology	Group D: Economy of Horticulture of Food Security
08.00-08.40	Session 3	Session 3	Session 3	Session 3
08.40-09.20	Session 4	Session 4	Session 4	Session 4
09.20-10.00	Session 5	Session 5	Session 5	Session 5
10.00–10.20	Break			
10.20-11.00	Session 6	Session 6	Session 6	Session 6
11.00-11.50	Session 7	Session 7	Session 7	Session 7
11.50–13.00	Lunch and Prayer			
13.00-14.00	Session 8	Session 8	Session 8	Session 8
14.00	Closing			

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4	Spatial Marketing System: an Alternative to more Effective Distribution System of Fresh Horticultural Product from Highland Area in West Papua Region	Fitryanti Pakiding, F.H. Listyorini, Arif Faisol Department of Agriculture and Agricultural Technology Papua State University, Indonesia E-mail: fitry.pakiding@fapertek.unipa.ac.id; fitryanti@yahoo.com
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20	Model Of Technology Valuation System (A Case Study Of Evaporative Cooling System For Horticulture Products)	Budi Dharmawan[1)] and Ropiudin[2)] [1)]Department of Agricultural Economics and Social Sciences, Faculty of Agriculture, Jenderal Soedirman University, Purwokerto, Indonesia [2)]Department of Agricultural Engineering, Faculty of Agriculture, Jenderal Soedirman University, Purwokerto, Indonesia Corresponding author: b_dharmawan@yahoo.com
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32	Analisis Pertumbuhan dan Korelasinya terhadap Hasil Jagung Manis pada Pemberian Dosis Kompos Lumpur Sawit yang Berbeda.	Merakati Handajaningsih Program Studi Agroekoteknologi Fakultas Pertanian Universitas Bengkulu, Jln. Raya Kandang Limun Bengkulu 38371A E-mail: merakati@gmail.com
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36	The Effects of Types and Percentages of Sugar Solution on The Characteristics of Lactic Fermented Drink from Sesbania (Sesbania grandiflora (L.) Poir) Milk	Samsul Rizal, Marniza, and Sutikno Institution: Departement of Agro-Industrial Technology, University of Lampung E-mail: srizal_thp@unila.ac.id
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41	Vegetative Compatibility Group Test Of *Fusarium Oxysporum* F. Sp. *Cubense* Isolates And Identification Of Infected Banana Varieties In Banana Development Area In Lampung Province	Jumjunidang and Riska Indonesian Tropical Fruit Research Institute, Solok Jln. Raya Solok-Aripan Km 7 Solok, West Sumatra E-mail: jjunidang@yahoo.co.id
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46	The effect of packaging materials on the qualities of vacuum packed fresh cut carrot during low temperature storage	Muhammad Nur dan Susilawati Faculty of Agriculture , University of Lampung Indonesia
47	The Effects of Water and CMC Addition on Organoleptic Properties on Mangosteen Juice, Vitamin C and Total Sugar	Siti Nurdjanah[1], Sefanadia Putri[2], Moralita Tauhid[2] [1]Department of Agro-Industrial Technology Faculty of Agriculture, Lampung University Indonesia [2]Postgraduate student, Magister of Technology Agro-Industry, University of Lampung, Indonesia E-mail: nurdjanah_thp@unila.ac.id
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49	Fresh-Cut Vegetables, Time Efficiency And Vegetables Business Prospect" (Survey At The District Of Umbulharjo, Gondokusuman, Danuejan, ANd Gedongtengen, In Yogyakarta City)	Rr. Leslie Retno Angeningsih Instansi: Sekolah Tinggi Pembangunan Masyarakat Desa "APMD" Jl. Timoho 317 Yogyakarta, Indonesia Telp (0274) 561971 E-mail: leslie_angeningsih@yahoo.com
50	Food Security Status of Horticulture Farmers in the Highland Region of the Manokwari District	Nouke L. Mawikere*, Fitryanti Pakiding*, Mudjirahayu** *Department of Agriculture and Agricultural Technology **Department of Animal Husbandry, Fishery, and Marine Science Papua State University, Indonesia E-mail: lenda.mawikere@fapertek.unipa.ac.id
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52	Potential of floatingHorticulture System on SwampLand in South Sumatra	Siti MasreahBernas Faculty of Agriculture, University of Sriwijaya E-mail: bernasmasreah@yahoo.com
53	Developing Hydroponic technology at MediumAltitude, without pesticide for medium and small agribusiness Case:tomato cultivarRecento	Dedy Widayat, Aos M Akas and Nursuhud E-mail: widayatdedi@yahoo.com
54	Effects Of Goat Manure On Growth, Yield, And Economic Impacts Of Vegetable Intercrops In Young Coffee Plantation	Agus Karyanto*, Sugiatno, and Rusdi Evizal Jurusan Budidaya Pertanian, Fakultas Pertanian Universitas Lampung * E-mail: agusk@unila.ac.id dan agsknila@yahoo.com
55	Aspirasi Masyarakat Dalam Pengembangan Komoditas Buah Unggulan Di Kabupaten Bojonegoro	Indra Tjahaja Amir E-mail: wurjani@gmail.com
56	Calcium Chloride Infiltration Methods To Extend The Storage Life Of Fresh Duku	Anny Yanuriati, Musolli Arief, and Parwiyanti Agricultural Technology Department, Sriwijaya University, Jl. Raya Palembang Prabumulih Km. 32, Indralaya (30662), South Sumatra, Indonesia. E-mail: annyyanuriati@yahoo.com

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59	Behavior Of Consumer Fruit In Traditional Market And Modern Market In Jember District	Evita Soliha Hani and Nyra Dewi Sartika Social Economic of Agriculture Department/Agribusiness Faculty of Agriculture-Jember University E-mail: ita_hani@yahoo.com
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61	The Response of Cocoa Seedlings due to Application of Trichoderma spp Grown on Different Media	Sriwati R [1], Chamzurni T [1], Ardiansyah [1] [1] University of Syiah Kuala, Faculty of Agriculture, Agro technology Department, Darussalam Banda Aceh, INDONESIA E-mail: rin_aceh@yahoo.com
62	Study of Control System Temperature And Humidity Using Microcontroller AVR Atmega 8535 On Evaporatif Cooling Equipment Used As A Store For Guarding Of Product Quality Fruit And Vegetables Postharvest	Priswanto[1)] and Ropiudin[2)] Jenderal Soedirman University of Purwokerto Jl. HR Bunyamin Purwokerto,Indonesia 55212 E-mail: prist_02@yahoo.com, prist009@gmail.com
63	Lactic Acid Bacteria and Some Biochemical Changes during Natural Fermentation of the Purple Sweet Potatoes *(Ipomoea Batatas* L.) Pickle	Neti Yuliana, Siti Nurdjanah and Zahroh Hayati Octarini THP-Agriculture Faculty-University of Lampung E-mail: yuliana_thp@unila.ac.id
64	Soybeans for the Production of Modified Tempe with *Saccharomyces cerevisiae*	Maria Erna Kustyawati (Department of Post Harvest Technology Faculty of Agriculture the University of Lampung, Jl. S.Brojonegoro No.1 BandarLampung, Phone 0721781823, E-mail: mariaerna@unila.ac.id)
65	The Effect of Nitrogen Sources and Types of Medium Subculture on Brassolaeliocattleya (Blc.) Amy Wakasugi Shoots Growth	Yayat Rochayat, Anne Nuraini and Mirna Oktavani E-mail: nuraini_yunandar@yahoo.com
66	Effects of Benzyladenine concentrations on in vitro shoot multiplication of Banana (*Musa paradisiaca Linn*) cv. Ambon Kuning and Tanduk	Dwi Hapsoro, Mochamad Ivan Alisan, Titiek Ismaryati, and Yusnita Department of Agronomy, Faculty of Agriculture, University of Lampung Jl. Sumantri Brojonegoro 1 Bandar Lampung, Indonesia. Phone: 081379155175 E-mail: hapsorodwi@yahoo.com, dwihapsoro@unila.ac.id
67	*In Vitro* Propagation of *Anthurium plowmanii* cv. Wave of Love	Yusnita[1*)], Sismanto [2)] and Dwi Hapsoro[1)] Department of Agronomy, Faculty of Agriculture, University of Lampung Jl. Sumantri Brojonegoro 1 Bandar Lampung, Indonesia. Phone: 081379155175 E-mail: hapsorodwi@yahoo.com, dwihapsoro@unila.ac.id

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69	The Study of Consumer's Preference and Behavior of Banana Chips in Bandar Lampung	Fibra Nurainy [1)], Zulferiyenni [1),] Wiriawan Sada Melindra [2)] [1)]Dosen Pembimbing Jurusan Teknologi Hasil Pertanian FP Unila [2)] Alumni Jurusan Teknologi Hasil Pertanian FP Unila E-mail: nurainy_thp@unila.ac.id
70	Technology Of Passive Packaging For Chitosan-Coated 'Mutiara' Guava And 'Muli' Banana	Zulferiyenni[1] dan Soesiladi E. Widodo[2] [1]Department of Agriculture Industrial Technology and [2]Department of Agronomy/Agroecotechnology, Faculty of Agriculture, University of Lampung; E-mail: zulyenni@yahoo.com; sewidodo@yahoo.com
71	Prey Consumption Rate Of Menochillus Sexmaculata Fabr. (Coleptera: Coccinellidae) On Different Prey Densities Aphis Gossypii Glover (Homptera: Aphididae)	Syafrina Lamin[1], Siti Herlinda[2], Yulia Pudjiastuti[2] and Arinafril[2] [1]Department biologi, faculty of Matemathic and Natural Science, Sriwijaya University [2]Dept.Plant protection, faculty of Agriculture, Unsri E-mail: rinapps_unsri@yahoo.com
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73	Freezing Method Of Straw Mushroom (*Volvariella Volvaceae*) Using *Dry Ice*	Kurnia Novianti[(1)], Sutrisno[(2)], dan Emmy Darmawati[(3)]. E-mail: e_ku_no@yahoo.co.id
74	Quality variation of Chilli fruit (*Capsicum annum*) due to the salt changes in the Saline Soil Solution	Wanti Mindari FP, UPN "Veteran " Jawa Timur E-mail: wanti.81263@gmail.com
75	Mobile Application: Land Resources Information System For Horticulture Practices	Purnomo Edi Sasongko Agritechnology Department, Faculty of Agriculture – UPN "Veteran" Jawa Timur E-mail: wanti.81263@gmail.com
76	In Vitro Seed germination, Seedling Growth and Acclimatization of *Dendrobium* hybrids (Orchidaceae)	Sri Ramadiana, Ronald Bunga Mayang, Dwi Hapsoro and Yusnita Plant Science Laboratory, Department of Agronomy, Faculty of Agriculture The University of Lampung. E-mail: sri_ramadiana@yahoo.com
76	Yeild tests of some yard-long bean genotype On two environment	Nyimas Sa'diyah[1)], Tjipto Roso Basoeki[1)], Eko Suprihanto[2)] Ricky Aris Tiawan[2)] dan Setyo Dwi Utomo[1)] Faculty of Agriculture of the University of Lampung Jl. Sumantri Brojonegoro 1. Bandar Lampung E-mail: nyimas_diyah@ yahoo.com or nyimas_diyah@unila.ac.id
77	Insecticidal Activity Of Brucein-C From Buah Makasar (*Brucea Javanica*) Against Cashew Insect Pest *Helopeltis Antonii*	Subeki[1], Sri Hidayati[1], Elna karmawati[2], and Chandra Indrawanto[2] [1]Department of Agricultural Product Technology, Faculty of Agriculture, Lampung University, Jl. S. Brojonegoro No. I, Gedong Meneng, Bandar Lampung 35145 [2]Research and Development Center of Plantation, Departmen of Agriculture, Jl. Tentara Pelajar No. 1, Cimanggu Bogor E-mail: bekisubeki@yahoo.com
78	Population and spesies of Fruit fly (*Batrocera* spp.) with Attractant Sticky Yellow Trap (ASYTA) Formulation from Natural Plant Product (1)	Sylvia Sjam, Sulaeha dan Zulfitriani (2) Lecturer : Department Pest and Disease plant, Faculty of Agriculture Hasanuddin University E-mail: sylviasjam@yahoo.com

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82	Improvement The Harvest Dan Handling Method To Reduce The Postharvest Decay Of Palembang Duku	Anny Yanuriati and Rindit Pambayun Agricultural Technology Department, Sriwijaya University, Jl. Raya Palembang Prabumulih Km. 32, Indralaya (30662), South Sumatra, Indonesia. E-mail: annyyanuriati@yahoo.com
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84	Introgression Of Cmv Tolerance Genes To Hybrid Parent Of Hot Pepper: Employing Morphological And Rapd Marker To Identify Recurrent Parent Characteristics In Bc2 Population	Catur Herison, Sri Winarsih, Merakati Handayaningsih and Rustikawati Fakultas Pertanian Universitas Bengkulu, Indonesia E-mail: herisoncatur@yahoo.com
85	Application of Growth Retardant (CCC) and Irrigation At Different Times to Promote Potato Tuberization at Low Elevation of Bengkulu	Usman Kris Joko Suharjo [1,3)], Fahrurrozi[1)] , Sigit Sudjatmiko [1)], and Popi S.[2)] *1)* Faculties at the College of Agriculture, Bengkulu University, Jl. Raya W.R. Supratman, Bengkulu; 2) Former student at the Dept of Agronomy, College of Agriculture, Bengkulu University, *3)* Corresponding author: usman_maine@yahoo.com
86	The Possibility of Using Near Infrared Spectroscopy with Portable Spectrometer to Evaluate Some Internal Properties of Pineapple Fruit Nondestructively	Sandi Asmara *, Diding Suhandy*, and Meinilwita Yulia** *Bioprocess and Postharvest Engineering Laboratory Agricultural Engineering Department, Faculty of Agriculture The University of Lampung, Indonesia Jl. Soemantri Brojonegoro No.1 Bandar Lampung, Lampung 35145 Phone: 0721-701609 ext: 846
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88	Effectivity of Insect Pathogen, *Fusarium* sp. in Controlling Cabbage Worm, *Plutella xylostella* L.	Melina [1)] and Yumarto [2)] 1) Department of Plant Pest and Disease, Faculty of Agriculture, Hasanuddin University, Makassar 2) Staff of BPTPH Maros, Soh Sulawesi E-mail: melinayumarto@yahoo.com

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90	Distribution Of Fusarium Oxysporum F.Sp. Cepae Which Caused Moler Disease Through Shallot Seed Bulbs	Sri Wiyatiningsih[1], Bambang Hadisutrisno[2], Nursamsi Pusposendjojo[2], and Suhardi[3] [1] Faculty of Agriculture UPN "Veteran" East Java [2] Faculty of Agriculture Gajah Mada University, and [3] Indonesian Ornamental Crops Research Institute E-mail: heriner@gmail.com
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97	Effect of Gamma Rays Mutagen on Callus In Vitro of Pineapple (Ananas comosus (L.) Merr.)	Erni Suminar[1], Sobir[2], Agus Purwito[2] [1]Agriculture Faculty of Padjadjaran University, [2]Department of Agronomy & Horticulture IPB E-mail: suminarerni@yahoo.com
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ENERGY INPUT-OUTPUT ANALYSIS FOR WATERMELON PRODUCTION

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ABSTRACT

The purpose of this study was to analyze input and output energy in watermelon production. The study was conducted using face to face questioner for watermelon farmers in Bunga Mayang, North Lampung. Energy input was analyzed based on the farm activities (land preparation, planting, plant management, harvesting and transportation) as well as input types (human labors, machineries, fuel, fertilizers, chemicals, and other materials). The result showed that total input energy of 57,532 MJ/ha was required for watermelon production in which chemical fertilizer was the highest contributor (29,887 MJ/ha or 51.94 % of total inputs). With average yield of 25000 kg/ha, the output-input energy ratio was 0.54, whereas specific energy was 2.30 MJ/kg and energy productivity was 0.43 kg/MJ.

Keywords: watermelon, input energy, output energy, energy ratio, specific energy

INTRODUCTION

Watermelon originally comes from Kalahari Desert, South Africa, and then widespread into Japan, China, Taiwan, Thailand, India, Germany, America and Indonesia (Prajnanta, 2004). It grows rapidly at 20ºC - 30º C temperatures and can be grown at soil, bag culture or hydroponic system with pH 6 - 7 and 0 – 1000 meter above sea level (Kalie, 2000).

Watermelon is considered as one of the most popular fruits consumed in Indonesia because it is healthy and tastes good. Every 100 gram of watermelon consists of water 92.1 %, protein 0.1 gram, carbohydrat 7.2 gram, fat 0.2 gram, vitamin A 50.0 SI, vitamin B1 0.02 mg, vitamin B2 0.03 mg, vitamin C 7.00 mg, fibre 0.5 gram and niacin 0.2 gram. Watermelon is a low calory fruit that can be used as a diuretic. Its high flavonoid content also good for antioxidan.

During 2000-2007, harvested area and yield for watermelon production increased significantly from 22,433 ha to 32,326 ha and 76.6 ton/ha to 108.5 ton/ha (Table 1). The main area for watermelon production in Indonesia includes Yogyakarta, Magelang, Kulonprogo, Indramayu, Karawang, Malang, Pekalongan, Purworejo, Kebumen, Magelang, Sragen, Demak, Banyuwangi, and Lampung.

Table 1. Watermelon production in Indonesia 2000-2007 (FAOSTAT, 2010)

Year	Area (Ha)	Yield (kg/ha)	Production (tones)
2000	22,433	76,621	171,885
2001	26,176	91,800	240,298
2002	25,567	104,393	266,904
2003	32,223	141,348	455,466
2004	28,725	142,800	410,195
2005	31,499	116,417	366,702
2006	31,843	123,288	392,586
2007	32,326	108,513	350,780

Efficient use of energy sources for watermelon cultivation is important because it is one of the principal requirements of sustainable agriculture. Efficient use of energy in agriculture processes will minimize cost and environmental problem. Energy audit is one effective way to analyze the energy used for crop production. It can also be used to evaluate whether a production process uses energy effectively. It is also important to identify opportunities to reduce energy consumption (Thumann and Younger, 2007). Therefore, energy audit becomes an important part in the whole management because of direct relation between energy and cost.

Quantification of inputs-outputs by their energy values is a method accepted globally for energy analysis (Baruah and Duta, 2007). There were several studies on energy audit to determine the use of energy in some horticultural productions such as potato (Mohammadi *et al*., 2008), tomato (Esengun *et al*., 2007), apple (Kizilaslan, 2009a; Strapatsa *et al*., 2006), and cherry (Kizilaslan, 2009b). The objective of this research was to determine the input energy used for watermelon production and to identify the opportunity to reduce energy consumption.

MATERIALS AND METHODS

Data were collected from watermelon farmers in Bunga Mayang (North Lampung) by using face-to-face questionnaire. The harvested area for watermelon at the location was about 45 ha. Field observation was conducted for a week (25-30 May 2010). Figure 1 shows a schematic of watermelon production, while field situation was depicted in Figure 2. Watermelon was harvested at 52-60 days after planting and the fruit was transported to a broker in Kota Gajah (Central Lampung) at a distance of 120 km, approximately.

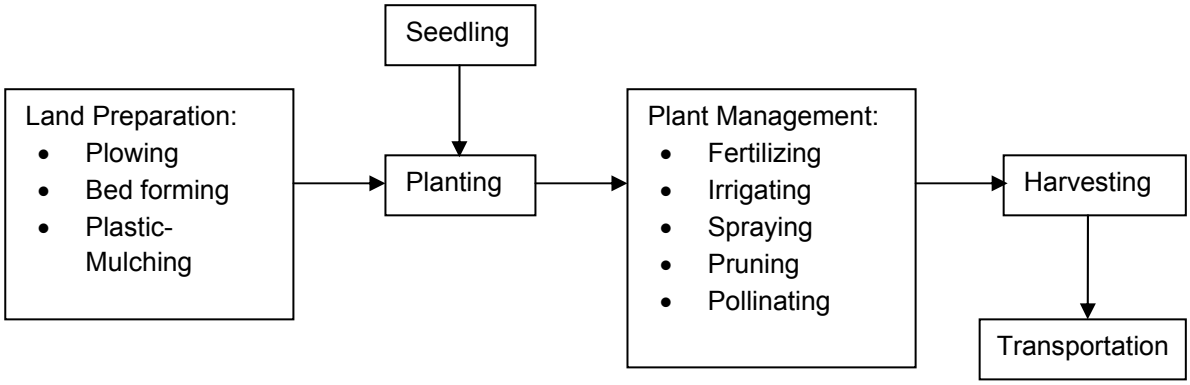

Figure 1. Scheme for watermelon production by farmers in Bunga Mayang, North Lampung

Figure 2. Field condition of watermelon production in Bunga Mayang, North Lampung

Energy inputs to be considered for crop production are human labor, fuel, and embodied energy for machineries (tractor, truck, and water pump), fertilizers, chemicals, and materials (plastic mulch, irrigation pipe, compost and seeds). Irrigation hose was used for three times. It is worthy to note that natural sources such as solar energy (radiation) and water was ignored in our analysis. Energy equivalent is calculated as in the following:

- Energy equivalent for human power (LABEN):
  LABEN = (LABTIME × LABENCO) [1]
  where LABTIME is man-working time (hour/ha), and LABENCO is energy coefficient for human power (MJ/h).
- Energy equivalent for fuels (FUELEN):
  $FUELEN = \Sigma\ (FC \times FUELENCO)_i$ [2]
  where FC is fuel consumption (L/ha), and FUELENCO is energy coefficient of fuel (MJ/L). Subscript *i* is for different fuels used (diesel fuel and gasoline).
- Energy equivalent for machineries (MACHEN):
  $$MACHEN = \sum\left(\frac{MW \times MACHENCO}{SL} \times h\right) \quad [3]$$
  where MW is machine weight (kg), MACHENCO is energy coefficient for machine (MJ/kg), h is machine-working time (hour), and SL is service life of machine (hour). Subscript *i* is for different machines used (tractor, water pump, and truck).
- Energy equivalent for fertilizers (FERTEN):
  $FERTEN = \Sigma\ (RATE \times AI \times FERTENCO)_i$ [4]
  where RATE is fertilizer consumption (L/ha), AI is active ingredient in the fertilizer, and FERTENCO is energy coefficient of fertilizer (MJ/L). Subscript *i* is for different fertilizers.
- Energy equivalent for chemicals (CHEMEN):
  $CHEMEN = \Sigma\ (DOS \times AI \times CHEMENCO)_i$ [5]
  where DOS is chemical dosage (L/ha), AI is active ingredient (%), and CHEMENCO is energy coefficient of fertilizer (MJ/L). Subscript *i* is for different chemicals used.
- Energy equivalent for materials (MATEN):
  $MATEN = \Sigma\ (MQ \times MATENCO)_i$ [6]
  where MQ_i is the quantity of material used (kg/ha), and MATENCO is energy coefficient for respective material. Subscript *i* is for different materials used (plastic mulch, irrigation hose, compost, and seeds). Energy coefficient of inputs and output is presented in Table 2.

Table 2. Energy equivalent of input and output in agricultural production

Input	Unit	Energy Coefficient (MJ/unit)	Reference
1. Human labor	h	2.2	Pimentel and Pimentel (2008)
2. Machinery, Tractor	Kg	82.2	Nagy (1999)
Truck	Kg	100.2	Nagy (1999)
Water pump	Kg	74.3	Nagy (1999)
3. Fuel	L	47.8	Pimentel and Pimentel (2008)
4. Fertilizer: Nitrogen	Kg	55	FEES (1991)
Phosphate	Kg	8.3	FEES (1991)
Potassium	Kg	5	FEES (1991)
Phosphor	Kg	5	FEES (1991)
Magnesium	Kg	5	FEES (1991)
Potassium chloride	Kg	8.85	Nagy (1999)
Sulphur	Kg	1.12	Nagy (1999)
5. Irrigation hose	Kg	103	Baird *et al*. (1997)
6. Plastic mulch	Kg	308	Silvernail *et al*. (2006)
7. Chemical: Insecticides	Kg	284.82	West and Marland (2002)
Fungicides	Kg	288.88	West and Marland (2002)
Herbicides	Kg	266.56	West and Marland (2002)
8. Seeds	Kg	0.12	Mohammadi *et al*. (2009)
Output: Watermelon	Kg	1.34	http://www.whfoods.com

Energy performance is determined using energy indicators including energy ratio (ER), energy productivity (EP) and specific energy (ES) (Moerschner and Lücke, 2006):

$$\text{ER (desimal)} = \frac{\text{Energi Output } (\text{MJ.ha}^{-1})}{\text{Energi Input } (\text{MJ.ha}^{-1})} \quad [7]$$

$$\text{EP (kg/MJ)} = \frac{\text{Watermelon production } (\text{kg.ha}^{-1})}{\text{Energi Input } (\text{MJ.ha}^{-1})} \quad [8]$$

$$\text{ES (MJ/kg)} = \frac{\text{Energi Input } (\text{MJ.ha}^{-1})}{\text{watermelon production } (\text{kg.ha}^{-1})} \quad [9]$$

Tabel 3. Amount of inputs and output as well as energy inputs and output in watermelon production on a hectare basis.

No	Energy input/activity	Unit	Quantity	Energy Equivalent MJ	Energy Equivalent %
1	*Human labor:*			*4562.8*	*7.93*
	Plowing	h	2	4.4	0.01
	Bed forming & mulching	h	62.8	138.2	0.24
	Seedling	h	14	30.8	0.05
	Planting	h	34	74.8	1.22
	Fertilizing	h	320	704	0.13
	Irrigating	h	479	1,053.8	1.83
	Spraying	h	314	690.8	1.20
	Pollinating and pruning	h	672	1,478.4	2.57
	Harvesting	h	126.2	277.6	0.48
	Transportation	h	50	110	0.19
2	*Machine*			*1117.2*	*1.94*
	Tractor (80 HP, 2890 kg)	h	2	30.7	0.05

No	Energy input/activity	Unit	Quantity	Energy Equivalent MJ	Energy Equivalent %
	Water pump (29 kg)	h	149	42.8	0.07
	Truck (2500 kg)	h	50	1043.8	1.81
3	*Fuels*	L	330	*15,574.0*	*27.42*
4	*Fertilizer*			*29,877.1*	*51.93*
	ZA	kg	310	19,436.3	33.78
	NPK (16-16-16)	kg	490	4,699	8.17
	Mutiara	kg	160	3,840	6.67
	KCL	kg	240	549.6	0.96
	TSP	kg	70	24.8	0.04
	BAS	kg	30	307.4	0.53
	Superphose	kg	180	1020	1.77
5	*Chemicals*			*1,646.5*	*2.26*
	Insecticide	kg	1.35	217.1	0.67
	Fungicide	kg	1.42	221.4	0.71
	Herbicide	kg	1.9	1,208	0.88
6	*Plastic Mulch*	kg	100.8	*2,902*	*5.04*
7	*Irrigation hose*	kg	153.6	*1,757.9*	*3.06*
8	*Compost*	kg	320	*240*	*0.42*
9	*Seed*	kg	0.18	*0.02*	*0.00*
	TOTAL ENERGY INPUT			**57,532.2**	**100.0**
	TOTAL OUTPUT (Watermelon)	kg	25000	33,445	

RESULTS AND DISCUSSION

Physical inputs in each step for watermelon production along with equivalent energy values are given in Table 3. It is revealed that watermelon production required energy input total of 57,532 MJ/ha. Table 3 reveals that fertilizer application contributed the most energy used in the watermelon production, accounted for 29,887 MJ/ha or 51.93% of the total inputs. It is, therefore, important to increase the use of organic compost like cow manure, chicken manure or farmyard manure in order to reduce energy input.

Other important inputs including fuels which accounting 15,774 MJ/ha or 27.42% and human labor (4,562.8 MJ/ha or 7.93 %). Most fuel was used for fruit transportation and irrigation operation which summed up to 95.5% of the fuel used. Only 4.5% of fuel was used for land preparation. As a dryland crop, water requirement for watermelon production is actually low. However, the yield is very critical to the water shortage even in short period. Therefore, in order to provide enough water for the plants, irrigation facility was operated every another day for the first 45 and everyday afterward with working time 2-3 hours for each operation day.

The high requirement in human labor implied that a lot of works like mulching, seedling, planting, spraying, pollinating, and harvesting were done manually. Another reason is that farmers used labor from their own family which is free of charge.

In comparison to findings of other previous studies (Table 4), our finding of the total energy inputs for watermelon production was comparable to those reported by Pimentel (1980) and Biondi et al. (1991). With average watermelon yield of 25000 kg/ha (equivalent to 33,445 MJ/ha), it can be calculated that energy output-input ratio was 0.58. This ratio was close to the energy ratio in melon production (0.46) reported by Campiglia *et al*. (2007). Specific energy was found to be 2.30 MJ/kg of watermelon which implied that 2.30 MJ of energy input was required to produce a kilo of watermelon. Our work showed a higher value of specific energy than the work of Biondi *et al*. (1991). Our result, however, is better than or at least comparable to that reported by Pimentel (1980) which was in the range of 2.4-7.6 MJ/kg.

Table 4. Energetic comparison for watermelon production

Item	Value	Reference
Energy input (GJ/ha)	52.3	Biondi *et al*. (1991)
	52.8-68.4	Pimentel (1980)
	57.5	This work
Specific energy (MJ/kg watermelon)	0.87	Biondi *et al*. (1991)
	2.4-7.6	Pimentel (1980)
	2.30	This work

CONCLUSION

Based on the discussion above we conclude that watermelon production required input energy of 57,519 MJ/ha. The highest energy input was from chemical fertilizer which accounted 51.94% of total input. The average yield of watermelon was 25000 kg/ha (equivalent to 33,445 MJ/ha). The energetic parameters for watermelon production was 0.58, 2.30 MJ/kg, and 0.43 kg/MJ, respectively for output-input energy ratio, specific energy, and energy productivity.

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