EXAMINING RICE YIELD IN CHIANG MAI, THAILAND WITH CUSUM CHART

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Abstract: The change production of rice in Chiang Mai was examined with the excellent CUSUM chart. The study result capably illustrated a significant signal since 2010 to 2013. That meant, there was an apparently increase of rice yield in Chiang Mai particularly during 2011-2013.

Keywords: Rice yield, Chiang Mai, CUSUM chart.

INTRODUCTION

Chiang Mai is one of the developing provinces located in the northern part of Thailand so it is not only the center of business and economic but also agriculture. One of the important main crops harvested in Chiang Mai is rice. Also, Chiang Mai can produce a large amount of rice in both of in-season and off-season rice. Many researches focused on prediction of rice yield in Thailand, for example; [1], [2], [3], [4], [5]. Only a few works mentioned about how to check whether the rice production had changed. Page proposed the cumulative sum or CUSUM chart. The statistics of CUSUM is a running total of deviations from a reference value so it is appropriate for examining the small shift [6]. The CUSUM chart is not only limited in the manufacturing process [7], [8] presently but also appears in other fields such as [9], [10] firstly exemplified the excellent examples of using CUSUM chart for detecting fishery or [11], [12] applied in environment. This study then purposed to examine rice yield in Chiang Mai by using CUSUM chart following a recommendation of [13]. In the Introduction section, present clearly and briefly the problem investigated, with relevant references. The main results should be enunciated.

Objectives: To examine the change production of rice yield in Chiang Mai with CUSUM chart.

MATERIALS AND METHODS

The yearly data of rice yield (unit of ton) in Chiang Mai was provided by Office of Agricultural Economics, Ministry of Agriculture and Cooperatives since 2001 to 2013 [14]. The in-control state was assumed from a reference period or preliminary study in order to determine both parameters of in-control state, mean and standard deviation, because the rice yield data in Chiang Mai just orderly managed in a few decennium.

A sequence of rice yield \( t \) was collected at time \( t; t=2001, 2002, \ldots, 2013 \). The mean and standard deviation of rice yield were then calculated for the in-control state by assuming the reference period in seven years (2001-2007). To examine the change of rice yield in Chiang Mai, 4 steps were processed as follows.

1. Computing the standardization of rice yield at time \( t (z_t) \) by replacing the 1. Computing the standardization of rice yield at time \( t (z_t) \) by replacing the estimators of mean \((\bar{x})\) and standard deviation \((s)\) of rice yield in \( z_t = \frac{x_t - \bar{x}}{s} \).

2. Determining both of CUSUM statistics. First, the one-sided upper CUSUM deviation derived from \( S^+_t = \max[0, S^+_{t-1} + z_t - k] \). The other was the one-sided lower CUSUM deviation defined as \( S^-_t = \min[0, S^-_{t-1} + z_t + k] \) where \( k \) be the referenced or allowed parameter of CUSUM chart. The starting value was often specified as \( S^+_0 = S^-_0 = 0 \).
3. Constructing the control limits of CUSUM chart with the decision limit $h$ known the decision interval as UCL/LCL.$\pm h$ and CL.$=0$.

4. Plotting both of the one-sided upper CUSUM deviation ($S_i^+$) and the one-sided lower CUSUM deviation ($S_i^-$) to figure the CUSUM chart of rice yield in Chiang Mai.

As a suggestion of [13], the referenced parameter and the decision interval were respectively defined as $k = 1.3$ and $h = \pm 1$. Whenever any $S_i^+$ or $S_i^-$ maintained the control limits, the process would be stated in-control. Otherwise, the process was said to be out-of-control.

RESULTS

Once the standardization of rice yield $z_i$ was computed by replacing $\bar{x}$ and $s$, both of the one-sided upper CUSUM deviation, $S_i^+$, and the one-sided lower CUSUM deviation, $S_i^-$, were determined. Plotting $S_i^+$ and $S_i^-$ into the chart contained the predefined control limits as mention above therefore the CUSUM chart was illustrated as of Figure 1.

![The CUSUM Chart of Rice Yield in Chiang Mai, Thailand](image)

Figure 1. The CUSUM Chart of Rice Yield in Chiang Mai, Thailand

As of Figure 1, it indicated there were four $S_i^+$ fell above the UCL. (2010, 2011, 2012 and 2013) while all of $S_i^-$ maintained along the CL.

DISCUSSIONS

The CUSUM technique was efficiently utilized in agricultural application. The positive and negative deviations are equally considered because the CUSUM approach does not presume the characteristic of change. Hence, it is best fitted for detecting small persistent shift. For this reason, the resulting CUSUM chart of this study suddenly illustrated the production of rice significantly expanded since 2011 to 2013. The findings of this study might usefully assist the one who authorize to plan or make a policy of rice production for a future.

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REFERENCES


