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## TABLE OF CONTENTS

	<b>PAGE</b>
<b>THESIS DECLARATION</b>	i
<b>ACKNOWLEDGMENT</b>	ii
<b>TABLE OF CONTENTS</b>	iii
<b>LIST OF TABLES</b>	viii
<b>LIST OF FIGURES</b>	xiii
<b>LIST OF ABBREVIATIONS</b>	xvi
<b>LIST OF SYMBOLS</b>	xix
<b>ABSTRAK</b>	xxi
<b>ABSTRACT</b>	xxii
<b>CHAPTER 1: BACKGROUND OF STUDY</b>	1
1.1 Research Justification	1
1.2 Problem Statement	4
1.3 Objectives	5
1.3.1 Main Objective	5
1.3.2 Specific Objectives	5
1.4 Research Scope	6
<b>CHAPTER 2: LITERATURE REVIEW</b>	7
2.1 Introduction	7
2.2 Paddy Production Industry in Malaysia	7
2.2.1 Rice Granary Areas	7
2.2.2 Paddy Production	8
2.2.3 Commercial Paddy Varieties	11
2.2.4 Paddy Production Issues Relating to Weedy Rice	12

2.2.4.1	Water Resources	12
2.2.4.2	Weeds	12
2.3	Malaysian Rice Seeds Production	17
2.3.1	Rice Seed Categories	17
2.3.2	Rice Seed Consumption and Production Policy	19
2.3.3	Role of Government Agencies	20
2.3.4	Rice Seed Quality Parameters	21
2.3.5	Seed Quality Control	22
2.3.6	Rice Seed Producers	26
2.4	Rice Seeds Processing Plant	27
2.5	Seed Classification and Identification using Machine Vision	35
2.5.1	Software Application for System Development	36
2.5.2	Image Acquisition	38
2.5.3	Image Processing	39
2.5.4	Features Extraction	44
2.5.5	Features Selection	49
2.5.6	Classification Techniques	50
<b>CHAPTER 3: METHODOLOGY</b>		<b>53</b>
3.1	Introduction	53
3.2	Collection of Seed Samples	53
3.3	Machine Vision System	55
3.4	Image Acquisition	56
3.5	Image Processing	56
3.6	Features Extraction	59
3.6.1	Morphological Features Extraction	59

3.6.2	Colour Features Extraction	62
3.6.3	Textural Features Extraction	63
3.7	Features Selection	65
3.8	Rice Seeds Classification	66
3.8.1	Discriminant Function Analysis	66
3.8.2	Support Vector Machine	69
3.8.3	Neural Network	71
3.9	Development of Rice Seeds Identification System	72
<b>CHAPTER 4: RESULTS AND DISCUSSIONS</b>		<b>73</b>
4.1	Introduction	73
4.2	Features Extraction	73
4.2.1	Morphological Features Extraction	73
4.2.2	Colour Features Extraction	75
4.2.3	Textural Features Extraction	76
4.3.	Features Selection for Classification Models	78
4.3.1	Morphology Model	78
4.3.2	Colour Model	80
4.3.3	Texture Model	80
4.3.4	Morphology-Colour-Texture Model	81
4.4	Classification Accuracy Results	83
4.4.1	Discriminant Function Analysis	83
4.4.1.1	Morphology Model	84
4.4.1.2	Colour Model	89
4.4.1.3	Texture Model	92
4.4.1.4	Morphology-Colour-Texture Model	95

4.4.2	Support Vector Machine	99
4.4.2.1	Morphology Model	100
4.4.2.2	Colour Model	104
4.4.2.3	Texture Model	108
4.4.2.4	Morphology-Colour-Texture Model	111
4.4.3	Neural Network	116
4.4.3.1	Morphology Model	116
4.4.3.2	Colour Model	119
4.4.3.3	Texture Model	122
4.4.3.4	Morphology-Colour-Texture Model	124
4.5	Summary of the Classification Accuracy Results	127
4.5.1	Classification Accuracy Levels between Seed Groups	127
4.5.1.1	Training Data Set Accuracy Levels	127
4.5.1.2	Testing Data Set Accuracy Levels	128
4.5.2	Classification Accuracy Levels of Extracted Features	128
4.5.3	Evaluation of the Classifiers	131
4.6	Development of Cultivated and Weedy Rice Seeds Identification Research Prototype System	133
4.6.1	Graphical User Interface of the RiSe IViS	133
4.6.2	Descriptions of the Operating System	135
	<b>CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS</b>	139
5.1	Conclusions	139
5.2	Recommendations for Further Research	140
	<b>REFERENCES</b>	143
	<b>APPENDIX A</b>	152

<b>APPENDIX B</b>	157
<b>APPENDIX C</b>	159
<b>APPENDIX D</b>	160
<b>APPENDIX E</b>	162
<b>APPENDIX F</b>	164
<b>APPENDIX G</b>	165
<b>APPENDIX H</b>	166
<b>APPENDIX I</b>	168
<b>LIST OF PUBLICATIONS</b>	171
<b>LIST OF AWARDS</b>	171

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## LIST OF TABLES

NO.		PAGE
2.1	The categories of rice seed production.	18
2.2	The minimum standard for the rice seed field plot.	24
2.3	Rice seeds production standard.	25
2.4	Successful tenderers of paddy seed supply for the year 2013 and 2014.	27
2.5	Rice seed morphological features.	45
2.6	The extracted colour features of seeds and grains.	46
2.7	Textural features.	48
3.1	Rice seed samples collection.	54
3.2	Morphological features.	60
3.3	Tunable parameters in SVM.	70
4.1	Summary statistics of the seed morphological features extraction results of MR 263 and weedy rice seed variants.	74
4.2	Summary statistics of the seed colour features extraction results of MR 263 and weedy rice seed variants.	75
4.3	Summary statistics of the seed textural feature extraction results of MR 263 and weedy rice seed variants.	77
4.4	Stepwise discriminant analysis result of optimized features of morphology model after step 7.	79
4.5	Summary of the stepwise discriminant analysis result of optimized features of colour model after step 3.	80
4.6	Summary of the stepwise discriminant analysis result of optimized features of texture model after step 6.	81
4.7	Summary of the stepwise discriminant analysis result of all the extracted features of the morphology-colour-texture model after step 22.	82
4.8	Discriminant function coefficients for original 12-feature of morphology model using DFA.	85
4.9	Function equation group centroids and sectioning point of the original	86

	12-feature of morphology model using DFA.	
4.10	Classification result of the original 12-feature of morphology model using DFA.	87
4.11	Function equation group centroids and sectioning point of optimized 7-feature of morphology model using DFA.	87
4.12	Classification result of the optimized 7-feature of morphology model using DFA.	88
4.13	Function equation group centroids and sectioning point of original 6-feature of colour model using DFA.	90
4.14	Classification results of original 6-feature of colour model using DFA.	90
4.15	Function equation group centroids and sectioning point of the optimized 3-feature of the colour model using DFA.	91
4.16	Classification result based on the optimized 3-feature of colour model using DFA.	92
4.17	Function equation group centroids and sectioning point of original 5-feature of texture model using DFA.	93
4.18	Classification result based on the original 5-feature of texture model using DFA.	94
4.19	Function equation group centroids and sectioning point of optimized 4-feature of texture feature model using DFA.	94
4.20	Classification results based on the optimized 4-feature of texture model using DFA.	95
4.21	Function equation group centroids and sectioning point of original 23-feature of morphology-colour-texture model using DFA.	97
4.22	Classification results based on the original 23-feature of morphology-colour-texture model using DFA.	97
4.23	Function equation group centroids and sectioning point of optimized 14-feature of morphology-colour-texture model using DFA.	98
4.24	Classification result based on the optimized 14-feature of morphology-colour-texture model using DFA.	99
4.25	Optimization of SVM parameters based on the original 12-feature of morphology model.	101
4.26	Classification results based on the original 12-feature of morphology model using SVM.	101
4.27	Optimization of SVM parameters based on the optimized 7-feature of	103



	morphology model.	
4.28	Classification results based on the optimized 7-feature of morphology model using SVM.	103
4.29	Optimization of SVM parameters based on the original 6-feature colour model.	105
4.30	Classification results based on the original 6-feature of colour model using SVM.	106
4.31	Optimization of SVM parameters based on the optimized 3-feature of colour model.	107
4.32	Classification results based on the optimized 3-feature of colour model using SVM.	107
4.33	Optimization of SVM parameters based on the original 5-feature of texture model.	109
4.34	Classification results based on the original 5-feature of texture model using SVM.	109
4.35	Optimization of SVM parameters based on the optimized 4-feature of texture model.	110
4.36	Classification results based on the optimized 4-feature texture model using SVM.	111
4.37	Optimization of SVM parameters based on the original 23-feature of morphology-colour-texture model.	112
4.38	Classification results based on the original 23-feature of morphology-colour-texture model using SVM.	113
4.39	Optimization of SVM parameters based on the optimized 14-feature of morphology-colour-texture model.	114
4.40	Classification results based on the optimized 14-feature of morphology-colour-texture model using SVM.	115
4.41	MSE values based on the original 12-feature of morphology model using NN.	117
4.42	Classification results based on the original 14-feature of morphology model using NN based on 10 hidden neurons.	117
4.43	MSE values based on the optimized 7-feature of morphology model using NN.	118
4.44	Classification results based on the optimized 7-feature of morphology model using NN based on 10 hidden neurons.	118

4.45	MSE values based on the original 6-feature of colour model using NN.	119
4.46	Classification results based on the original 6-feature of colour model using NN based on 10 hidden neurons.	120
4.47	MSE values based on the optimized 3-feature of the colour model using NN.	120
4.48	Classification results based on the optimized 3-feature of colour model using NN based on 15 hidden neurons.	121
4.49	MSE values based on the original 5-feature texture model using NN.	122
4.50	Classification results based on the original 5-feature of texture model using NN based on 20 hidden neurons.	123
4.51	MSE values based on the optimized 4-feature of texture model using NN.	123
4.52	Classification results based on the optimized 4-feature texture model using NN based on 20 hidden neurons.	124
4.53	MSE values based on the original 23-feature of morphology-colour-texture model using NN.	125
4.54	Classification results based on the original 23-feature of morphology-colour-texture model using NN based on 20 hidden neurons.	125
4.55	MSE values based on the optimized 14-feature of morphology-colour-texture model using NN.	126
4.56	Classification results based on the optimized 14-feature of morphology-colour-texture model using NN based on 10 hidden neurons.	126
4.57	Comparison of mean classification accuracies for the 3 classifiers (DFA, SVM and NN) for the corresponding models based on the training data set listed in descending order.	129
4.58	Comparison of mean classification accuracies for the 3 classifiers (DFA, SVM and NN) for the corresponding models based on the testing data set listed in descending order.	130
4.59	Mean classification accuracy levels of DFA, SVM and NN of the 8 extracted features model for the 2 data sets.	132
4.60	ANOVA results on the classification accuracy levels of the 8 models.	132
4.61	Summary of statistics of the 3 classifiers.	133

B.1	Example of morphological features extraction data.	157
C.1	Example of colour features extraction data.	159
D.1	Example of textural features extraction data.	160
E.1	The extracted features variables of the original 12-feature of morphology model that failed tolerance test.	162
E.2	The Wilk's lambda table of the discriminant function equations.	162
E.3	Discriminant function coefficients for optimized 7-feature of morphology model using DFA.	163
F.1	Discriminant function coefficients for original 6-feature of colour model using DFA.	164
F.2	The extracted features variables of the original 6-feature of colour model that failed tolerance test.	164
F.3	Discriminant function coefficients for optimized 3-feature of colour model using DFA.	164
G.1	Discriminant function coefficients for original 5-feature of texture model using DFA.	165
G.2	Discriminant function coefficients for optimized 4-feature of texture model using DFA.	165
H.1	Discriminant function coefficients for original 23-feature of morphology-colour-texture model using DFA.	166
H.2	The extracted features of the original 23-feature of morphology-colour-texture model that failed tolerance test.	167
H.3	Discriminant function coefficients for optimized 14-feature of morphology-colour-texture model using DFA.	167

## LIST OF FIGURES

NO.		PAGE
2.1	Average yield of paddy by season in Malaysia (2003-2012).	9
2.2	Paddy production in Malaysia (2003-2012).	10
2.3	Weedy rice that grows higher than the cultivated rice.	14
2.4	Weedy rice that grows at the same height as the cultivated rice.	14
2.5	Close panicle weedy rice plant variant.	15
2.6	Close panicle weedy rice plant variant.	15
2.7	Flow chart of the agency involvement in rice seed production.	19
2.8	The seed samples in the germination containers.	22
2.9	A typical seed processing plant layout.	28
2.10	The intake pit.	29
2.11	A Cimbra Delta Pre Cleaner.	29
2.12	Silos in the MADA rice seed processing plant.	30
2.13	A Cimbra fine cleaner in Seri Merbok Sdn. Bhd..	31
2.14	The indented cylinder.	32
2.15	A gravity separator.	33
2.16	Weighing and bagging station.	34
2.17	Blue tag on a certified seed bag.	34
2.18	(a) 3 x 3, 45° Gradient filtered image.	41
	(b) 5 x 5, 45° Gradient filtered image.	
	(c) 7 x 7, 45° Gradient filtered image.	
2.19	(a) Original crushed terra cotta image.	41
	(b) 3 x 3 Laplacian filtered image.	

	(c) 5 x 5 Laplacian filtered image.	
2.20	Smoothing kernels and filtered images.	42
2.21	Offset values of the GLCM.	47
3.1	The machine vision system.	55
3.2	IMAQ extract single colour plane and convolute function.	57
3.3	IMAQ threshold function.	57
3.4	IMAQ morphology function.	58
3.5	IMAQ particle filter function.	58
3.6	(a) Input image.	59
	(b) Binary image obtained after some image processing operations.	
3.7	IMAQ Particle Analysis VI.	61
3.8	Block diagram of seed width extraction.	62
3.9	IMAQ Color Histogram VI.	63
3.10	Block diagram of colour features extraction.	63
3.11	IMAQ Cooccurrence Matrix VI.	64
3.12	Block diagram of texture features extraction.	65
3.13	Selection variable box.	68
3.14	Discriminant analysis statistics box.	68
3.15	Discriminant analysis classification box.	69
3.16	Discriminant analysis save box.	69
4.1	Front panel of RiSe IViS.	134
4.2	Upload input image of RiSe IViS.	135
4.3	Input Image display panel of RiSe IViS.	136
4.4	Example of classification results for MR 263 seed group from RiSe IViS.	137
4.5	Input image and classification results for weedy rice seed group from	138

	RiSe IViS.	
4.6	Front panel of RiSe IViS.	138
I.1	Block diagram of RiSe IViS.	168
I.2	Block diagram of Rise IViS subVI.	170

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## LIST OF ABBREVIATIONS

ISF	International Seed Federation
NASM	National Seed Association of Malaysia
APSA	Asia Pacific Seed Association
NKEAs	National Key Economic Areas
RM	Ringgit Malaysia
MARDI	Malaysian Agricultural Research and Development Institute
SJPM-2009	Paddy Seedlings Verification Scheme and the Malaysia Department of Agriculture Standard
ISTA	International Seed Testing Association
DOA	Department of Agriculture
SDA	Stepwise Discriminant Analysis
DFA	Discriminant Function Analysis
SVM	Support Vector Machine
NN	Neural Network
CCD	Charge Coupled Device
LabVIEW	Laboratory Virtual Instrument Engineering Workbench
GUI	Graphical User Interface
MADA	Muda Agricultural Development Authority
IADA	Integrated Agricultural Development Area
BLS	Barat Laut Selangor
KADA	Kemubu Agricultural Development Authority
KETARA	Northern Terengganu Integrated Agricultural Development Area
LPP	Lembaga Pertubuhan Peladang

FAO	Food and Agriculture Organization of the United Nations
BERNAS	Padiberas Nasional Berhad
USD	United State Dollar
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MS	Malaysian Standard
PPK	Pertubuhan Peladang Kawasan
GLCM	Grey level co-occurrence matrices
PSIRS	Plant Seed Image Recognition System
VI	Virtual Instruments
MATLAB	Matrix Laboratory
BMP	Bit-mapped protocol
RGB	Red, green and blue
ROI	Region of interest
JPEG	Joint Photographic Experts Group
R	Red
G	Green
B	Blue
H	Hue
S	Saturation
I	Intensity
GLCM	Grey level co-occurrence matrices
PCA	Principal Component Analysis
PC	Principal Component
LED	Light Emitting Diode



CPU	Central Processing Unit
PNG	Portable Network Graphics
IMAQ	Image Acquisition
SPSS	Statistical Package for the Social Sciences
SMO	Sequential minimal optimization
QP	Quadratic problem
LS	Least square
RBF	Radial basis function
MLP	Multilayer perceptron
ANOVA	One way analysis of variance
SD	Standard deviation
Min	Minimum
Max	Maximum
DF	Degree of freedom
MSE	Mean square error
SS	Sum of Square
MS	Mean Square
RiSe IViS	Rice Seed Identification Vision System

## LIST OF SYMBOLS

\$	Dollar
%	Percent
°C	Degree Celsius
$\Delta$	Delta
$\theta$	Angle
$\mu$	Mean
$\sigma$	Standard deviation
/	Per
C	Regularization parameter
E	Exponent
=	Equal
+	Plus
-	Minus or Negative
kg	Kilogram
ha	Hectare
mt	Metric Tonne
mm	Millimeter
CO <sub>2</sub>	Carbon Dioxide
ppm	Parts per million
m <sup>2</sup>	Meter square
cm	Centimeter
<i>d</i>	Displacement
m	Meter

min      Minute

K        Kelvin

t        Tonne

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## Identifikasi Biji Benih Padi MR 263 yang Ditanam dan Varian Padi Angin Menggunakan Sistem Penglihatan Mesin Berasaskan Kamera CCD

### ABSTRAK

Tujuan utama kajian ini adalah untuk membangunkan sistem prototaip identifikasi benih padi untuk mengelas benih padi yang ditanam dan varian padi angin menggunakan sistem visi mesin dengan mengekstrak maklumat ciri morfologi, warna dan tekstur benih padi. Lima jenis sampel varian padi angin yang terdiri daripada tangkai terbuka, tangkai tertutup dan jejanggut telah dikumpul dari beberapa ladang komersil di Kedah. Benih padi MR 263 pula diperolehi daripada beg benih padi komersil daripada pengedar tempatan. Dalam kajian ini, sampel benih terdiri daripada 600 biji benih MR 263 dan 600 biji benih varian padi angin. Imej biji benih padi diperolehi menggunakan sebuah peranti digandingkan caj (CCD) kamera berwarna. Perisian *Laboratory Virtual Instrument Engineering Workbench* (LabVIEW) digunakan untuk memprogramkan pemprosesan imej, pengekstrakan ciri dan analisis mengelas. Terdapat 12 ciri morfologi, 6 warna dan 5 tekstur telah di ekstrak daripada imej biji benih. 4 jenis model pengelasan yang dinamakan model morfologi, warna, tekstur dan morfologi-warna-tekstur telah ditubuhkan berdasarkan data yang telah diekstrak. Setiap model telah dianalisis untuk pemilihan ciri menggunakan SDA untuk membangunkan model ciri yang dioptimumkan. Kemudian, model-model ciri yang asal dan yang dioptimumkan telah dianalisis menggunakan 3 pengelas yang berbeza; analisis fungsi pembezaan (DFA), mesin sokongan vektor (SVM) dan rangkaian saraf (NN). Analisis varians (ANOVA) telah dijalankan keatas ketiga-tiga pengelas untuk menilai min tahap ketepatan pengelasan 8 model ciri yang diekstrak. ANOVA menunjukkan tiada perbezaan ketara bagi min ketepatan pengelasan antara ketiga-tiga pengelas. Hasil pengelasan menggunakan ciri model morfologi-warna-tekstur mendapat tahap ketepatan mengelas yang lebih tinggi berbanding model-model ciri tunggal. Sebuah sistem identifikasi telah dibangunkan menggunakan LabVIEW untuk mengklasifikasi biji benih padi MR 263 dan padi angin menggunakan model ciri yang dioptimumkan bagi morfologi-warna-tekstur dalam DFA. Sistem yang dibangunkan itu dapat mengklasifikasi kedua-dua kumpulan biji benih pada tahap 99.4% dengan menggunakan set data ujian.

## **Identification of Cultivated Rice MR 263 Seed and Weedy Rice Seed Variants using CCD Camera-based Machine Vision System**

### **ABSTRACT**

The main purpose of this study was to develop rice seed identification research prototype system to classify cultivated rice and weedy rice seeds variants using machine vision system through the extraction of morphological, colour, and textural features of the seeds. Five different types of weedy rice seeds variants samples of open panicle, close panicle and awn type were collected from several commercial farms in Kedah. The MR 263 seed was obtained from a commercial rice seed bag from a local supplier. In this study, seed samples were consisted of 600 seeds of MR 263 and 600 seeds from weedy rice seed variants group. Images of the rice seed samples were acquired using a charge coupled device (CCD) colour camera. Laboratory Virtual Instrument Engineering Workbench (LabVIEW) development environment was used to program the image processing, features extraction and the classification analysis. There was 12 morphological, 6 colour and 5 textural features were extracted from the seed images. Four types of classification model namely morphology, colour, texture and morphology-colour-texture models were established based on the extracted data. Each of the models was analyzed for feature selection using stepwise discriminant analysis (SDA) to develop the optimized features model. Then, the original and optimized features models were analyzed using 3 classifiers; discriminant function analysis (DFA), support vector machine (SVM) and neural network (NN). Analysis of variance (ANOVA) was conducted on the 3 classifiers to evaluate the mean classification accuracy levels of the 8 extracted features models developed. The ANOVA showed that there is no significant difference of mean classification accuracies between the 3 classifiers. The classification results using morphology-colour-texture features model was found to obtain higher classification accuracy levels as compared to the single feature models. An identification system was developed in the LabVIEW to classify the cultivated rice MR 263 and weedy rice seed groups using optimized features of the morphology-colour-texture model in DFA. The developed system was able to classify both seed groups at 99.4% accuracy level using testing data set.

## **CHAPTER 1**

### **BACKGROUND OF STUDY**

#### **1.1 Research Justification**

Rice is one of the world's most important staple foods, being served to about half of the world's population. In Southeast Asia, the predominant rice consumers, 80% of the population eats rice in their everyday meal. Throughout maintaining rice production at the highest level is not only an issue of food availability but also of security.

In rice cultivation, the productivity depends on a number of factors such as the quality of seeds or planting materials, labour, fertilizer, irrigation, crop protection and cultivation practices, climate and others. However, the primary and essential starting point in any agricultural production is the seed (Mahmood, 2006). To a certain extent, the country's food security can be directly linked to the strength of its seed industry. Current technology in the seed industry value chain including processing must be developed and implemented to achieve high productivity of seed production as well as its quality. Therefore, the country's advancement in seed industry must be parallel with other international seed industry.

According to the International Seed Federation (ISF), an association that facilitates the international movement of seeds, the commercial world seed market is

estimated to be worth \$45 billion for the year 2012. In Malaysia, the National Seed Association of Malaysia (NSAM) is an official forum for producers, exporters, importers, scientists and extension agents to interact in current matters related to the seed industry. NSAM is a member of Asia Pacific Seed Association (APSA); the largest regional seed association in the world representing the Asia and Pacific regions. Such an affiliation is important to the advancement of national seed industry so as to be paralleled with the international seed industry.

The development of seed industry is of significantly importance to Malaysia's progress towards achieving a developed nation status by 2020 that the National Key Economic Areas (NKEAs) policy under the Agriculture Sub-sector is the Seed Industry Development Program. The seed industry is expected to contribute about Ringgit Malaysia (RM) 467 million to the country's gross national income (Bernama, 2011). The strategies to develop seed industry to support NKEAs is also featured National Agro-food Policy (2011-2020) document recently released.

In Malaysia, more than 60% of paddy seed supply comes from the private companies (*Berita Harian*, 2013). The annual paddy seeds requirement in paddy cultivation is estimated to be about 60,000 t/year; 53,000 t are produced locally leaving a deficit of 7,000 t (Izham et al., 2003). In 2013, the government allocated RM2.2 billion in subsidies and incentive to increase paddy seed and rice production as well as to reduce production cost. The incentives allocated (RM35 million) also included the production of 80,000 t of high quality certified paddy seed each year. The sole production and distribution of breeder and foundation seeds (250 - 300 t/year) to the

certified seed producers is carried out by the Malaysian Agricultural Research and Development Institute (MARDI).

The production of the seed in Malaysia is regulated under Paddy Seedlings Verification Scheme and the Malaysia Department of Agriculture Standard (SJPM-2009) to ensure seed uniformity in term of production procedure and standard. Seed testing procedure is carried out by following the standard procedure of International Seed Testing Association (ISTA).

In the rice field, weedy rice (*Oryza sativa* complex) is a serious threat to direct seeded culture especially in Malaysia because of its taxonomic and physiological similarities to cultivated rice (Azmi et al., 2012). It is reported that the main sources of weedy rice infestation are caused by rice seeds contaminated with weed seeds and weedy rice seed bank in soil (Labrada, 2002).

Weedy rice is difficult to control by the conventional herbicides because of the close genetic relationship to the commercially grown rice varieties and the similarity in morphological characteristics make it more difficult to control compared to other weeds in the field. A heavy infestation of weedy rice can contribute in lodging of weedy rice plants and it can potentially cause total yield loss under tropical climatic conditions (Azmi et al., 2012). Thus, it is very important to avoid weedy rice contamination in certified seeds bags produced by the local processors to reduce weedy rice infestation in the field to avoid yield loss and cost for weeds control.

The current process used by the seed producers to separate weedy rice seeds from certified rice seeds before retail packaging for farmers is entirely rely on the