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By

CHOE LIP HAW

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

IMAGE PROPERTIES OF MALAYSIAN RICE GRAINS DURING THE MATURING PROCESS

By

CHOE LIP HAW

July 2014

Chair: Wan Ishak B. Wan Ismail, PhD

Faculty: Engineering

Quality of harvested rice and its production are influenced by harvesting day. Harvesting at the right time gives the best yield and best quality. The purpose of this research was to determine image properties of paddy during maturing process, and evaluate the losses and quality of grain when harvested in different maturing period. Parameters such as weight of florets, hardness of florets, hue colour of florets, and hue colour of flag leaf were determined. The trends of the changes were observed towards maturity until 2 weeks after harvesting day. The research was carrying out at Sekinchan rice field where the samples were cultivated as usual. Destructive sampling test was carrying out for grains' hardness test and grains' weight test, while grains' colour test and flag leaf colour test was non-destructive test. The rice variety that was use in the research was Malaysia Rice (MR) 220. The hue value for florets maturation is 40^{o}, and 61^{o} for leaf hue colour. In the period of maturity, the florets' hue value decreased from green to yellowish and remained constant at 40^{o}. The maturity process began gradually from florets at outermost spikelet to florets at basal part. Florets at basal part matured 8 days later than the florets at apical part. Results show that the colour changes of leaf linearly decreased from green to yellowish. It was observed that the weight for a matured floret increased rapidly towards maturity, but remained constant when it reached mature stage. The mature floret can weight up to 28.8mg, and later dropped gradually due to loss of moisture contents after the optimum maturity stage. The hardness of florets may not able to deliver good correlation, as it had constraint when florets were in milky stage, the hardness of floret at optimum maturity stage was 64 N. Optimum harvesting day was 108 days after sowing (DAS).

It was concluded that maturity of paddy can be observed, and losses of yield can be evaluated through colour of leaf, and colour of the florets. Harvesting at 2 days before or after the optimum harvesting day, the yield reduced by 1.5%, and after 4 days, yields reduced by 3%. Optimum harvesting day can be predicted through floret's colour with accuracy of 93.1%, and flag leaf's colour with accuracy of 90.3%.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia Sebagai memenuhi keperluan untuk ijazah Sarjana Sains

CIRI-CIRI IMEJ BUTIR BERAS MALAYSIA SEMASA PROSES KEMATANGAN

Oleh

CHOE LIP HAW

Julai 2014

Pengerusi: Wan Ishak B. Wan Ismail, PhD

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Kualiti dan pengeluaran beras yang dituai dipengaruhi oleh peringkat penuaian. Penuaian pada masa yang tepat memberikan hasil dan kualiti yang terbaik. Tujuan kajian ini adalah untuk menentukan masa terbaik untuk menuai dan menilai kualiti dan kerugian hasil penenuaian dengan menggunakan teknik pemprosesan imej. Parameter seperti berat benih, kekerasan benih, warna kulit benih dan warna daun telah ditentukan, trend perubahan sempena kematangan diperhatikan sehingga 2 minggu selepas hari menuai. Kajian ini dijalankan di jelapang padi Sekinchan, dan dijaga seperti biasa oleh petani. Data berat dan kekerasan padi diambil secara destruktif, manakala data imej padi dan daun diambil secara bukan destruktif. Padi jenis MR220 mempunyai warna hue kulit benih 40^o , dan daunnya mempunyai warna hue 61^o . Sempena kematangan padi, warna hue kulit benih berubah (berkurang) dari warna hijau ke warna kuning, iaitu pada nilai 40^o, dan dikekalkan. Proses kematangan bermula secara beransur-ansur dari benih di hujung spikelet sehingga ke pangkal spikelet. Benih di hujung spikelet matang 8 hari lebih awal dari benih di pangkal spikelet. Keputusan menunjukkan bahawa perubahan warna daun telah menurun secara linear dari hijau kepada kekuningan. Ia diperhatikan bahawa berat benih matang meningkat secara mendadak sempena kematangan sehingga 28.8 mg, tetapi kekal malar apabila ia mencapai peringkat matang, dan kemudiannya jatuh secara beransur-ansur akibat kehilangan kandungan lembapan selepas peringkat matang. kekerasan benih tidak dapat menunjukkan korelasi yang baik, kerana ia mempunyai ketidakstabilan apabila benih berada di peringkat benih susu, dan kekerasannya ialah 64 N. DAS optimum di mana berat maksimum berlaku ialah 108 DAS.

Akhir sekali, kesimpulan dapatdibuat bahawa kematangan padi dan kerugian penenuaian dapat ditentukan melalui warna daun, dan warna benih. Penenuaian pada 2 hari sebelum dan selepas hari penenuaian optimum, kerugiannya ialah 1.5%, manakala perbezaan 4 hari akan mendatangkan kerugian sebanyak 3%. Hari penenuaian optimum dapat diramal dengan ketepatan 93.1% melalui warna benih padi, dan 90.3% melalui warna daun padi.

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APPROVAL

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

Declaration by graduate student

I hereby confirm that:

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LIST OF ABBREVATIONS

ANOVA	Analysis of Variance
B.C	Before Christ
Bernas	Padiberas Nasional Berhad
cm	centi-meter
CR	Cultivar Rice
DAA	Days After Anthesis
DAS	Days after Sowing
DAT	Days after transplanting
DF	Degree of freedom
DMRT	Duncan's Multiple Range Test
DNA	Deoxyribonucleic Acid
FAO	Food and Agriculture Organization of the United Nations
FFB	Fresh Fruit Bunches
HRY	Head Rice Yield
HSV	Hue Saturation Value
IRRI	International Rice Research Institute
IT	Information Technology

LKPP	Lembaga Kemajuan Perusahaan Pertanian
LSD	Least Significant Difference
MARDI	Malaysia Agriculture Research Development Institute
MATLAB	Matrix Laboratory
MC	Moisture Contents
mm	mili-meter
MR	Malaysia Rice
MS	Mean Square
NCSU	North Carolina State University
nm	nano-meter
PC	Personal Computer
PP	Polypropylene
Pr.	Probability
RGB	Red Green Blue
SAS	Statistical Analysis System
SRI	System of Rice Intensification
SS	Sum of Square
USDA	U. S. Department of Agriculture

CHAPTER 1

INTRODUCTION

1.1 Background

World population increase rapidly after 20th century, and had reached 7.16 billion today (Census, 2013). However, productive land for agriculture is decreasing every year due to urbanization, pollution, natural disaster and human intervention. According to a research done by IRRI (International Rice Research Institute) (2013), productive land is lost at the speed of 7.67 seconds per hectare.

Figure 1.1: Human population and productive land at 11:41am (GMT +8), 26Nov2013 (Source: IRRI Organization)

In order to cope with food shortage problem due to lack of productive land, deforestation activities for agriculture productive land took place at every corner in the world, and deforestation will cause global warming, thus create more environmental problem. Reduction of productive land and increase of world population is the current issue that urgently need a solution. Solution for increasing food production without increase productive land becomes a challenge for today agriculture's research. Many researches have been carried out in biology, DNA, automation, sensors and precision agriculture, to increase the efficiency of productive land, and these efforts had increase the productive land efficiency. In a research by FAO (Food and Agriculture Organization by United Nation), the crop production had increase threefold in the past 50 years. The result is driven largely by increased the quality of crops genetic, multiple cropping, higher yields per unit of land, better management and precision agriculture (FAO, 2013).

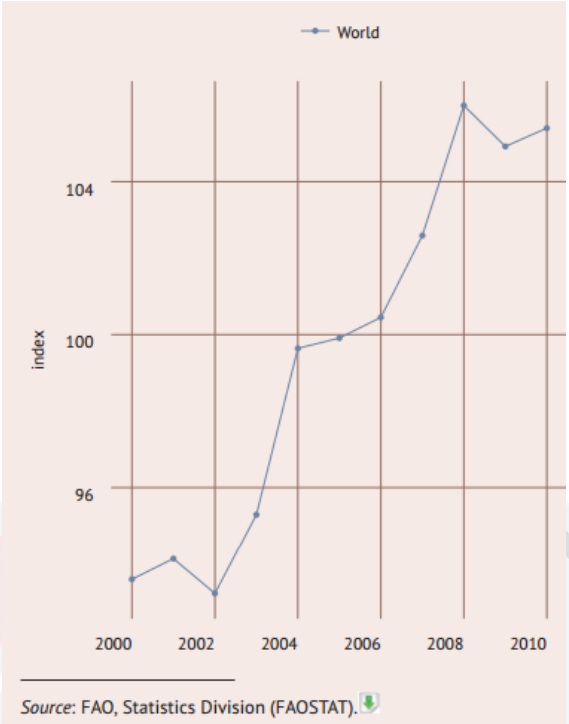

Figure 1.2: Crops, gross per capita production from year 2000-2010
(Source: FAO, 2013)

Rice is the major staple food and the most common cereal crop for mankind, as there is some documented history shows that rice became the source of food in China and India since 2500 B.C. (Thomas, 1997). In modern days, there are more than 3.5 billion people depend on rice for their daily energy resource, especially in Asia countries. There are 2 species of rice that most planted in the world, *Oryza sativa*, grown worldwide; and *Oryza glaberrima*, grown in parts of West Africa. There is average of 100kg of rice consume yearly by an Asian adult (IRRI, 2013), and Malaysia is about 77kg per year per adult. (McIntyre, 2008). Asia is the biggest rice production region. More than 90% of rice is cropped in Asia, and more than a billion people in the world depend on rice cultivation for their lives-hood. Many countries in Asia produce rice to support local market. Some of the Asia countries like Thailand, Vietnam and India become the main exporter and supplier in the global rice market (USDA, 2012). There are more than 0.5 million hectares paddy fields (sawah padi) in Malaysia (Abdul Rahman et .al, 2004). Malaysia import 1.05 million metric ton per year, where 48% of the total consumption is imported from Thailand and Vietnam (USDA, 2012). The four common rice types in Malaysian market are brown rice, white rice, fragment rice and glutinous rice (Bernas, 2013). Among these types, white rice is the most common rice in local market. Brown rice and white rice come from the same variety while white rice is produced after the brown rice has undergone polishing process.

Beside genotype of rice and field condition, yield of rice is highly depends on harvest management. Quality of rice is determined by the numbers of head rice after milled. Good quality rice contains high numbers of head rice, however low numbers of head rice decreases the quality of rice (Rachmat et. al, 2006). Perfect head rice can be obtained by mature florets. If the florets are immature, the rice is chalky or

sometimes unfilled kernel, and the starch is easily loss during the milling process. Overripe crops results in higher shattering losses (Datta, 1981). The paddy plant has some significant morphology growth, such as the rice florets increase in size and weight to accumulate sugars, starches, storage proteins and other storage compounds (Yonghong and Li, 2005). The colour of leaves change from green to yellow during ripening stage as Nitrogen is transferred from leaves to seeds. Mature florets also change its colour from green to golden brown, but wet climate condition may delay the de-greening process of the florets (Morris, 1980).

There are multiple wavelengths in light spectrum; each wavelength is one true colour. The true colour may look different when there is shadow interference, even though the wavelength remains unchanged (Charlotte, 1995). Hue is the true colour, which have the colour value from 0^o to 360^o. Hue value is widely use in scientific task due to its unchanged characteristic, instead of RGB (NCSU, 2000). The colour of the florets and leaves is recorded base on its hue value, as this can eliminate the weather constrains, such as weather interferences and daylight interferences. The hue parameter is commonly used in fruit's ripeness prediction, such as tomato (Tiznado et. al, 2013), oil palm fruit in Malaysia (Hudzari et. al, 2011).

1.2 Problem statement

Wrong harvest time will cause losses to farmer, thus it is critical for farmer to harvest paddy at right time. In conventional way, farmer determines the maturity and the harvest time by counting the number of days after planting. If the variety has the life span of 120 days, farmer will harvest around this period. The farmers begin harvesting whenever the florets and leaf colour turn into yellowish at the mature period. However, this is merely based on experience and naked eyes observation, and it may vary due to human judgment. Inexperience farmers always suffer from harvesting loss due to wrong timing judgement. Furthermore, aging of farmers is a big problem in Malaysia agriculture. The average age of farmers is more than 46 years old (Farah and Bahaman, 2013). Thus, it is a must to innovate a solution to help the new generation farmers in harvesting paddy without depend much on experiences. One of the solutions is using camera vision technology to determine the optimum harvesting time (the day that can harvest maximum yield) by observing the morphology changes of paddy plants.

1.3 Research Objectives

The objective of this research is to determine the image properties of paddy during its maturing process. Colour of florets and colour of flag leaf are two of the main properties that determine the maturity of paddy, and these two image properties are supported by the correlation with floret's weight and floret's hardness. 4 specific objectives are listed as below:

i. To determine the relationship of the floret's colour, flag leaf's colour, floret's hardness, and floret's weight at the date of maturity.
ii. Scientifically determine morphology changes of paddy during maturity stage.

iii. To calculate the date of harvesting based on colour vision of floret's hue and flag leaf's hue.
iv. To determine the effect of right harvesting date based on image properties.

A scientific study had to be carried out in order to obtain paddy's optimum maturity period.

1.4 Scope of the research

Ripeness of paddy can be observed through two aspects; one is by plant's physical morphology changes, such as leaf's colour changes, florets' colour changes, floret's weight, straw's strength, hardness of rice grain, moisture contents of rice grain, and size of rice grain (Aurora, 1968). Another one is through its chemical changes such as nitrogen contents in leaf, endosperm's colour, amylose and amylopectin contents (Ashogbon, 2012). The focus of this study is on four physical parameters: florets' colour, florets' weight, flag leaf's colour, days of planting and floret's hardness. The correlation between each parameter is figured out as listed below and the trend of each parameter is observed.

i. Floret's colour vs. days of planting
ii. Flag leaf's colour vs. days of planting
iii. Grain's weight vs. days of planting
iv. Grain's breaking force vs. days of planting
v. Floret's colour vs. Flag leaf's colour vs. rice grain's weight vs. rice grain's hardness

The maturing days of paddy is then correlated by these parameters, and the accuracy of the equation will be verified by another two season's data.

1.5 Importance of the project

The outcome of the project can help farmers predict optimum harvesting date by knowing the image properties changes of paddy during maturing process, thus reduce the risk of misjudgement. Furthermore, the mathematic model can be refined to include the chemical parameters such as endosperm's colour, amylose and amylopectin contents, and leaf's Nitrogen contents. The model which includes more parameters will increase precision of the prediction.

This study will also help evaluate quality of the grain when harvested in different maturing period which can be used to calculate harvest loss and economics of grains production.

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