KnE Life Sciences

ICSAFS Conference Proceedings
2nd International Conference on Sustainable Agriculture and Food Security: A Comprehensive Approach
Volume 2017

Knowledge E
Engaging minds

Conference Paper

# Incorporating Risk to Technical Efficiency Measurement in Organic Farming: Study in East Java, Indonesia

**Agustina Shinta, Silvana Maulidah, and Gita Prastanti**

Faculty of Agriculture, Universitas Brawijaya, Malang, Jawa Timur

Corresponding Author:
Agustina Shinta
shint4_71ub@yahoo.com
agustina.fp@ub.ac.id

Received: 28 July 2017
Accepted: 14 September 2017
Published: 23 November 2017

Publishing services provided by Knowledge E



Selection and Peer-review under the responsibility of the ICSAFS Conference Committee.

OPEN ACCESS

## Abstract

Farmer's risk aversion determines the decision to farming, especially in organic farming. In Indonesia, organic farming still has not shown encouraging progress, whereas movement "Go Organic" has been initiated by the government since 1980 after the green revolution program was stopped. Organic agriculture has the potential failure obstacles in the process of production and farming. International policy, human resources, government supporting, land, water, local seeds, marketing, climate, can be sources of risk in organic paddy farming in developing countries. The farmer's risk aversion become crucial issues that influencing the production resulting from using a combination of inputs. Purposes of this study are a) analyzing sources of risk in organic farming, b) measuring the risk behavior of farmers and c) analyzing the effect of the risk behavior of farmers to production. The location of this research is purposive with consideration that the location is an organic rice production centres in Malang. The method to determine the respondents is census method. The method used a) quantitative descriptive, b) quadratic utility functions of the Bernoulli principle with technical-NM and c) Stochastic Frontier production function. The study found that the dominant source of the risk faced by organic paddy farmer is local rice seedlings are susceptible to pests and diseases, the behavior of most farmers are risk neutral and there is a positive and significant influence between behavior risk with productivity, causing the efficiency to be 93.31%. It is hoped with this study can be used as a reference for the government in the development of organic farming in the framework of "Healthy Indonesia".

**Keywords:** paddy organic, risk aversion, efficiency, sources of risk.

## 1. Introduction

The efficiency level of organic farming is still lower than conventional farming, such as coffee in Tanzania [1], dairy milk in Austria [2], rice in Bogor [3] and Philippines [4], coffee in Hawaii [5], and cotton, paddy, rice, wheat in India [6]. On the contrary, the level of efficiency of coffee is high in Nepal [7] while Reference [8] said that organic rice in the $5^{th}$ and $8^{th}$ year began more efficient than conventional rice, this was a case in Central Java, Indonesia. The efficiency level is influenced by the decision of farmers to allocate some inputs of farming which have an impact on the productivity level that they will achieve it.

The small-scale's or smallholders of farmers are tend to resist or avoid some risk, because the farmers aren't thinking to maximize profits, but whatever the family's need are met [9]. The farmer's risk behavior explains how the farmers face the risk as a personal power to make basic decision of trust on occurrence of uncertain event and a personal evaluation of the potential risk. Risk is related to attitudes and behavior of individual farmers for deciding how to combine the level of input use of production factors and the other factors [10]. The tendency of farmer's behavior differences has an impact on readiness to bear the risk. Thus the phenomenon illustrates that the behavior of farmers against the risk can be a crucial issue, especially related to farming activities, especially in decision-making by farmers.

According to Reference [9, 11] that avoidance of risk will cause yields lower than the farmers who behave to like of the risk, so the income will be lower which is cause of the unwillingness of the farmers for adopting technology. Farmer's behavioral measurement of the production risk with some approaches, such as a) approaches of variance value, standard deviation and coefficient of variation [12]; b) The average function and variance approaches in the frontier production [13–15]; c) Expected Utility of Income Approaches [9] using the Bernoulli principle, technical of Neumann-Morgenstern, Arrow Pratt Theory and quadratic utility function [16]; d) The level of risk with standard value or z-score approaches; and e) Production risk of perception approaches [17]. The researchers found that farmer's risk are different based on their commodity. Farmer's risk behavior is averse on plant crops, vegetables and organic [14–16] while farmers who risk taker have plant crop farming [12].

Knowledge and understanding of the farmer's risk behavior can provide a good basic understanding about the productivity constrains, especially for some high value commodity such as organic rice commodities. Ignoring the existence of the risk farming will lead to biases some estimates of parameters and level of technical efficiency which will cause problems when the interpretation of productivity phenomenon [18]. According to Reference [19] that the impact of production risk and level of technical inefficiency from farmers in Russia caused variability of production or the production risk will give some contribution to instability of agricultural output. If the ignore the risk, so it will cause estimates of technical efficiency to be biased.

## 2. Materials and Method

## 2.1. The determination of location

The research location was in Sumberngepoh Village, Lawang District, Malang Regency, East Java Province. This place was chosen based on the consideration that Sumberngepoh Village was the centre of organic rice production area in Malang with the level of productivity is 4.67 tons in 2012. Respondents were 42 farmers with census method and collection data method by using deep interviews with all respondents.

## 2.2. Methods of data analysis

Analysis of qualitative descriptive is used to know all the risk sources which are cause the risk of organic rice farming. Econometric analysis is used to analyze the level of risk and of organic rice farming and to analyze the influence of farmer's risk behavior to the level of technically efficiency of organic rice farming.

## 2.3. Analysis of risk sources

The statement of risk source of farming organic rice was submitted to the respondents, are a) The seed of rice are susceptible to pests and diseases, b) the uncertainty of climate, c) the uncertainty of price when it is sold by farmers to middlemen, d) Need more costs, time and workers for manufacturing fertilizers and organic pesticides, e) Lack of capital and there is no credit farming, f) lack of information about rice organic farming, g) lack of storage good facilities, h) lack of affordable transportation to transport the crops for selling, i) difficulties in obtaining the labor of organic rice farming. In order to know the most dominant source of risk accompanies farmers' behavior.

## 2.4. Analysis of risk and farmer's risk behavior

There are two steps in analyzing the behavior of farming. First, risk analysis is used to analyze the level of production, price and income risk. Assessment of the level of risk be done with measuring the deviations that occur in organic rice farming itself generated from the calculation of parameters based on indicators. Before doing the calculation of risk value on farming by the farmers, the first thing to do is calculate organic rice farming which is include costs, revenues and profit of farmers in the planting season. The measurement of deviation are: a) Expected result (E) value of the expected results is obtained from the calculation of average production, prices and incomes by summing the total value of each these variables and then divided by the total respondents; b) variance and standard deviation; c) Coefficient of Variation

(CV) is a comparison between the risks which must be covered by farmers by farmers with the amount of profits earned as a result of capital invested during the production process. The greater the value of the coefficient of variation, it shows that the risk covered by the greater organic rice farmers when compared with the benefits to be received; d) Lower bound (L) is the lowest average value that may be received by the organic rice farmers in the farming activities. If the value of $L \geq 0$, then the farmers who conduct organic rice farming will avoid losses. Conversely, when the value of $L < 0$, then in the process of organic rice farming, farmers likely to suffer losses, which the assessment criteria are if the value $CV \leq 0.5$ or $L \geq 0$, then the farmers avoid losses and if the value of $CV > 0.5$ or $L < 0$, then the farmers have the opportunity to experience the loss [20].

Second, farmer behavior analysis on risk will use two items of analysis. The first analysis uses a model of analysis utility functions are formulated in quadratic form with Bernoulli principles and techniques N-M (Neumann-Morgenstern) enhanced. On this analysis will result utility function approach Certainty equivalent (CE) and formulated in the quadratic. And the second analysis is quadratic regression, where the value of the utility and value of CE that has been obtained can be estimated and regressed into a quadratic utility function. The CE determination procedure conducted by several steps as follows [21]:

- The first question was given to farmers about the value of the real income of the highest ever obtained by the farmer's respondent during organic rice farming in the period of time which has been done. This is done in order to determine the value of the highest income in which these values can be referred to as the value of income at the level of neutral because it is not a risk.
- Ask questions to farmers about the value of the expected revenue will be received. With the condition of the farmers that grow organic rice with certain seed type area of land owned by the planting period is now considering the farming conditions that might occur in the next 120 days is very good (the level of risk of crop failure is very small). So in these conditions will be obtained CE values at the highest level of satisfaction (high utility value).
- Ask questions to farmers about the same question with step number two, but by using the consideration which the conditions of farming that may occur at 120 days to come is not as good when compared with the conditions on the first question, or in other words, there is a risk of failure at harvest time farmers organic rice, On the second question will be obtained CE values at lower levels of satisfaction compared to the value of CE in the previous question.
- Questions like before is done continuously by 8 levels, taking into account the possibility of farming conditions continue to decline (the level of risk increasing

or fluctuating), to obtain CE value 9 (8 CE value plus the value of the lowest CE is zero).

- CE is the ninth value, which is nested start by the greatest value to the smallest, and paired with the value of util largest to smallest.

After the value of the utility and value of CE obtained the utility function can be estimated using a quadratic function [21]:

$$U = \beta_0 + \beta_1 M + \beta_2 M^2 \tag{1}$$

Where U: Value for revenue expected utility (in util), $\beta_0$: Constants, $\beta_1, \beta_2$: coefficient of utility functions, M: Revenues are expected at the balance point (rupiah from CE). Based on the value of the utility function coefficient ($\beta_2$) shows that the behavior of farmers against the risk as follows:

1. Estimation of farmers behavior to accept the risk (risk lover) if $\beta_2 > 0$
2. Estimation of risk neutral farmer behavior (risk neutral) when $\beta_2 = 0$
3. Estimation of risk averse behavior of the farmers (risk averter) if $\beta_2 < 0$

## 2.5. Analysis of farmer's risk behavior influence to organic farming efficiency

Stochastic frontier production function model is based on the theory of frontier production [22]. The frontier production function is the production function which describes the maximum output from given input [22]. If a farmer has reached a frontier, it is said that the farmers are already in technical efficiency, and if it has not been achieved, the technical inefficiency can be searched by comparison of the actual position relative to frontier. With SPF method (stochastic Production Frontier) can be obtained parameters that work in the production process that can be estimated simultaneously with the effect parameter that reflects the capability of managerial inefficiency of farm and farmer characteristics. The stochastic frontier model is estimated by the Cobb Douglass and computer software of Frontier 4.1 which is the production function considers to the farmers' risk behavior variables as follows:

$$\begin{aligned} CP_i = & [\alpha_0 + \alpha_a A_i + \alpha_s Si + \alpha_{of} OFi + \alpha_{lf} LFi + \alpha_{op} OPi + \alpha_l Li\alpha_{tl} + \alpha_{rb} RB] \\ & +[\beta_0 + \beta_a A_i + \beta_s Si + \beta_{of} OFi + \beta_{lf} LFi + \beta_{op} OPi + \beta_l Li\alpha_{tl} + \beta_{rb} RB\} v_{it} - u_{it}] \end{aligned} \tag{2}$$

With CP: crops production (kg), A: area of land; S: rice seed (kg), OF: organic fertilizer (kg), LF: complementary liquid fertilizer, OP: bio pesticides, L: labor, RB: risk behavior.

Furthermore, technical inefficiency occurs thought is caused by age's farmers ($Z_1$), family number ($Z_2$) education level of farmer ($Z_3$), the period of farming ($Z_4$), and subsistence systems ($Z_5$). N ($\mu$, $\sigma_u^2$). It assumed normal iid N ($\mu$, $\sigma_v^2$)., while $u\_it$ with one side of the assumed non-negative distribution truncated distribution N($\mu$, $\sigma_u^2$). Of the stochastic frontier production function equation above involving technical inefficiency estimates can be obtained simultaneously, the factors that influence the occurrence of technical inefficiency, so the equation formulated in accordance phenomenon, that is:

$$\text{Ln}u_{it} = \delta_1 \ln Z_1 + \delta_2 \ln Z_2 + \delta_3 \ln Z_3 + \delta_4 \ln Z_4 + \delta_5 \ln Z_5 + e_1 \quad (3)$$

Whereas for calculating the level of efficiency achieved using a formula of rice farming is the most commonly used measure of output-oriented technical efficiency is the ratio of the observed output divided by the corresponding stochastic frontier, that is:

$$TE = \frac{y_i}{\exp(x_i' \beta + v_i)} = \frac{\exp((x_i' \beta + v_{i\_} u_i)}{\exp(x_i' \beta + v_i)} = \exp(-u_i) \quad (4)$$

TE has the value indicator between zero and one. It measures the output of the i-th a farmer relative to output that can be generated by individuals by efficiently using a full condition of the same input vector. In the stochastic frontier models, there are three hypotheses to be tested are: Ho: $\alpha_h = \beta_h = 0$; independent variables and the interaction of independent variables are insignificant associated with the dependent variable. Testing Likelihood Ratio Test (LR test) will be used with the following formula:

$$LR = -2(L_0 - L_1)\chi_m^2 \quad (5)$$

Where: Lo is the value of the log likelihood function in the regression model without limitation, L1 is the value of the log likelihood function in the regression model with restrictions, and m is the number of restrictions. In testing the $\chi^2$ value which has been calculated in comparison with the critical value of $\chi^2$ at a certain confidence level. If $\chi^2$ value is greater than the $\chi^2$critical value, then $H_0$ is rejected (all parameters equal to zero), it means that at a certain confident level, independent variables simultaneously are significantly influence the dependent variable.

## 3. Result and Discussion

Sumberngepoh Village has an area of 745.7 hectares which is divided into a number of land use, ie residential areas, yards, technical irrigated rice, semi technical irrigated rice, moorland, forest conversion, land and public facilities. Generally Sumberngepoh Village is an area which lays at an altitude of 490 meters above sea level with spans an area of plains and hills. The average temperature in the country is 20°C-30°C and an average rainfall of 2000 to 2500 mm per year. Sumberngepoh Village has an area of 741.6 ha area which is divided into three hamlets namely Krajan Hamlet, Ngapuk

Table 1: Characteristic and data of rice farming cost of farmers respondent.

| Variable | Min | Max | Mean | Median | Standard deviation |
|---|---|---|---|---|---|
| Age of farmer (year) | 40 | 90 | 62 | 60 | 12 |
| Level of education | SD | S1 | SD | SD | |
| Land ownership status | Rent | Owned | Owned | Owned | |
| Old Farming (years) | 2 | 10 | 7.26 | 9 | 2.8 |
| Yield (kg/ha) | 4,000 | 8,000 | 5,517 | 5.333 | 868 |
| Farm size (hectares) | 0.25 | 2 | 0.58 | 0.57 | 0.369 |
| Seed Costs (IDR/ha) | 168,750 | 225,000 | 192,280 | 200,000 | 12,551 |
| Animal Fertilizer Costs (IDR/ha) | 125,000 | 2,642,500 | 692,083 | 500,000 | 588,068 |
| Complimentary liquid fertilizer costs (IDR/ha) | 20,000 | 100,000 | 53,826 | 50,000 | 17,923 |
| Bio pesticides costs (IDR/ha) | 20,000 | 150,000 | 64,121 | 50,000 | 32,241 |
| Workers costs (IDR/ha) | 897,500 | 5,880,000 | 1,951,291 | 1,500,000 | 1,085,571 |
| Total Costs | 2,233,489 | 10,148,289 | 4,459,638 | 3,807,661 | 1,660,362 |
| Revenue | 15,600,000 | 33,600,000 | 22,898,376 | 21,969,231 | 3,832,324 |
| Profit | 11,021,207 | 27,921,867 | 18,438,739 | 17,706,233 | 3,845,156 |
| Source: Primary Data 2014 | | | | | |

Hamlet and Barek Hamlet and consists of 7 Citizens Associations and 30 Neighborhood Associations

The number of respondents of organic rice farmers is 42 people obtained by using census method. Characteristics of respondents analyzed were age, education level, period of the farming and land area. In Table 1 are presented the data descriptive statistics about the characteristics of farmers and organic rice farming cost data. The characteristics of the farmer's respondent and farming costs are presented in Table 1 as follows.

## 3.1. Identification of risk source

The most dominant statement is answered by the respondent local rice seedlings are susceptible to pests and diseases, then climate uncertainty, the input is not available easily and tractors are not available easily. Based on the interview, as many as 73.81% of the farmers of the respondents state that it is as one of the activities at issue in the organic rice farming and should immediately covered. In the other hands, 21.43% of respondents felt that the seed growers are susceptible to pests and diseases aren't a problem for them and as much as 4.76% said neutral or indifferent.

One of the most dominant pests attacking paddy rice field research are rats and birds. Rats will attack the plant boundary so that the plant cannot grow maximal or

Table 2: The relation value coefficient of variation (CV) and lower limit (L).

| No | Risk Aspect | CV | L | Indicators |
|---|---|---|---|---|
| 1 | Production | 0.51 | -48 | Farming has a big risk and potentially loss |
| 2 | Costs | 0.03 | 3,900.54 | Farming has a small risk and there is no chance to risk |
| 3 | Revenue | 0.51 | -137,453.37 | Farming has a big risk and potentially loss |
| Source: Processed Primary Data, 2014 | | | | |

even fail which then can lead to a decrease in production or even crop failure. The birds will attack when the rice plants begin to enter a period of ripening grain. The birds will eat the grains of rice in the land which can lead to a decrease in production output drastically or even crop failure. The dominant plant disease attacks the rice plant is the stem borer, the impacts are the same with the attack of the rat pest.

## 3.2. Risk analysis and risk behavior farmers

The average revenue per planting season per hectare is Rp 22,898,376, the total cost per planting season per hectare is Rp 4,459,638 so that the average income of organic rice farmer per planting season per hectare is Rp 1,.438,739. Risk analysis using benchmarks deviation standard deviation (V), the coefficient of variation (CV) and lower bound (L)., with the following results:

From the above analysis, the production and income aspects have a large degree of risk and farmers suffer losses in organic rice farming.

## 3.3. Analysis of farmer's risk behavior of organic rice farming

Analysis of farmer's behavior against risks encountered by farmers in organic farming conducted with initial process namely determining of *Certainty Equivalent (*CE) value and followed by the determination of the utility value that raced on CE values obtained in the initial process. *Certainty Equivalent* (CE) is a value that seems to be received by farmers, so that there will be *indifferent* between exact values and prospect that contains the risk. The next process is to analyze the results of the utility quadratic regression to determine the behavior of each category of farmers on organic rice farming.

Based on the analysis presented in Table 3 indicates that as many as 31 respondents or 78.31% of farmers and can be said to be a large part of organic rice farmers behave in a neutral (Risk-Neutral) to the risks that exist in organic rice farming. It is shown from the results that showed a quadratic regression utility $\beta 2$ value or magnitude coefficient

Table 3: Farmers risk behavior in organic rice farming.

| No | Farmer Behavior | Total Respondent | Percentage (%) |
|---|---|---|---|
| 1 | Risk Averter | 2 | 4.76 |
| 2 | Risk Neutral | 31 | 73.81 |
| 3 | Risk Lover | 9 | 21.43 |
| Total | | 42 | 100 |

Source: Primary data are processed, 2014

of utility value is positive or negative and insignificant (> 0.05). While as many as 9 or 21: 43% organic rice farmers as risk lover against the risks that exist in organic rice farming which shows that the value of $\beta_2$ or magnitude coefficient of utility value is positive and significant (< 0.05). And 2 or 4.76% of organic rice farmers as risk averter by demonstrating the value of $\beta_2$ or magnitude coefficient of utility value is negative and significant (< 0.05).

The data about farmers behavior against organic rice farming linked with the results of the risk analysis is described previously. Based on the results of risk analysis concluded that organic rice farming is potentially losses. While the results of the above regression analysis of quadratic utility concluded that the majority (78.31%) of organic rice farmers is neutral. So it can be concluded that the organic rice farming is potentially losses, then most of farmers is neutral against the risks encountered in organic rice farming. One of the causes of production risk is the main source of risk that local seedlings that susceptible against the pests and diseases.

## 3.4. Analysis of farmer risk Behavior on efficiency of farming

Frontier production function is the relationship between production potential which can be achieved by the use of farmers' inputs. Rice frontier production function in Malang as follows:

$$\begin{aligned}\text{Ln}CP_i \;=\; & 11.22^{****} + 1.496\ln A^{***} - 0,7555\ln S^{****} - 0.045\ln OF^{***} \\ & +0.0565\text{Ln}LF - 0.0032\text{Ln}OP - 0.0293\ln L + 0.00165RB^{***}\end{aligned} \quad (6)$$

Note:

**** it means that independent with variable have positive and significant effect to dependent variable on the level of 0.99

*** it means that independent variable have positive and significant effect to dependent variable on the level of 0.95

The impact of efficiency:

$$\text{Ln}u_i = 0.00165\,\ln Z_1 + 0.019\,\ln Z_2 - 0.1228\,\ln Z_3 + 0.0118\,\ln Z_4 - 0.029\,\ln Z_5 + e_1 \quad (7)$$

Estimates MLE (*Maximum Likelihood Estimation)* consists of estimation of the parameters that are unknown in their behavior that the probability of observing a predetermined variable Y is carried out to the maximum possible. Results showed that the LR test of 5:28 with 6 restrictions greater than the critical point of 2.2, but only at the 0.1% level of confidence. Null hypothesis constructed so that no effect simultaneously between explanatory variables on the dependent variable is received. From the estimation of a factor that influence positively and significantly (by 90-99% confidence level) is the widespread use of land, fertilizer and liquid complement farmers' risk behavior. While the factors that negatively affect and significant is the use of seeds and organic fertilizers. For factors affecting technical inefficiency nothing significant, due to the level of technical efficiency has been achieved farmer nearing 1 that is equal to 0.933.

## 4. Conclusion

This paper investigates the positive influence of farmers on the risk behavior generated by the production of organic rice farmers in Malang Regency with the efficiency of 0.933, which is not proven the existence of technical inefficiency. The level of technical inefficiency of 0.067 made possible the existence of other factors outside the model. The weakness of this model is not proven the simultaneous influence of production factors use on production, due to the small amount of organic farmers. To avoid the risk sources faced is the use of rice local seedlings susceptible to pests and diseases and avoid the risk levels of production and income are suffer losses, the farmers group of organic rice farming suggested more intensive discussions with extension (counsellors), crops research centres and agricultural official, in order to obtain the information technology which can avoid the source of these risks.

## References

[1] Harold T. 2013. Comparison Of Economic Efficiency Of Organic And Conventional Coffee Farming.

[2] Karagiannias, G., K. Salhofer, F. Sinabell. 2006. Technical efficiency of conventional and organic farms: some evidence for milk production. OGA Tagungsband.

[3] Lestari,Y.K.,2013. Analisa Komparasi Efisiensi Teknis Padi Semi Organik dan Konvensional di Kota Bogor. Kasus : Kelurahan Situ Gede dan Sindang Barang. Jawa Barat. Unplublised. Disertasi IPB.

[4] Rubinos R, et al.,2007. Comparative Economic Study of Organic and Conventional Rice Farming in Magsaysay, Davao Del Sur. 10th National Convention on Statistics. EDSA.

[5] Masuda T, 2007. Economic Analyses of Organic Farming. The Case of Kona Coffee Industry in Hawaii. A Dissertation in University of Hawaii.

[6] Charyulu, A.K. and Biswas S, 2010. Economics and Efficiency of Organic Farming vis-à-vis Conventional Farming in India. Indian Institute of Management. Ahmedabad. India

[7] Poudel, K. L., N. Yamamoto, and T. G. Johnson, 2012. Comparing technical efficiency of organic and conventional coffee farms in Nepal using data envelopment analysis (DEA) approach. Selected Poster prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August.

[8] Prayoga, 2010. Analisis Produktifitas, Efisiensi Teknis dan Pendapatan Usahatani Padi Organik, serta Level Penerapan Pertanian Organik Padi Sawah, Naskah disertasi Program Doktor Ilmu Pertanian Universitas Brawijaya Indonesia. Tidak dipublikasikan.

[9] Ellis,F., 1989. Peasant Economics: Farm Household and Agrarian Development, Cambridge University Press

[10] Kay, R.D. and W.M. Edwards. 1999, Farm management, WCB/McGraw-Hill, New York, USA.

[11] Wik, M., S. Holden and E. Taylor, 1998. Risk, Market Imperfections and Peasant Adaptation : Evidence from Northern Zambia. Discussion Paper D-28, Department of Economics and Social Sciences. The Agricultural University of Norway.

[12] Siddik, M,. 2015. Perilaku Ekonomi Rumahtangga Petani Tembakau Virginia dalam menghadapi risiko usahatani di Pulau Lombok Provinsi Nusa Tenggara Barat. Disertasi Doktor. Program Pasca Sarjana. Fakultas Pertanian. Universitas Brawijaya. Malang

[13] Just, R.E. and R.D. Pope, 1979. On the Relationship of Input Decisions and Risk. In: Roumasset,J.A., J.M.Boussard and I.Singh (Eds). Risk Uncertainty and Agricultural Development. Agricultural Development Council, New York

[14] Fariyanti, A., 2008. Perilaku Ekonomi Rumahtangga Petani Sayuran dalam menghadapi Risiko Produksi dan Harga Produk di Kecamatan Pengalengan Kabupaten Bandung. Disertasi Doktor. Sekolah Pasca Sarjana IPB, Bogor

[15] Saptana, A., H.K. Daryanto, dan Kuntjoro, 2010. Analisis Efisiensi Teknis Produksi Usahatani Cabai Merah Besar dan Perilaku Petani menghadapi Risiko. Jurnal Agro Ekonmi. Volume 28 no.2: 153-188.

[16] Ratnasari, I, 2013. Analisis Perilaku Petani Terhadap Risiko Usahatani Sayuran Organik, Studi Kasus pada Komunitas Organik Brenjonk, Desa Penanggungan, Kecamatan Trawas, Kabupaten Mojokerto, Jawa Timur, Tidak dipublikasikan

[17] Putri, DI. 2014. Analisis Persepsi Petani Padi terhadap Resiko Sistem Pertanian Padi Organik. Skripsi UB, Tidak dipublikasikan.

[18] Kumbhakar, C S. 2002. Specification and Estimation of Production Risk, Risk Preferences and Technical Efficiency. American Journal Agricultural Economic, 84(1) (Februari 2002): 8-22.

[19] Bokhuseva, R. and H. Hockmann. 2004. Output Volatility in Russian Agriculture: The Significance of Risk and Inefficiency. Working Paper. Institute of Agricultural Development in Central and Eastern Europe (IOMA), Halle.

[20] Hernanto, F. 1991. Ilmu Usahatani. Penebar Swadaya. Jakarta

[21] Soekartawi, 1993. Risiko dan Ketidakpastian dalam Agribisnis, Teori dan Aplikasi. PT.Raja Grafindo Persada. Jakarta.

[22] Coelli,T. 1995. Recent Developments in Frontier Modelling and Efficiency Measurement. Australian Journal of Agricultural Economics, Vol. 39, No.3, Page 219-245