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Analysis of Rice Production Instability in Southeast Asian Countries

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Abstract

This study measures the extent of rice production instability and the sources of instability in selected rice producing countries of Southeast Asia. A time series data on rice harvested area, yield and production of five Southeast Asian countries was used to analyze the components of production changes (area, yield and interaction effects) from 1980 to 2010. The production data is categorized into two periods: (i) 1980/81 to 1994/95 and (ii) 1995/96 to 2009/10. The results show a significant increase in rice production in all the countries during the reference period. However, the effect of area and yield to increase production differs from one country to another. It is noted that instability in area, yield and production in countries (except for Malaysia) are positively related. Furthermore, the decomposition analysis indicated that changes in mean yield mainly contribute to mean production in Malaysia, Philippines, Thailand and Vietnam while change in mean area contributed larger in Myanmar. However, changes in area-yield covariance between periods made a negligible contribution to the change in rice production.

Keywords: Instability, rice, production, yield, Southeast Asia

Introduction

Growth in agriculture and instability remained an intense debate in most agricultural economies in the literature especially the developing countries (Wasim, 2002). The desire to increase agricultural growth is obvious in most countries, however increase in instability in agricultural production is also considered for many reasons such as the risk of farm production, farmers' income as well as investment in agriculture. It is evident that production instability affects the stability of market price and consumers thereby increases the vulnerability of low income households to the market as well as impact on food security (Chand and Raju, 2009; Poudel and Chen, 2012). Reviews on literature indicate that several studies have some conflicting evidence of changes in instability in agricultural production due to adoption of new technology or new government policies. It is argued by some (Hazell,1982) that adoption of new technologies reduce classic instability in agricultural production caused by natural phenomenon such as weather, pests and diseases while others believed that much of the instability in food crop production is as a result of widespread

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adoption of new technologies (Mehra, 1981; Singh, 1989).

Mehra (1981) conducted a study in Indian agriculture purposely to compare variability in production between crops and regions during the period 1949 to 1965 and 1965 to 1979. The study estimated the changes in instability after the introduction of high yielding technologies in the region. The results indicate that during the decade after the adoption of new technology the instability (coefficient of variation) of all crop aggregates increased as compared to before the adoption of new technology.

However, another study by Hazell (1982) was conducted on the same data utilized by Mehra (1981) but adopted an improved analytical framework to study variability in food crop production. The results confirmed that of Mehra in 1981 and even examined further by concluding that increased production instability was inevitable because of rapid agricultural growth.

The two authors attributed the increase in production instability to the adoption of new technology.This has further increase the debate after the Indian experience for production instability studies in South and Southeast Asia after the introduction of modern rice technology.

Flinn and Hazell (1988) examined production instability in Philippine rice sector to report on micro analysis of changes in rice production instability between the periods that preceded the introduction of the new technology so as to contrast with the findings from Indian experience. The study also sought to find the factors that influence instability in the rice sector.

The same methodology was applied as in Hazell (1982) to identify the components and sources of instability in Philippine rice sector during the period 1948 - 1968 and 1969-1983 which roughly signifies before and after the introduction of modern rice technology.

The results indicated that growth in rice production since 1960s has been influenced by yield compared to area effect. The results indicated that relative instability has changed slightly while absolute variability increased significantly.

Among the sources that increased production variability include changes in production variances within the regions, increase in area-yield covariance as well as positive covariance between the regions.

However, the study concluded that irrigation may not have influenced production instability but real price fertilizer might have an impact on variability. Thus, an increase in irrigated area greatly helped to reduced production instability while increase intensification in rainfed second rice crop increased variability.

It is evident that Southeast Asian countries contribute about 25 percent to the global rice output (milled equivalent) as of 2010. The region's total production is said to be increased by 18 percent between the period 2000 and 2010 (Katherine *et al.*, 2012).

Thus to estimate instability of rice production for different countries in the region will be of paramount importance for government policies and programs.

The paper is organized into four sections including introduction and a brief review of some past studies done on agricultural production instability. Data and analytical procedures are discussed in section two. Section three presents empirical estimates of instability and sources of different components of instability. The last section consists of concluding remarks.

Data and analytical procedures

Times series secondary data on rice harvested area, yield and production from FAOSTAT are utilized. The study tried to analyze the components of production changes (area, yield and interaction effects) of rice produced in five rice producing countries from 1980 to 2010.

The production data is categorized into two periods: (i) 1980/81 to 1994/95 and (ii) 1995/96 to 2009/10. The designated two periods in reference to the post Green revolution, allow for an examination of sources and changes in instability intra and inter the two periods. The rationale for selecting these two periods is to test whether production instability changed during these two specified periods.

Crop production during the first period was the time growth in rice production in most countries largely depended upon improved farming methods and technologies due to green revolution while the second period was initiated to see the recent trend in production growth after phasing of the green revolution in most of the countries coupled with diversified agricultural production in many countries.

Following the work of Bohrnstedt and Goldberger (1969), who actually pioneered a work on 'the exact covariance of products of random variables' was the base of the approach and methodology used in this analysis. Many researchers applied this technique to study instability in production of crops notably Hazel, (1982), Mahendradev (1987), Wasim (1999), Farih (1996), Singh (1989) and Hazell (1984) where complete and detailed description of the approach is highlighted.

In this study, a standardized measure of instability represented by coefficient of variation is used to achieve the objectives. This is calculated for each period as the standard deviation (δ) divided by mean (μ) and then multiplied by 100 to have it in percent.

$$CV = \frac{\delta}{\mu} X\ 100 \qquad (1)$$

Hence a change in the coefficient of variation in Period II over Period I was calculated.

Average production for the entire period, E (P), can be expressed as:

$$E(P) = \mu A \mu Y + COV(A,Y) \quad (2)$$

Method of decomposition of average production

The equation above is further decomposed so as to partition the changes production variance and average production between the two periods into constituent parts, which can be related separately to changes in the means, variance and covariance of area and yield. From the equation (2), average production for each time period can be expressed as:

For period I:

$E(P_I) = \mu A_I \mu Y_I + COV(A_I, Y_I)$.....(3)

and

For period II:

$E(P_{II}) = \mu A_{II} \mu Y_{II} + COV(A_{II}, Y_{II})$..... (4)

Note that each variable in the second period can be written as its counterpart in the first period plus the difference in the variable (i.e area and yield) between the two periods. For example

$$\mu A_{II} = \mu A_I + \Delta \mu A \qquad (5)$$

Where $\Delta \mu A = \mu A_{11} - \mu A_1$, hence average production in the second phase can be represented as:

$$E(P_{II}) = (\mu A_I + \Delta \mu A)(\mu Y_I + \Delta \mu Y) + COV(A_I, Y_I) + \Delta COV(A,Y) \qquad (6)$$

As seen in the preceding equations, average production is influenced by changes in mean area and mean yield as well as changes in the covariance of area and yield. Thus, the change in average production over the entire period is measured by subtracting equation (3) from equation (6) as in equation (7) below:

$$\Delta E(P) = E(P_{II}) - E(P_I) = \mu A_I \Delta \mu Y + \mu Y_I \Delta \mu A + \Delta \mu A \Delta \mu Y + COV(A,Y) \qquad (7)$$

This change in average production has four different components (sources of change). These sources include the changes in mean area ($\mu Y_1 \Delta\mu A$), changes in mean yield ($\mu A_1 \Delta\mu Y$), the interaction between changes in mean area and mean yield ($\Delta\mu A \Delta\mu Y$); and the changes in the variability of area and yield [$\Delta CV(A,Y)$] (Mahir and Abdelaziz, 2011). These components of change in average production are arranged in the **table 1.**

Table 1: Components of change in average production

Sources of change	Symbol	Components of change
Change in mean yield	$\Delta\mu Y$	$\mu A_I \Delta\mu Y$
Change in mean Area	$\Delta\mu A$	$\mu Y_I \Delta\mu A$
Interactions between changes in mean Area and mean yield	$\Delta\mu A \Delta\mu Y$	$\Delta\mu A \Delta\mu Y$
Change in area – yield covariance		$\Delta CV(A,Y)$

Results and discussion

Change in area, production and yield of rice over the periods

Agricultural production varies as a result of variability in area planted to crop and yield and the interaction between the two (Chand and Raju, 2008). It must be noted that these variations to some extent depend on climatic factors, distribution and availability of inputs, as well as some government policies. **Table 2** shows the changes in production, area and yield of rice from period I to period II. All the parameters increased significantly between the periods under study.

However, the extent of changes differs from country to country. Rice production in Malaysia showed an increase in average production between the two periods by 19.27%, yield increased by the same fold (19.35%) while the rice harvested area increased slightly by only 0.16% from period I to Period II.

With respect to changes in production over the period, Vietnam posed the highest increase in average production (91.76%), followed by Myanmar (69.84%), Philippines (51.69%), Thailand (44.3%) respectively while Malaysia showed the least increase in average production with less than one fourth (19.27%).

In terms of area harvested to rice over the reference periods, Myanmar showed the highest increased in rice harvested area (40.03%) followed by Vietnam, Philippines and Thailand each with 23.64%, 20.4% and 9.42% respectively.

In the same development, Malaysia posted the lowest (0.16%) in the average area harvested to rice from period I to period II. These results could be explained by individual country characteristics towards diversification of agricultural production to other plantation crops.

The results for the changes in yield show that Vietnam has really gone far in the attainment of yield increase with 56.41% with an average yield of 4.6Ha/ton in period II leading the countries in this study. However, all the countries have witnessed some quite increase in yield of rice. This could be as a result of improvement in total factor productivity in most countries.

With country specific analysis, the results indicate that Malaysia witness more increase in the yield than increase in production and area harvested to rice; while the other countries have witnessed more increase in the average production compared to increase in area harvested and the yield. The analysis indicate that, an increase in area harvested to rice is less compared to increase in yield and production (except for Myanmar), probably due to distribution of available land area for

other sectoral development such as plantation crops.

Thus, since land devoted to rice production has shown to be a constraint then the policies should be geared towards better land by given more priority to increase in yield through improved technologies such as high yielding varieties with subsidized inputs as also suggested by Poudel and Chen (2012).

Table 2: Average production, area and yield of rice in selected countries of Southeast Asia (Period I- 1980/81 - 1994/95 and period II - 1996/97 - 2009/10

	Production(Tons)			Area(Hectares)			Yield(Tons/Ha)		
Country	**I**	**II**	**Change**	**I**	**II**	**Change**	**I**	**II**	**Change**
Malaysia	1873.67	2234.68	19.27%	675.15	676.24	0.16%	2.8	3.3	19.35%
Myanmar	14648.28	24878.84	69.84%	4884.69	6840.11	40.03%	3.0	3.6	19.72%
Philippines	8988.96	13635.16	51.69%	3383.04	4073.05	20.40%	2.7	3.3	25.38%
Thailand	19441.60	28054.12	44.30%	9283.29	10157.50	9.42%	2.1	2.8	31.52%
Vietnam	17715.26	33970.45	91.76%	5979.47	7392.87	23.64%	2.9	4.6	56.41%

Instability in area, production and yield of rice

Instability in crop production could be attributed to variability in area and yield as well as their interactions which are mainly influenced by some natural phenomenon such as flood, climatic variations and some man made hazards.

In **table 3**, the results presented the instability in harvested area, yield and production of rice in five countries of southeast Asia for a period of 16 years and 15 years (indicated as period I (1980 -1995 and period II (1996-2010) respectively.

The instability index for the area harvested (shown as coefficient of variation) for the countries such as Myanmar, Philippines and Thailand have shown an increase from period I to period II while decline in the case of Malaysia and Vietnam.

This increase in instability is also reflected in statistically F ratios for the increase in area harvested variances between the two periods. Among the countries, Philippines has shown the highest instability in area harvested recorded as 60.95% at 1% significant level followed by Myanmar and Thailand recorded as 53.74% and 32.59% at 1% and 10% significant level respectively. However, instability in Vietnam and Malaysia declined by 64.37% and 42.6% at 1% and 5% significant level respectively.(note: it should be 1% and 5% significant level instead of 5% and 1% significant level)

In the case of instability in yield of rice in the region, Myanmar posted the highest instability with 194.96% at 1% significant level between period I and period II. This shows that Myanmar has tremendously increased its rice production in the recent period compared to others. The same trend is witnessed in Malaysia, Philippines and Thailand each recorded 5.99%, 21.21% and 14.64% respectively. However, increase in instability in Malaysia is not significant while the instability index in Philippines and Thailand is significant at 1% and 10% respectively.

The only country that has shown decline in instability of rice yield is Vietnam with 28.56% from period I to period II. However, this instability between the two periods has shown no significant change in the total yield variance. This is explained by an increase in both area harvested and production over the reference periods.

Table 3: Coefficient of Variation of Production, Area and Yield of Rice for Period I and Period II

Country	I	II	Change	F-Ratios
Malaysia				
Area	3.45%	1.98%	-42.61%	3.03**
Yield	7.53%	7.99%	5.99%	0.62
Production	9.95%	7.17%	-27.98%	1.36
Myanmar				
Area	9.48%	14.57%	53.74%	0.22*
Yield	3.53%	10.41%	194.96%	0.08*
Production	10.76%	24.35%	126.22%	0.07*
Philippines				
Area	4.80%	7.72%	60.95%	0.27*
Yield	8.90%	10.78%	21.21%	0.43***
Production	10.93%	17.03%	55.84%	0.18*
Thailand				
Area	3.90%	5.17%	32.59%	0.48***
Yield	7.25%	8.32%	14.64%	0.44***
Production	7.99%	12.13%	51.80%	0.21*
Vietnam				
Area	6.95%	2.48%	-64.37%	5.15*
Yield	15.89%	11.35%	-28.56%	0.8
Production	22.51%	12.04%	-46.50%	0.9

Note: *, ** and *** indicate statistically significant F ratios (one tail tests) at 1%, 5% and 10% respectively between the two periods

The results also indicate production instability in the region in which Myanmar, Philippines and Thailand have witnessed high increase of instability in production each estimated as 126.22%, 55.84% and 51.80% at 1% significant level for each respectively.

However, Malaysia and Vietnam has shown decline in production instability from period I to Period II measured as 27.98% and 46.50% respectively, although the decline has shown no significant difference in the variance of total rice produced in the two countries.

On the basis of the above results it can be noted that rice production fluctuates increasingly in the period II of three rice producing countries (Myanmar, Philippines and Thailand) while fluctuations declined in the second period in Malaysia and Vietnam

Sources of instability

The components of change in average rice production of the selected countries are presented in **table 4**. The table indicates that increases in rice yield and rice harvested areas have contributed positively to the increased in rice production in most countries.

However, production changes were dominated by mean yield in most countries except for Myanmar where increased in harvested area contributed significantly to the increased rice production.

Changes in harvested area varied considerably between countries, from a high of about 57% in Myanmar, to a low of about 0.8% in Malaysia. The impact of the area effect was the major cause of production change in Myanmar rice production recorded as 57.21% compared to 28.18% in the yield effect.

The highest change in mean yield was observed in Malaysia about 100%, followed by Thailand with an increase of 71% while Vietnam and Philippines posted 61% and 49% respectively.

However, some studies reported similar findings regarding sources of production changes especially in Philippine's rice production (Flinn and Hazell, 1988) and India's agriculture (Larson *et al.,* 2004; Chand and Raju, 2009) , though some studies done in India have shown mean area to be the major components of increased rice production (Hazell, 1984). The table gives an insight into the sources of increased rice production in each country.

The four countries (Malaysia, Thailand, Vietnam, and Philippines) have shown increased rice production as a result of changes in mean yield compared to changes in mean area while increased rice production in Myanmar was a result of changes in mean area than mean yield.

These increases in mean yield in the countries might be related to varietal breakthroughs through research and development, increased irrigation facilities as well as use of chemical fertilizers.

On other hand, changes in area-yield covariance between periods in the countries made a negligible contribution to the change in rice production as reported in other country studies (Larson *et al.,* 2004). Most of the countries have shown less than a percent that accounted for the total change in average rice production between the periods.

However, in Myanmar and Philippine average production has been influenced by 3% and 2% change in area-yield covariance respectively. Changes in the interaction effect in each country occurred as a result of simultaneous changes in mean yield and mean area between periods. The highest interaction effect was observed in Vietnam (14%), followed by Myanmar (11%), Philippines (10%), and Thailand (8%).

However, interaction effect between mean area and mean yield has negligible effect in Malaysia (0.2). This happened as a result of decline in mean area for rice production.

Also in the **table 4**, it is seen that change in yield of crop play a major role in increasing instability in rice production. Thus country policies should focused more on increase in yield of rice sector.

Table 4: Components of change in the mean production of rice in each selected country, 1980/81 -1994/95 and 1995/96-2009/10 (percent)

Country	Change in Mean Area	Change in Mean Yield	Change in Area Yield Covariance	Interaction between Changes in Mean Area and Mean Yield
Malaysia	0.84	100.31	-1.31	0.16
Myanmar	57.21	28.18	3.34	11.28
Philippines	39.32	48.93	1.77	9.98
Thailand	21.26	71.14	0.91	6.70
Vietnam	25.54	60.96	-0.91	14.41

Conclusion and recommendation

A significant increase in rice production in all countries has been witnessed during the reference period. However the effect of area and yield to increase production differs from one country to another. In Myanmar, mainly due to area increase whereas in others, yield played a dominant role in increasing rice production.

With regards to instability in yield, the study of instability of rice production has witnessed a continuous increase in some countries (Myanmar, Philippines and Thailand) and sharp decrease in others (Malaysia and Vietnam) over the two sub periods under study with regards to instability in yield, all countries witnessed increased instability except Vietnam which experienced a sharp

drop in instability from 15.89% to 11.35 in the second period.

It is worth of mention from this instability study that instability in area, yield and production in countries (except for Malaysia) moved in the same direction. That is to say their decreasing/increasing trend results in decrease/increase instability.

Thus, in these countries we might say that increase in rice production due to an increase in either area or yield would subsequently increase instability. However, in Vietnam, an increase in yield would further help to reduce production instability.

The decomposition analysis for the sources of changes in mean rice production in the selected countries indicated that mean production in Malaysia, Philippines, Thailand and Vietnam is mainly driven by changes in mean yield. However, change in mean area contributed larger in the case of Myanmar. On other hand, changes in area-yield covariance between periods in the countries made a negligible contribution to the change in rice production.

All the countries have shown low percent (less than 4%) that accounted for the total change in average rice production between the periods. Changes in the interaction effect in each country occurred as a result of simultaneous changes in mean yield and mean area between periods.

The highest interaction effect was observed in Vietnam (14%), followed by Myanmar (11%), Philippines (10%), and Thailand (7%). However, interaction effect between mean area and mean yield has negligible effect in Malaysia (0.2%). This happened as a result of decline in mean area for rice production. Thus in order to stabilize instability, government policies and programs should ensure increase productivity through provision of basic inputs for rice production and also strengthen and intensify agricultural research in the coming decades.

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References

Bohrnstedt, G. W. and Goldberger, A. S. (1969). On the exact covariance of products of random variables. Journal of the American Statistical Association, 64(328): 1439-1442.

Chand, R. and Raju, S. (2008). Instability in Andhra Pradesh agriculture–A disaggregate analysis. Agricultural Economics Research Review, 21(2): 283-288.

Chand, R. and Raju, S. (2009). Instability in Indian agriculture during different phases of technology and policy. Indian Journal of Agricultural Economics, 64(2): 283-285.

FAO (2012). FAOSTAT database. http:www.fao.org

Farih, A. A. (1996). Instability in agricultural production and its effects on farmers' income. Unpublished M.Sc Thesis, University of Khartoum, Sudan

Flinn, J. C. and Hazell, P. B. (1988). Production instability and modern rice technology: a Philippine case study. The Developing Economies, 26(1): 34-50.

Goodman, L. A. (1960). On the exact variance of products. Journal of the American Statistical Association, 55(292): 708-713.

Hazell, P. B. (1982). Instability in Indian foodgrain production. Research Paper No. 30.

Hazell, P. B. (1984). Sources of increased instability in Indian and US cereal production. American Journal of Agricultural Economics, 66(3): 302-311.

Katherine, B., Nathan, C., John, D. and Jim, H. (2012). Southeast Asia's Rice Surplus (pp. 38): A Report from the

Economic Research Service, USDA www.ers.usda.gov.

Larson, D. W., Jones, E., Pannu, R. and Sheokand, R. (2004). Instability in Indian agriculture - a challenge to the Green Revolution technology. Food Policy, 29(3): 257-273.

Mahendradev, S. (1987). Growth and Instability in Foodgrains Production: An Inter-State Analysis. Economic and Political Weekly, 22(39): 82-92.

Mahir, M. E. A. E. and Abdelaziz, H. H. (2011). Analysis of agricultural production instability in the Gezira scheme. Journal of the Saudi Society of Agricultural Sciences, 10(2): 53-58.

Mehra, S. (1981). Instability in Indian agriculture in the context of the new technology, Research Report No. 25, International Food Policy Research Institute, Washington, D. C. and U. S. A

Poudel, M. P. and Chen, S. E. (2012). Trends and Variability of Rice, Maize, and Wheat Yields in South Asian Countries: A Challenge for Food Security. Asian Journal of Agriculture and Rural Development, 2(4): 584-597.

Singh, I. (1989). Agricultural instability and farm poverty in India. Indian Journal of Agricultural Economics, 44(1): 1-6.

Wasim, M. P. (1999). Growth rates and fluctuations in area, production and productivity: A study of major crops in Sindh. Pakistan Economic and Social Review, 37(2): 155-168.

Wasim, M. P. (2002). A study of rice in the major growing countries of the world: their growth instability and world share. Pakistan Economic and Social Review, 40(2): 153-183.