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Available online freely at www.isisn.org Bioscience Research Print ISSN: 1811-9506 Online ISSN: 2218-3973 Journal by Innovative Scientific Information & Services Network RESEARCH ARTICLE BIOSCIENCE RESEARCH,201815(3):000-000 OPEN ACCESS Bambang Kusmanadhi and Mohammad Setyo Poerwoko Environment Science Faculty of Agricultur-Estate CropsJember University, Indonesia Plant Breeding Faculty of Agriculture Jember University, Indonesia *Correspondence: kusmanadhi.faperta@unej.ac.id Accepted: 00 jun.2018 Published online: 00 July.

2018 Allinputsintoagro-ecosystems can be expressed in terms of energy which is a key input in production processes.Many environmental issues are associated to the production, transformation and useofenergy. Improvements in energy efficiency willl eadto more environment-friendly production systems.The objective softhe study are to developan effective frame work tocarry outenergy accounting operation in rice farming and to assess energy use of the existing rice production systems.This paper compares the energy use of 24 group paddy producer sintwo districts in East Java Province.The energy-ratio(out pu energy toinput energy ratio),denotedby GJ,offarmers in crop production systems is indices that can definethe efficiency and sustainability of farms.

Keywords: rice farming,energy efficiency,energy INTRODUCTION Impact of agro chemical inputs on environment and green house gase missions of rice farming is a major environmental challenge of agriculturein Indonesia. Every year the country produces rice on more than 13 million hectares of harvest edagriculturall and mostly in Java Island (Indonesian Statistic ,2012).These vast farming areas,that are largely conventional systems,have been long history in contributing to The environmental deterioration (Suzuki etal.,1980;Bachelet and Neue,1993;World Bank, 1994;Lumbanraja et al., 1998; Yuwono, 1998; Las et al., 2006).

All inputsto perform various operations for crop production can be expressed in terms of energy(Ozkan,2004;Alam et al., 2005; Nassiri and Singh, 2009).However, many environmental issues are associated to the production, transfor-mation and useof energy (Dincer, 2002). Effects of increasing the consumption of fossil based energy on agriculture are of growing cer 990 agricultureis responsible for about 5% of the total global energy consumption(Stout, 1990; Pinstrup- Andersen, 1999). Two decades later, energy for theworld food sector shares for around 30 percent(FAO, 2012).

Many studies have shown that fossil energy input causes the release of carbon dioxide and nitrogen oxide from agricultural fields (Dyer and Desjardin, 2003;Robertson and Grace, 2004; Tzilivakis et al., 2005; Syvasalo et al., 2006). Forthis reason, reducing the energy derived from fossil fuels has important implications for decreasing environmental pollution.

This mayleadto the application of best management practices through energy efficiency (Kaltsas et al., 2007; Franzese et al., 2009; Kavargiris et al., 2009). Odum (2007) defined efficiency of energy transformation as the energy output (energy stored) divided by the energy input.In earlier reference,Spedding(1981) defined efficiency in biological term, so- called ‘logaleficy’as Kusmanadhi and Poerwoko Input Output Ratio...

Bioscience Research, 2018 volume 15(3): 000-000 2 output over input wherethe outputs andinputs aremeasured in physical or biological units. Furthermore, in a wider view, biological efficiency is defined as the efficiency of a biological process or processes.Hence, we can assess the efficiencies of combined processes including a complicated combination such as agricultural ecosys-tem.

Input and output of energy are two important factors for determining the energetic and ecological efficiency of crop production (Rathke and Diepenbrock, 2006). Energy intensity and energy output/input ratio are integrative indicators of the environmental effects of crop production (Hulsbergen et al., 2001). For this reason improvements in energy efficiency will lead to more environment-friendly production systems (Gundogmus and Bayramoglu, 2006).Accordingly, efficient energy use is oneof the most important conditions for a sustainable agriculture.

Within an agricultural region, many physical,chemical and biological properties directly related to the production system exhibit spatial variability,even at small distances. Such variation implies that different levels of input factors willresultin varying output (Rilwani and Ikhuoria, 2006;Bojaca et al., 2012). The variability of a farming system can be exploited to characterize farmers in terms of their energy efficiency(Tabar et al.,2010).

Such characteriza-tion can indicate pathways to optimize the energy efficiency of the system as a whole. Consider able studies have been conducted in different countries on energy use in agriculture. Through comparative studies,energy analysis has also been used to assess the efficiencyof different production systems such as conventional, organic,and integrated farming (Daalgard et al.,2001; Deike et al., 2008; Michos,2011; Bojaca et al.,2012).

On a global scale, the input of energy for the crop sproduction differs to alarge extent.In some traditional low-input farming systems, e.g. in large areas of Africa, the energy inputon arable land is lo n Ghaorm1978)where n some modern high- input farming systems in Western Europe andUSA can exceed 20 Gha-1(en tel et al., 1983; Schroll, 1994; Hulsbergen et al., 2001).

Therefore, there is a range of energy input and output relationships for the same crop based on the regionand technological level. Various methods may be applied to calculate the energ yuse for crop production depending on the goal of the study. The methods presented in the literature varyin the spatial and temporal system boundaries chosen, in the fluxes of materials and energy considered , and in the energy equivalents assigned to these fluxes (Jones, 1989).A widely applied method is the energ yinput/output analysis.In this method, allagricultural inputs in production process are multiplied by conversion factors to approximate input and output energy (Hulsbergen et al.,

2001; Dallgaard et al.,2001; Muhammadi et al., 2008; Tabar et al, 2010).Once the inputs and outputs are transformed into energy units, indicators such as energy use efficiency, energy productivity, specific energy and net energy can be derived. Green (1978) argued that high agricultural productivity is energy demanding and energy efficient is associated with low productivity.This the sisis particularly true in the energy intensive modern agriculture system.However,it is not necessarily always the casein other systems.Craumer (1979) found that less energy intensive of Old Order Amish fer'sm in North America ,including use of draft animals,lower energy inputs per unit of production more than the modern farms can accomplish without a lower over all productivity InJava Island there are sever alalternative ways of rice farming with reduced in organic agrochemicals that gave even higher yields compared to national 'aver age yield of conventional farming (Setyono, 2010; Anonymous, 2011).

However, In Indonesia, the use of inorganic fertilizer is estimated continues to increase. By comparison,the total fertilizers for rice cropping in 2003 were 4.42 million tonnesandin 2006 reached4.50 million tonnes (Las et al., 2006),where as total requirement of N, P 2O5, and K 2O in 2015 is projected 6.9 million tonnes (Irawan et al,2013). In summary, improving the environmental performance of agricultural production can be traced through energy analysis.

This paper attempts to analyse the energy use efficiency of rice farming being practiced by farmers at the field level which is ultimately aimed to promotes ustainable agriculture. Conceptual framework All living systems (organisms,populations, communities,and eco systems) can be considered as open thermodynamic systems that are not in thermodynamic equilibrium and that continuously utilize and convert energy.

Energy transfers and conversions in these systems strictly obey the first and second laws of thermodynamics (Odum, 1971;Zhouetal., 1996). Kusmanadhi and Poerwoko Input Output Ratio... Bioscience Research, 2018 volume 15(3): 000-000 3 Energy that enters a systemeither is stored the reorflows out (Figure1).Energy is constantly converted from one form to another by natural or human-controlled processes ruled by the laws of thermody namics.The first law of thermody namics (conservation of energy) states that energy can be neither created nor destroyed,althoug hit can change form.

These condlaw(law of entropy)states that it is impossible to convert a given quantity of heat completely in to work.Energy is always degraded in the conversion process and less eningits ability to do work(Odum,2007).The two laws may be resumed:although energy can be neither created nor destroyed,in any real process the availability of potential energy is lost.

In recent years,available potential energy(the amount of energy which can be extracted as use fulwork)has been called exergy.Hence,the laws of thermodynamic are the basis of all energy analysis of any production systems, including agricultural systems. The first law,also called energy balance principle,suggested that the energy of input (including any un priced material from the environment)must exactly equal the energy of output (including the energy in the waste) for any transformation process.The flow of natural re sources(materials/ mass/energy) taken from the environment goes to transfor-mational processes (such as production,consumption,and recycling)is eventually return edto the environment as wastes and pollution (Ayres, 1998; Akao and Managi, 2007; Ebert and Welsch,2007).

The first law is more concerned with the magnitude (quantity) of energy (Dincer et al., 2005).In this view,production is basically the transformation of materials in to desired out puts.Due to the thermodynamiclaws,this transformation can never be completed. Some residual un avoidably arises as a by-productor un desirable out put.This residualis linked by the materials balance.

In regard to the second law,Odum (2007) explained that the potential energy,or available energy to carry out a process,isused up.It is degraded from a form of energy cap able of driving phenomenain to a form that is not cap able to do so.Dincer (2005) added that these condlawis concerned with the quality of energy,i.e.the quality of energy to cause change,degradation of energy during a process,entropygeneration and the lost opportunities to do work.

In order to integrate environmental concern in any production systems, several attempts have been made to adjust the standard technical and economic efficiency measures. Many authors describe the environmental effects are caused by either abad out putor an environmentally detrimentalin put in production functions. For instances, nitrogen usein Dutch dairy farms (Reinhard and Thijssen, 2000),best management practices of agriculture in Canada (Ghazalian et al.,

2010), efficiency of American petroleum refineries (Mekaroonreungand Johnson, 2010). Based on the analysis, they found that input efficiency is a viable choice to reduce environmental impacts with out affecting the productivity. Based on Figure1,aconceptual frame work on energy input and output in paddy rice farming system was developed (Figure2).The operational assessment of energy inputs and output follow the model of energy flows in rice production systems (Figure3).Energy is utilized in food production process both off and on the farm. Figure1.

A system of production, consumption, and recycle that has inflows and outflows (Adapted from: Odum, 2007). Kusmanadhi and Poerwoko Input Output Ratio... Bioscience Research, 2018 volume 15(3): 000-000 4 Figure2. Conceptual framework of research onenergyassessment in a paddyrice farming system Figure3.Model of energyflows in the production ofpaddyrice crop Off the farm energy isused in the manufacture of agricultural equipments,construction of agricultural structures, fertilizers and pesticides.On the farm,energy is consumed during the process of crop production.It divides energy usage of rice production in to eight broadly distinct processes, including seed be dpreparation, till age (land preparation),transplanting,fertilization,irrigation,we ed and pests control ,harvesting and postharvest handling.This enables both the total energy inputs and the energy usage in each production process to be assessed.

MATERIALS AND METHODS The study are aisintworegencies of East Java Provinces,i.e.Banyuwan giand Jember.The selected locations are consisted of thre edifferent zones,low land,moderate and upland.The two regencies are the main rice-bowl in East Java.There is rice farming systems that are managed conventionally and(semi) organically. Kusmanadhi and Poerwoko Input Output Ratio...

Bioscience Research, 2018 volume 15(3): 000-000 5 Sampling procedure Method of sampling was stratified random sampling. The first stage is intentionally select ingther egencies base don he capacity to producer ice and the differences in agro- ecosystem, such assoil type,average of rain fall,and micro climate.These cond stage is selecting fersgroups (aloose organizationof farmers who have land in a neighbor hood area) base don the list available at the local agricultural offices.A

planned question-naire for groups was applied as instrument to investigate the total energy used in their cropping activities. Energyuse efficiency The data used in the study were collected from 24 groups of conventional and organic rice farmers at the same number in the district of Jember and Banyuwangi, East Java,Indonesia.The study are as were representing three different regimes, low land, moderate,and upland zones.

The energy input/output analysis was carried out following the standard approach where the production inputs andyield were averagedin hectare for over the entired at a set. After wards,average inputs and output were transformed in to energy units according to the energy equivalents presented inTable 1. The energycontent of the crop residues retained on the field was not considered.

Energy output and inputis calculated and stated in giga-joule (GJ)per hectare (Hulsbergen et al.,2001; Dalgaard et al.,2001; Ozkan et al., 2004; Deike et al., 2008), forthe entiresampled areas in one rice cropping season.Energy use assessment for the farming system was estimated through the energy use efficiency(EUE)according to the following formulas: = E output (/) E input (/) The inputs used in the calculation of agricultural energy use include human and machinery, diesel fuel, fertilizers, pesticides, straw, manure,and seeds.In order to make an energy analysis, it is necessary to consider the use of human and machinery in agricultural processes.The ageof Indonesian farmers is mostly about 40 years old (Ilham et al., 2007).

The working hour of agricultural workers are taken an average of 6 hours of work a day formen and 5 hours a day for women. The calculation of human or man power energy was based on a Joint FAO/WHO/UNU Expert Consultation (2001) formula. No anal's energy was used with in the groups. There is no precise way to account for the indirectly energy used in agricultural production.

This would be the energy that goes in to the production of machinery,equipment,building and other non-land resources that contribute to food and fiber production over the long term and are normally treated as capital assets.One of the most important of these is farm machinery.The calculation of energy used for tractor and plow based on formula given by Doering (1980 in Pimentel, 1980).

There are no energy data available for the application of bio-pesticides. Farmers used locally- madebio-pesticide. The calculation of bio-pesticide is based on theformula: E bio - pesc = T xCI Where, E is energy (Kcal); T is time required to make 1 litrebio-pesticide(hour); CIisaverage calorieín take of person(Kcal/hour). Here, CIis taken 2000 Kcal per-day (Indonesian Body of Statistic, 2012).

In order to beable to make the analysis, it is essential to consider energy sources, i.e. the amount of energy store din the seed. Energy equivalent for seeds were taken to be equal to the energy equivalent of the product itself. Energy output was calculated by multiplying the production amount by its corresponding equivalent.

RESULTS Energy analyses are madein agriculture in order to understand the role of direct and indirect energy inputs as production factors, to find measures for energy savings,and to improve energy efficiency.The performance evaluating indicators/parameters are presented in Table 2.Ingeneral view, it is evidenced that conventional farming system shows a higher output/inputratio. This means the conventional farmers can produce higher output per unit input.

In most publications, both smaller energy inputs and a higher energy use efficiency (higher out put per unit input or less input per unit output) were reported for organic farming. The majority of these comparisons between organic and conventional farming were carried out at the farm level (Dalgaard et al., 2001; Gundogmus and Bayramoglu, 2006).

In this research, it was found that most farmers groups in upland are aandorganic farmers used straw and manure for their energy sources.A high quantity of straw and manureuse, i.e. 5 and 2 tonnes ha-1respectively,contributed to high quantity of energy input.Theuse of straw and manureis of utmost importance in organic farming Kusmanadhi and Poerwoko Input Output Ratio...

Bioscience Research, 2018 volume 15(3): 000-000 6 systems and in upland are a where the in organic fertilizers supply is generally limited. Table 1. Energy equivalent of inputs and outputs Input Description Energy equvalent Reference urea 59.83 MJ/kg Lockeretz, 1980 nitrogen 61.50 MJ/kg Lockeretz, 1980;Heichel, 1980;Rutgerand Grant, 1980 phosphorus(P2O5) 12.55 MJ/kg Pimenteland Burgess, 1980;Rutgerand Grant, 1980 potassium(K2O) 6.69 MJ/kg Pimenteland Burgess, 1980;Rutgerand Grant, 1980 ;Lockeretz, 1980;Heichel,1980 seed 14.64 MJ/kg Stout,1979;M.S.Alametal, 2005;N.S. et al., 2006 Chauhan dieselfuel 39.58 MJ/L Huslbergenetal. 2001; Deikeetal. 2008 pesticide 120 MJ/L Nassiriand Singh, 2009; Chauhan et al., 2006 bio-pesticide 0.84 MJ/L Based oncalculation tractor 24.90 MJ/ha Calculationbased on Doering, 1980 sprayer 0.04 MJ/ha Calculationbased on Doering, 1980 C-organic 41.84 MJ/kg Salonen et al.,1976 male labour 1.03 MJ/hr Calculationbased on FAO,2001 female labour 0.84 MJ/hr Calculationbased on FAO,2001 Table 2.Input Output and Ratio Energy per Hectare Farmer Group Input (GJ) Output (GJ) Ratio O/I jlcg-1 25.83 114.64 4.44 jlcg-2 26.45 116.05 4.39 jmcg-1 24.19 103.83 4.29 jmcg-2 24.72 104.17 4.21 jucg-1 142.75 151.21 1.06 jucg-2 91.13 95.40 1.05 jlog-1 60.44 131.35 2.17 jlog-2 54.15 107.31 1.98 jmog-1 53.45 98.11 1.83 jmog-2 52.37 98.32 1.88 juog-1 160.03 86.29 0.54 juog-2 155.62 86.32 0.55 blcg-1 19.11 98.44 5.15 blcg-2 21.44 108.23 5.05 bmcg-1 15.88 94.38 5.94 bmcg-2 19.09 94.04 4.93 bucg-1 85.92 85.42 0.99 bucg-2 88.44 86.12 0.97 blog-1 52.52 100.96 1.92 blog-2 48.83 102.52 2.10 bmog-1 55.05 88.38 1.60 bmog-2 42.18 88.03 2.09 buog-1 148.17 83.36 0.57 buog-2 148.55 85.49 0.57 Note: j:Jember l :lowlandzone c:conventional b:Banyuwangi m:moderatezone o:organic u: uplandzone g: group The higher application rates of strawand manureled to higher energy input, thus, lowerin the output/input ratio (Graph 1 and 2).

It is assumed that therisk of harmful environ- mental effects is lower with organic than with conventional farming methods, though not necessarilyso (Hansen et al., 2001). When comparing and assessing different farming Kusmanadhi and Poerwoko Input Output Ratio... Bioscience Research, 2018 volume 15(3): 000-000 7 systems in regard to terms of their performance not only energy use efficiency.

The in tensity of agro chemical use should be considered since possible contaminations of soil, water, and air,as well as the endangerment residues remaining on food(Deike et al., 2008). Thus, long-term comparison of cropping systems comprising different management of energy sources as inputs such aspresented in this study is in dispensable. Graph1.Input-output energy usein conventional rice cropping based on zone (per-ha) Graph2.Input-output energy usein organic rice cropping based on zone (per-ha) CONCLUSION Energy consumption perunitland area and the amount of energy needed for the production of one unit of product or one unit of energy output are fundamental indicators to assess the environmental effects of crop production.

The finding showed thatthe energyusein conventional farming systems more efficient with regard to energy require-ments, where as the output in put ratio is higher compare to organicone. Based on zone,farmers in lowland and moderate are as are more efficient compare to farmers in upland areas.However, there is no significantly different in output between the whole systems. Kusmanadhi and Poerwoko Input Output Ratio...

Bioscience Research, 2018 volume 15(3): 000-000 8 CONFLICT OFINTEREST This study was conducted without any conflict of interest. ACKNOWLEGEMENT Thank you for the expenses incurred for “ia Bran” research from DP2M. AUTHOR CONTRIBUTIONS Bambang Kusmanadhi Environmental Scince Program as whole. Moh. Setyo Poerwoko designed his plant breeding program as a whole

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