EFFECT OF RICE PLANTING PRACTICES ON WEED DIVERSITY IN SEBERANG PERAI AND MUDA RICE GRANARIES

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LIST OF SYMBOL

cm	Centimeter
m^{-2}	Meter square
° C	Celcius
%	Percentage
<	Less that
>	More that

KESAN AMALAN PENANAMAN PADI TERHADAP DIVERSITI RUMPAI DI JELAPANG PADI SEBERANG PERAI DAN KAWASAN MUDA

ABSTRAK

Masalah serangan rumpai di sawah padi telah didorong oleh perubahan secara nyata oleh kultura penanaman secara manual kepada kaedah penanaman secara tabur terus di sawah padi Semenanjung Malaysia pada lewat 1980an. Kajian terhadap kesan-kesan perbezaan kaedah penanaman padi ke atas sesaran rumpai di Seberang Perai dan kawasan Muda telah dijalankan sejak September 2011 sehingga Januari 2013. Kajian ini terdiri daripada tiga eksperimen melibatkan kerja lapangan dan di rumah kaca di MARDI Seberang Perai. Berdasarkan kajian pertama, suatu siri tinjauan rumpai di sawah padi Seberang Perai dan kawasan Muda mendedahkan *Oryza sativa* Complex atau padi angin, *Echinochloa crus-galli* dan *Leptochloa chinensis* merupakan spesies yang noksius and mempunyai nilai kepentingan yang tertinggi iaitu terletak di antara 139.1% hingga 52.3%. Spesies ini juga hadir di keempat-empat penanaman di kedua-dua kawasan. Bagi kajian bank biji benih rumpai ia menunjukkan jumlah anggaran simpanan biji benih rumpai di kedua-dua kawasan ialah 3,045806 $m^{-2.}$ Daripada ini, 2, 853772m^{-2} (93.7%) merupakan biji benih yang bercambah dan hanya 192,034m^{-2}(6.3%) kekal tidak bercambah. Tambahan juga, kultura penanaman yang berbeza menunjukkan jumlah bank biji benih rumpai yang berbeza. Keputusan memdedahkan penanaman secara mekanikal menunjukkan jumlah bank biji benih bercambah yang tertinggi dan bagi tabur

terus basah, ia menunjukkan bank biji benih tidak bercambah yang paling tinggi. Bagi survey sosio-ekonomi, ia menunjukkan petani dari kedua-dua kawasan mempunyai tahap persepsi dan sikap yang berbeza dalam kawalan dan pengurusan rumpai kerana para petani mempunyai perbezaan tahap pendidikan, pengalaman, penegetahuan dan sikap dalam penanaman dan pengurusan rumpai. Agensi dari kedua-dua kawasan memainkan peranan yang penting dalam menyebarkan informasi dan teknologi kepada petani agar petani dapat mengubah sikap dan persepsi mereka kearah pengurusan rumpai yang baik di sawah padi.

EFFECT OF RICE PLANTING PRACTICES ON WEED DIVERSITY IN SEBERANG PERAI AND MUDA RICE GRANARIES.

ABSTRACT

The problem of weed infestation in rice fields has been induced by the dramatic change of cultural practices from manual transplanting to direct seeding in rice field of Peninsular Malaysia in the late 1980s. The study on different rice planting practices effect on weed succession in Seberang Perai and Muda rice fields were conducted from September 2011 to January 2013 which involved surveys and experiments in field and glasshouse at MARDI Seberang Perai. Based on the series of weed survey in Seberang Perai and Muda rice fields reveals that *Oryza sativa* Complex or weedy rice, *Echinochloa crus-galli* and *Leptochloa chinensis* were the most noxious weed and had the highest important value lies between 139.1% to 52.3% and these species also present in four planting practices plot in both area. The outcome from weed seed bank study shown that the total estimated weed seed reserved for both areas was 3,045,806 m^{-2}. Of these, 2, 853,772m^{-2} (93.7%) seeds were germinated and only 192,034m^{-2} (6.3%) remains un-germinated. In addition, different planting practices show different number of weed seed bank. Results revealed, weed seed bank from mechanical transplanting area showed the highest number of germinated seed and for wet seeding practice shown the highest number of un-germinated seed. Socio-economic surveys also revealed that farmers from both areas have a different level of perception and methods in weed

control and management in rice field. This due mainly to different level of education, experienced, local knowledge and behavior in practicing weed management. Moreover, the authorities from both areas play an important role in spreading the information and the new technology to the farmers so that they will follow and change their perception and attitude to the better weed management in rice field.

CHAPTER 1

INTRODUCTION

There are about one third of people in this world are depend on rice as a staple food especially in Asian and one quarter of world agriculture in this world was planted with paddy after oil palm and rubber. According to Department of Agriculture (DOA, 2010), there are 387,160 ha of rice fields area in Peninsular Malaysia which cover eight granaries in Peninsular Malaysia which are Muda (193,104 ha) in Kedah, Seberang Perai (20,610ha) in Penang, Kerian Sg.Manik (53,188 ha) and Seberang Perak (16,185ha) in Perak, Projek Barat Laut Selangor (PBLS) (37,472 ha) in Selangor, Kemubu (50,615 ha) and Kemasin Semarak (6,140 ha) in Kelantan and Besut (9,846 ha) in Terangganu. In Malaysia there are about 6.38 billion ha land for agriculture purpose, only 0.452 billion ha was used for rice paddy and the remains for rubber and palm oil (Anon, 2008). However the demands for rice in Malaysia exceed its production, thus creating problem in terms of insufficient supply for Malaysian.

The existence of rice field since 6000 years ago has been proven when paddy has been found in a cave at Thailand and during 1709s a trader from France claim Kedah rich of rice yield (Badriyah, 2006). The planting method that has been used is manual transplanting. During late 1970s, in Peninsular Malaysia, about 85% of total areas where manual transplant has been practiced were replaced direct seeding. This was to increase successful planting and save labour but indirectly it increase weed infestation and change the important weed species. For example, during traditional

transplanting *Monochoria vaginalis, Sphenoclea zeylanica, Sagittaria guyanensis, Fimbristylis miliacea* and *Limnocharis flava* were the dominant species but in 1993 the range of species were shifted to graminea such *Leptochloa chinensis, Echinochloa crus-galli* and *Echinochloa colona.* This is because the germination period of rice seed and weed seed are same and it is too difficult to control weed infestation by manual weeding and other method weed control via herbicides (Azmi and Supaad, 1990). Consequently, by using same herbicides frequently, it causes weed resistance to herbicides such *Fimbristylis miliacea* are resistance to 2,4-D, *Cyperus difformis* resistance to Bensulfuron (Valverde *et al*., 2000) and it also causes herbicides residue in rice plant that has been detected in rice grain that give high effect to human and animal (Subbaiah, 2008).

Weed has become one of the major problems that reduce the rice production due to the changes of cultivation practice and rice management include land preparation, soil moisture content and water management (De Datta, 1981). Through the changes of cultural practice from transplanting to direct seeding, weed flora and weed dominant also been shifted from broadleaved; sedges to grasses group (Azmi, *et al*., 1995).

In general, weed is plants that human do not want because they inhibit plant growth The word "weed" can be interpreted into a lot of meaning based on time, place and human action. In Malay language of weed is "rumpai' and known as "gulma" in Indonesia (Mashhor, 1994). According to Harlan and De Wet (1965), weed can be interpreted as '*unwanted organism'* or plants that grow spontaneous and infest the areas disturbed by human action. Earlier plant scientist defined weed as "a

plant out of place*"* or growing where it is not wanted. Nowadays weed plant became a familiar plant in our environment that exist and infested the roadside, lawn, ditches, pond, garden, agricultural areas and forest (Anderson, 1996).

In rice fields, weed can be categoried into four classes according to their group; broadleaved, fern, grasses and sedges (Azmi, 1988). Lately *Leptochloa chinensis, Echinochloa crus-galli* and *Oryza sativa* Complex or known as weedy rice become the major problem weed that infests Muda area. Yields loss due to the weed infestation is more serious in direct-seeded area compared to transplanting areas. According to Lo *et al* (1990) their study revealed that unweeded direct seeded rice field area in Malaysia normally reduced rice yield up into 35% and forunweeded transplanting area was about 13% (Azmi, 1992).

Weedy rice or "padi angin" is a plant similar to cultivated rice (*Oryza sativa* L.) and can be categorise as rice plant that grow spontaneously in rice field area. In 1988, weedy rice was first detected in Project Barat Laut Selangor (Azmi, 1990) and in early 1990s it was discovered in Muda area due to the changes of cultivation practice. The morphological and physiology of weedy rice is similar with cultivated rice because they are in the same genus and species. The existence of weedy rice with the changes of planting practice it decreases the yield and rice production up to 74% yield in Muda areas and 16% in Vietnam rice field (Chin, 2001) due to shattering characteristic which occurred 10-20 days after heading and before cultivated rice matured (Azmi *et al.*, 1994a).

Abundant of viable weed seed which infest the soil in rice field either on the surface or in the soil is known as weed seed bank (Marfuzah *et al*., 2006). Once these seeds fall on the surface or in the soil, it is hard to remove and they remain in the soil for many years and created a lot of problem in rice field, such as limiting the growth of rice plant and reduce the yield loss due to weed competition between paddy and weeds (Azmi, 1990). This problem begins when seed in the soil seed bank emerge and grows indirectly infest that area (Wilson *et al*., 1985). For example, 86 panicle/m^2 of barnyard grass or *Echinochloa crus-galli*, it will decline yield loss until 50% (Hill *et al*., 1985) and according to Azmi (1992) estimated of RM292.30/ha will be loss if there is one hill of barnyard grasses in the rice field and the loss will be increase to RM2000/ha if there are 80 hills/m^2. Weeds generally emerge earlier and growing faster than rice plant which makes them a better competitor for water and nutrient. Thus futher enhance their growth and consequently inhibit the rice plant's growth.

The study of weed seed bank is necessary because it can provide additional information to farmer as which species present in particular areas and what kind of herbicides that they can apply to that area (Lawson, 1988). This will be an advantage interm of the application using herbicides (Wilson *et al.,* 1985). According to Sago *et al* (1983), stated that density of the weed seed in the soil is related with the dominant weed that emerge for the next season.

Farmers play an important role in rice field because they are well aware of the changes or problems in the rice fields. Farmers usually have substantial knowledge, resource, technology based on their experimental practise or technique

from their inquisitive or from their observation in solving problem (Mortimer, 1996). Thus, local knowledge and experience are most likey to differ between each individual farmer.

Several farmers are still practising the traditional weed control method because they can't adapt the new technologies due to lack of practical knowledge. It was suggested that this was due to failure of receiving proper information from agency which could be not well delivered as well as poor understanding and application of the information (Borkhani *et al*., 2010). Some farmer applied wrong methods in weed control due to insufficient of cost investment, labour shortage and input material such herbicides, pesticides and fertiliser because they are expensive. So they take a risk by buying illegal herbicides that are prohibited in Malaysia with is cheaper.

So it is important to understand farmer's attitude in rice field because yield and rice production are depend on their practice. To sustain the good practice in farmer attitude without causes any damage or give harm either to human or soil, it can be achieve by give a talks to them and explain the right method by agencies. The agencies were responsible to increase the rice production in Malaysia such Malaysia Agricultural Research and Development Industry (MARDI) or Ministry of Agricultural (MOA).

1.1 Objectives

The objectives of this study are:

i. To determine the composition, distribution and the similarity and dissimilarity of weed flora in different communities with the different planting practice in Muda and Seberang Perai areas in three seasons,

ii. To identify the composition of weed seed bank in different planting practice in both areas,

iii. To determine the farmer attitude and perception on weed control and management toward sustainable farming practice.

CHAPTER 2

2.0Literature review

2.1 Weeds distribution in Rice Fields

Weed plays an important role in the environment and the existence of weed should be managed wisely to optimize the production of crop and to maintain the environment so that there would be no increasing of production cost in crop (Robert, 2013). Weed distribution can be interpreted as an expression of the influence of ecological elements and human effects. Weed flora in rice fields has been influenced by the several factors such type of culture practice, land preparation, crop established method, irrigation, type and rate of fertilizer used and herbicides that has been used by farmers (Azmi and Baki, 2007).

According to De Datta (1981), cultivation practice (usage of fertilizer and type of cultivar), land preparation (tillage, rotovation, land leveling), moisture regime (irrigated or rain fall) and crop established technique (transplanting or direct seeding) were the factors that increased the degree of infestation of weed in the rice fields.

Weed can be divided into several group based on the life cycle, habitat and morphology and Akobundu (1987). Weed can be group based on the state of noxiousness and taxonomy or scientific classification. Life cycle or life history of weed in the tropic was classified into two groups, annuals and perennial life cycle (Azmi, 1988). Annual weed complete their life cycle only in one season within 12 months (Anderson, 1983) or 3-12 month (Muzik, 1970) or complete life cycle one or two growing season in one year (Akobundu, 1987). The other characteristic for

annuals weed were rich of seed to survive and germinate (Akobundu, 1987). Several examplesof weed species are *Ageratum conyzoides*, *Amaranthus spinosus* and *Euphorbia hirta.*

Perennial weed plant is weed species that live for more than one years of calendar (Akobundu, 1987) or more than three years (Anderson, 1996). Characteristic for this weed are there hard to control, produce less seed compared to annuals weed and there depends on the vegetative structure to survive in poor condition. For example weed species are *Imperata cylindrica*, *Cynodon dactylon* and *Cyperus esculentus (*Akobundu, 1987).

Weed is distributed around the world and dispersed by several agent and different time dispersal. The dissemination of seed in space was influenced by location of the mother or parent plant and it involves the movement of seed from one location to the other. Moreover, weed seed also can be spread out by natural and artificial dissemination. The natural dissemination involve wind, water, animal, and forceful rupturing of capsule. For artificial dissemination of seed are resulted by man action or disturbance and agricultural activity (Anderson, 1983).

Irrigation canal is one of the important factors for seed disperse in western United States. Most annuals and perennial weed species grow in rice field and on the bank of irrigation canal (Baker and Terry, 1991). Furthermore, human activities in agriculture by using machinery play one of the factors in seed dispersal especially harvesting equipment, moving within a field or from field to another field (Anderson, 1996) and during land preparation

2.1.1Weed communities in Malaysia rice fields

Weed in lowland rice fields can generally be divided into broadleaves, grasses, sedges and submerge weed (Moody, 1991). There were about 350 weed species in rice field areas were belong to 150 genera and 60 families were recorded. Gramineae or family of grasses was a most dominant family that comprises of more than 80 species and followed by Cyperaceae, a sedges family, with 50 species and other main weed families were belong to Alismataceae, Asteraceae, Leguminoceae and Scrophulariacaea (Smith, 1981).

In Peninsular Malaysia, during 1980s, Azmi and Supaad (1986); (Azmi and Anwar, 1988) were recorded 72 weed species belong to 28 families that present in 8 rice granary areas in Peninsular Malaysia.Based on weed survey during 1989 until 1990 in major rice granaries areas Azmi and Baki (1993) stated that 78 weed species belong to 58 genera and 32 families. From this 78 weed species there are 35 species from broadleaves, 16 from grasses, 20 from sedges and 7 species from submerged weed as shown in Table 2.1. In this survey, *Monochoria vaginalis*, *Sagittaria guyanensis, Limnocharis flava, Fimbristylis miliacea, Leptochloa chinensis* and *Echinochloa crus-galli* were found to be the most dominant weed species in that particular areas.

Table 2.1 Distribution of weed species in major rice-growing areas in Peninsular Malaysia

Family	Species	Weed occurance							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Aquatic weeds (submerged)									
Characeae	*Chara zeylanica* K.l ex Willd.	-	-	-	x	-	-	-	-
Gentiaceae	*Nymphoides indica* (L.) O.K.	-	-	-	-	-	-	-	x
Hydrocharitaceae	*Blyxa malayana* Ridl.	-	x	x	-	x	-	-	-
	Hydrilla verticillata (L.f.) Royle	x	-	x	-	-	-	x	x
Lentibulariaceae	*Utricularia aurea* Lour.	x	-	x	x	x	x	x	x
Najadaceae	*Najas graminea* (non Del.) Ridl.	x	x	x	x	x	x	x	x
Nymphaeceae	*Nymphaea nouchali* Burm. f.	-	-	x	-	-	-	x	-
Broadleaved weeds									
Alismataceae	*Sagittaria guyanensis* H.B.K	x	x	x	x	x	x	x	x
Amaranthaceae	*Altenanthera sessilis* (L.)DC	-	x	-	-	-	-	-	-
Araceae	*Pistia stratoides* L.	-	-	-	-	-	-	x	-
Asteraceae (Compositea)	*Eclipta prostrata (*L.)L.	-	-	x	-	-	-	-	-
Azollaceae	*Azolla pinnata* R. Br.	x	x	x	-	-	x	x	-
Butomaceae	*Limnocharis flava* (L.) Buchenau	x	x	x	x	x	x	x	x
Capparaceae	*Cleome* sp.	-	-	-	x	-	-	-	-
Commelinaceae	*Commelina diffusa* Burm.f.	-	-	x	-	-	-	-	-
Convolvulaceae	*Ipomea aquatic*a Forsk.	-	x	-	-	x	-	x	x
Elatinaceae	*Elatine* sp.	-	x	-	-	-	-	-	-
Eriocaulaceae	*Eriocaulon cinereum* R. Br.	x	x	-	-	-	-	-	-
Euphorbiaceae	*Phyllanthus niruri* L.	-	-	x	-	x	-	-	x
Lemnaceae	*Lemna minor* L.	-	x	x	-	x	x	x	-
	Spirodela polyrhiza (L.) Schleid	-	-	-	-	-	x	x	x
Lythraceae	*Rotala indica* (Willd.) Koehne	-	x	x	-	x	x	x	x
	Rotala rosea (Poir.) C.D. Cook	-	x	-	-	-	-	-	-
Marsileaceae	*Marsilea crenata* Presl	x	x	x	-	x	x	x	x
Onagraceae	*Ludwigia adscendens* (L.) Hara	-	x	-	-	x	x	x	-
	Ludwigia hyssopifolia (G. don) Exell	x	x	x	x	x	x	x	x
	Ludwigiaoctavalvis (Jacq.) Raven	x	x	-	-	x	-	-	-
Parkeriaceae	*Ceratopteris pteridoides* (Hook) Hieron	-	-	x	-	x	x	-	-
Pontederiaceae	*Monochoria hastata* (L.) Solms	-	x	x	x	x	-	-	-
	Monochoria vaginalis (Burm. f.)Presl	x	x	x	x	x	x	x	x
Portulaceae	*Portulaca oleracea* L.	-	-	-	-	-	-	-	x
Rubiaceae	*Hedyotis corymbosa* (L.) Lamk	-	x	x	-	-	-	-	-
Salvinaceae	*Salvinia cucullata* Roxb.ex Bory	-	x	-	-	-	-	-	-

	Salvinia molesta D.S. Mitchell	-	-	x	-	-	x	x	x
	Bacopa rotundifolia (Michx.) Wettst.	-	-	-	-	x	x	-	-
	Limnophilia aromatic (Lamk.) Merr	x	x	x	x	x	x	x	-
	Lindernia anagallis (Burm.f.) Pennell	x	x	-	-	-	-	x	x
	Lindernia ciliata (Colsm.) Pennell	-	x	-	-	-	-	-	-
Scrophulariaceae	*Microcarpaea minima* (Koen.) Merr	x	x	x	-	-	-	x	x
Sphenocleaceae	*Sphenoclea zeylanica* Gaertn.	-	-	x	x	x	x	-	-
Sterculiaceae	*Melochia* corchorifolia L.								
Grasses									
	Brachiara mutica (Forsk.) Stapf	-	-	x	-	-	-	x	-
	Cynodon dactylon (L.) Pers.	x	-	-	-	-	-	-	-
	Echinochloa crus-galli (L) Beauv	x	x	x	x	x	x	x	x
	Echinochloa colona (L.) Link	x	x	x	x	x	x	x	x
	Echinochloa stagnina (Retz.) Beauv	-	-	-	-	x	-	-	-
Poaceae	*Eragrostis uniolodes* (Retz.) Nees ex Steud	x	x	-	-	-	-	-	-
(Graminea)	*Hymenachne acutigluma* (Steud.) Gililand	x	x	-	x	x	x	-	x
	Isachne globosa (Thunb.) O.K.	-	x	-	-	-	-	-	-
	Ischaemum rugosum Salisb.	-	-	x	x	x	-	-	x
	Ischaemum timorense Kunth	-	-	-	-	-	-	-	x
	Leersia hexandra Sw.	x	-	-	-	x	-	-	-
	Leptochloa chinensis (L.) Nees	x	-	x	x	x	x	-	x
	Paspalum vaginatum Swartz	x	x	x	-	x	x	x	x
	Paspalum commersonii Lamk.	-	-	-	-	-	-	-	x
	Paspalum longifolium Roxb.	-	-	-	x	x	-	-	-
	Panicum repens L.	x	-	-	-	x	x	-	-
	Sacciolepis myosuroides (R.Br.) A. Camus	x	-	-	-	-	-	-	-
Sedges									
	Cyperus babakan Steud	x	-	x	x	x	x	-	-
	C. compactus Retz	-	-	-	x	-	-	-	-
	C. difformis L.	x	x	x	x	x	x	-	-
	C.diffusus L.	-	x	-	-	-	-	-	x
	C. digitatus Roxb.	x	x	-	x	x	-	-	x
	C. distans L.f.	-	-	-	x	-	-	-	-
	C.haspans L.	x	x	-	x	x	-	x	x
	C. iria L.	x	x	x	x	x	x	-	x
	C.pulcherrimus Willd. Ex Kunth	-	x	-	-	-	-	x	-
	C.polystachyos Rottb.	-	x	-	-	-	-	-	-
	Eleocharis acutangula (Roxb.) Schult.	-	x	-	-	-	-	-	-

(Cyperaceae)	*E. geniculata* (L.) R. & S.	-	-	x	-	-	-	-	-
	E. ochrostachys Steud	-	x	x	-	x	-	x	-
	Fimbristylis acuminate Vahl	x	-	-	-	-	-	-	-
	Fimbristylis miliaceae (L.) Vahl	x	x	x	x	x	x	x	x
	Fimbristylis schoenoides (Retz.) Vahl	-	x	-	-	-	-	-	-
	Fuirena umbellate Rottb.	-	x	-	-	x	-	x	-
	Scirpus grossus L.f.	x	x	-	x	x	x	x	x
	Scirpus juncoides Roxb.	x	x	-	-	x	x	x	x
	Scirpus lateriflorus Gmel.	x	x	x	-	-	-	x	x

(Adapt Azmi *et al*., 1993)

(-) indicates absence (x) indicates presence

1 = Besut areas 2 = Kemubu areas 3 = PBLS areas 4 = Seberang Perak areas 5 = Muda areas

6 = Seberang Perai areas 7 = Kerian areas 8 = Sg. Manik areas

2.1.2The changes of weed composition

In the past two decades in Southeast Asia, there has been a shift in cultivation practice in rice field areas from transplanting to direct seeding practice which currently became the main culture practice in Malaysia, Thailand, Philippines, Vietnam and Sri Lanka (Moody, 1993). Lacked and increased labour cost in transplanting and the introduction of efficient herbicides (Itoh, 1991) and time consuming in the former practice (Johnkutty *et al*., 2002) were the factors that contributed to the shifted of cultural practice in rice field areas.

In double cropping season of rice planting in Malaysia, the first season is dry season or off season which is started in April and ends in September (Juraimi *et al*., 2011**)** or between March and August (Kanateni, 1991) where the season are usually hot and sunny throughout. Main season is the second cropping season which is has heavy rainfall that common in the afternoon or evening which started from October until March (Juraimi *et al*., 2011) or between September and February (Kanateni, 1991).

Recently, about 90% rice field areas were using direct seeding practice over the year for Main Season and Off Season (Cheong, 1998). Consequently, weed become the major problem in rice production due to the changed of weed flora (Karim *et al*., 2004). Based on Ampang-Nyarko and De Datta (1991) weed flora in rice field is significantly influenced by the culture practice and Connell and Slatyer (1977) cited that the changes of weed flora was as a result of the changes during land preparation and herbicides use.

Before the transforming of the cultural practice, weed flora during transplanting practice were in order of *Monochoria vaginalis*> *Fimbristylis miliacea*>*Ludwigia adscendens*>*Leersia hexandra*>*C.haspan*> *Limnocharis flava* >*Scirpus grossus* (Baki and Md. Khir, 1983). This weed group is not noxious or harmful position in that era, but by the shifting of cultural practice to direct seeding, it shifted the rice management technique including water regime, tillage and herbicides usage (Azmi and Mashhor, 1995) and also stimulated the emerging of the harmful weed position to become the dominance species in Muda areas and weed were claim as the hardest pest to manage (Ho, 1991a; Morooka and Yasunobu, 1993) because grasses group such *Echinochloa crus-galli* and *Leptochloa chinensis* were replaced and become major species in rice fields (Ho and Md-Zuki, 1988).

Among previous studies on weed species composition was by Azmi and Mashhor (1995), which the authors concluded that there are predominant weed shifting due to the changes of cultural practice from transplanting to direct seeding. During planting season of 1989, the agronomic practice in Kemubu area was still traditional transplanting and the dominance weed groups were broadleaves. However, during 1993 season, farmers in 79.6% of total area in Kemubu started to changed their agronomic practices into direct seeding, which eventually lead to the changes of dominant weed group from broadleaves into grasses and followed by sedges, grasses and aquatic weed group (Azmi and Mashhor, 1995).

Moody and Drost (1983) concluded that during transplanting practice, *Leptochloa chinensis* not a dominance weed species in early 1980s, but after practicing direct seeding continuously until today, it become one of the major weed

dominance in Muda (Ho and Itoh,1990;Azmi *et al*., 1993; Azmi, 1994) areas because *L.chinensis* seedlings were easy to emerge under dry-to saturated soil condition (Azmi and Mashhor, 1996; Bhagat *et al*., 1999) compared to transplanting practice where fields are permanently flooded. It was highly suggested that water plays an important factor insuppressing other weed growth from grasses group (Fajardo and Moody, 1990).

About 10 years, farmers in rice field areas try to adapt to direct seeding practice. When the changes practices to direct seeding practice in some way the usage and type of herbicides totally different and farmer tend to repeat the same herbicides because herbicides was a method in weed management to control weed in direct seeding practice (Lim and Azmi, 1986; Azmi & Baki, 1995; Ho, 1998). Consequently herbicides become another factor that shift the weed flora in rice fields. After continuo usage of the same herbicides, it will caused inherent resistance to the weed species because it change the biochemical process to make sure weed survive when they are treated to the same herbicides (Ismail *et al.*, 2003).

By using molinate continuously, it suppressed *E.crus-galli* but in the same ways it raises the infestation *L.chinensis* and *I.rugosum* (Ho, 1991a; Azmi & Mashhor, 1996). *Limnophilia erecta* and *Bacopa rotundifolia* were detected as new dominance species in Sekinchan Farm Block (SFB) located in Selangor's south West Project due to the continuously used of sulfonylurea herbicides. Acetolactate-synthase (ALS) inhibitor- resistant has been reported in a number of weed species in many countries, including Malaysia (Azmi & Baki, 2003). These ALS-inhibitor

herbicides such sulfonylurea, which lately has been widely used around the world because their small dosage, are actually toxic to mammalian.

2.1.3 The recent dominant weed species in Malaysia rice fields

According to Hakim *et al* (2010), based on a study of weed population in costal rice growing areas in Muda, about 42 weed species were recorded involving 25 annuals and 17 perennial weed. In this survey, *L.chinensis* was the most dominant species with the highest frequency (77.5 %) followed by *E.crus-galli* (72.5%) and *F. miliacea* (67.5%). Another studyin July 2003 where a survey was conducted in Muda areas involving 27 farm blocks involving 579 fields. The result from this survey shown that *Oryza sativa* complex (weedy rice) was the most dominant species in this granary area with 100% of weed infestation in district I and II in Muda areas, followed by *E. crus-galli* (93.8%) and *L.chinensis* (85.5%) (Begum *et al.,* 2005).

A similar pattern of weed dominance ranking was reported by Azmi and Baki (2002) in Muda rice granary areas in decreasing order of *Echinochloa crus-galli* complex, *L.chinensis, Oryza sativa, F. miliacea, Sphenoclea zeylanica* and *Scirpus grossus.* Other weed survey were conducted from 2001 until 2005 found that a total of 58 weed species including 27 broadleaves, 14 grasses, 12 sedges and 5 aquatic weed in field that practicing direct seeding in Muda rice granary areas. During five years involving five seasons a survey was conducted in Muda rice granary areas to gather more information on weed flora in new millennium. As a result, grasses group were the most dominant group that infest these areas and the most dominance species was *Oryza sativa* complex, followed by *Echinochloa crus-galli* complex, *L.chinensis, F. miliacea,* and *Scirpus grossus* (Azmi and Baki, 2007).

After direct seeded was practised in rice areas, the dominance weed group changed from broadleaved to grasses and the new dominance species also raise to infest rice field, for example *Oryza sativa* complex or normally known as weedy rice. Weedy rice was first observed in Malaysia in Projek Barat Laut Selangor (PBLS) and Muda area during early 1988 (Azmi *et al.,* 1994; Azmi & Abdullah, 1998; Azmi *et al.,* 2001). Thus it is strongly suggested that weedy rice, a weed that forms of rice existed since direct seeding was practiced in Malaysia.

Dry direct seeding and volunteer seeding cultural practiced in Malaysia was assumed as the factor that lead to the origin of weedy rice in Malaysia due to dry condition and shortage of water. Weedy rice also found in Thailand and Vietnam (Azmi *et al*., 2004) and it become noxious during Off Season 1993 and infested several areas such Sg. Burung, Sg. Leman, Sg. Nipah and Sekinchan and covered approximately 700ha areas of rice field in PBLS. In 1990, weedy rice was report appeared in Muda areas and during 1993 where it becomes noxious and infested 168ha area of rice field under Muda district (Md- Zuki & Kamaruddin, 1994).

Although morphologically similar to cultivated rice, weedy rice was considered as weed because of somemain characteristics of weedy rice, which areearly and easy to shatter, taller plant, few tiller (Chin *et al.*, 2007*),* hard to control when their infested that areas (Azmi *et al*., 1994a) and the grains harvested undergoing milling process but the process caused the grains to break, thus reducing the grade of grain as well as contaminating the milled rice (Ricardo, 1999). The presence of weedy rice in rice field creates huge problem to farmers because it drastically reduce the yield loss until 50-60% when it infested 35% of rice fields

areas (Watanabe *et al*., 1996) and under serious infestation, yield loss will exceed 75% under direct-seeding rice (Azmi *et al*., 1994a).

Until now, there is no single method in controlling of weedy rice. Weedy rice is not only difficult to control but also costly because it has a similar growth characteristic with cultivated rice. Recently, imadozolinone herbicides was used in controlling weedy rice and other noxious weed such *E.crus-galli, L.chinensis, C.iria, C.difformis* and *Ludwigia octovalvis* (Chin *et al*., 2007). By using these herbicides it improved rice quality and increased rice yield and reduced the number of weedy rice contaminant in rice product and reduces the soil seed bank due to low seed dropped in the soil surface. However, this control technique is expensive because it came with the package including CLEARFIELD. By applying single imadozolinone into normal cultivated rice, the herbicides will inhibit the growth of rice by disrupter of protein syntheses which impede DNA synthesis and cell growth (Shanner and Connor, 1991). So, to apply imadozolinone, CLEARFIELD rice must be used because this variety is resistant to imadozolinone. Although this technique is effective in controlling weeds, due to its expensive cost not all farmers in Malaysia apply this in their area.

2.2 Culture Practices in Malaysia

There are several types in the technique of planting rice in Malaysia. The technique of planting depend on the areas; either upland or low land. For example seed dibbling are suitable for upland rice and transplanting and direct seeding are suitable in lowland areas. In general cultural practice in rice field can be divided into two types; transplanting and direct seeding. Transplanting can be further divided into

two methods which are manual and mechanical transplanting. The direct seeding technique can be further divided depending on certain field conditions which are dry, wet, and water seeding (Johnkutty *et al*., 2002; Azmi *et al.,* 2004).

2.2.1 Manual Transplanting

Manual transplanting is a method that used rice seedling which is planted by hand in one location to another location. This is a traditional method that was established since rice was planted in Asia and it has been adopted in most of tropical Asia including Bangladesh, India, Thailand and Malaysia (De Datta, 1981). These methods needa proper nursery for rice seedling to grow until 15-30 days after seeding (DAS). Seedlings were transplanted manually by labour in puddle and leveled field at shallow water depth in optimum spacing of 20cm x 20 cm or 22.5cm x 22.5cm. This method may decrease weed infestation in rice field because cultivated rice survive and adapted in water compare to weed. Nevertheless, the main disadvantages of using this method are its very time consuming and require high number of labour. Evidently itis hard to get enough labor to transplant on time and it costly and it cause health problem to labor due to back problems

2.2.2Mechanical Transplanting

This method is an improvement of the manual transplanting as it used modern mechanical paddy transplanter. This method need rice seedling grown until 15-20 DAS that are modified into mat-type seedling grow in nursery box which is the root and soil is not separate (De Datta, 1981). This method is recommended for the field with worst weedy rice infestation (Azmi *et al*., 2004).

2.2.3Direct seeding

Direct seeding or direct sowing is a rice planting technique which is seeds is directly planted or sow directly on the ground without using seedling. Currently, knapsack mounted motorized blower is an innovative mechanical technology that is used to broadcast seed in field. This method was established since 1980s (Azmi and Mashhor, 1996) and replaced manual transplanting due to the increasing of labor cost and shortage of labour in Malaysia (Azmi and Yap, 1994b). The advantage of using this method is through reducing the usage of labour which requires less that 2 labour days/ha compared to 35-40 labour days/ha in the manual transplanting method (Supaad *et al*., 1990) and increase rice yield and production. This method removes the usage of seedling and related action for example seedling nursery preparation, mat-type seedling, the transporting and transplanting operation (Johnkutty *et al*., 2002). This method requires pre-germinated seed that are broadcast onto puddle and leveled field. The land preparation in this method is very important because it will control and prevent the germination of weed seed via ploughing that bury weed seed at the certain depth (Moody, 1992).

Direct seeding practice can be divided into three methods: One is dry seeding under non-puddle dry field condition: Second is wet seeding under puddle field condition and the third method is direct seeding in water or water seeding. All of this method has the same requirement but there are some differences on the amount and water depth and the duration of seed to become pre-germinated seed (Kanetani, 1991). Table 2.2 show the differences requirement in transplanting and direct seeding technique.

Table 2.2 The differences requirement in manual, mechanical transplanting and direct seeding in rice field

Practise& Requirement	Manual Transplanting	Direct Seeding	Mechanical Transplanting
1.Land preparation and operation	> Less precise	> Leveling land needed	> Same as direct seeding
	>100-120kg/ha seed are requires	>High rate of seed 150- 200kg/ha	> Moderate seed are requires 150-180kg/ha
	>15-30DAS seedling Used	> Ununiformly seed germination	>15-20DAS seedling used
2. Seeds and seedling	> Seedling facing shock during transplanting		>Fast recover from transplanting shock
	>Need outdoor seedling nursery	> Not require nursery	> Nursery anywhere, even indoor
	>Need 35-40 man day/ha	>Less than 2 man days/ha	> About 8man days/ha
	>Using hand, sometime with "kuku kambing".	>Manual or with knapsack mechanical	>Using mechanical Tranplanter Mechine
3. Planting	>Transplanting deep into soil	>Seed only near or on the soil surface	>Planting depth can be adjust
	> Root grow very poor	>Inadequate root anchorage.	> Moderate growth of root
	> Lodging rarely happen	> Lodging always happen due to : a) shallow rooting b)uneven growth	> Lodging rarely happen
4.Plant density	>Ununiform and sparse planting	> Uneven seed distribution	>Uniform and in straight line and adjustable
5.Water management	>Less precise	>Very precise	>Intermediate requirement
	>Normal care	>More intensive but	>Same as manual

6.Crop care		crop is less accessible	transplanting
7.Ripening	>Uniform	>Uneven	>Uniform
8.Harvesting	>Slower maturation due to shock duringtransplanting	>Faster maturation due to no shock	>Same as manual Transplanting
9.Yields	>Average but steady	>Inconsistent with Fluctuation	>Above average more likely
10.Distinctive Features	> Cost of labour	>High input, more crop care requires	> High initial cost

(Modified from Cheong, 1998)

2.3Manual operation in weed control and management in rice field

Manual operation in rice field is very important and it includes pre-planting and after planting operation. The rice management gives benefits to control weed infestation especially weedy rice to increase adsorption of nutrient and increase soil fertility, porosity and aeration. There are some manual that are recommended by Azmi and Muhammad (2003) (Table 2.3) for pre-planting and after planting.

The concept in integrated weed management or control (IWM) is the application of environment information, involving weed biology and ecology and every existing technologies for effective control weed in the same ways increase economy or crop yield, reduced the side effect or risk to human and environment (Sanyal, 2008). IWM very important because there was no single method in rice field to control in weed from heavy infested. The combination of preventive, cultural, mechanical, chemical and biological weed control will contribute effectiveness of IWM (Rao *et al*., 2007).

For example in controlling weedy rice it starting from the usage of certificate seed which is pure and quality seed, proper land preparation and water management, sequential of tillage in order to minimize weedy rice seed from germinate (Zainal and Azmi, 1994c). Furthermore, the movement of combine harvester from one rice field to another one of factor that contributed to seed dissemination in rice field. This can be prevented by clean the any machinery that was used in field before used it into other field (Azmi *et al*., 1994a)

Table 2.3 Manual operation in weed control and management in rice field

Time	Operation	Remarks
DAH*	**Day After Harvesting***	
0-1	Cut stubble	Using service cutter or shredder attached to a 4-wheel tractor. Straw and stubble are spread uniformly.
1-3	Burning stubble and straw	Weed seed on the ground will destroy and promote the emergence of weed from the soil seed bank.
8-10	1st tillage (dry/wet) after harvesting (shallow rotovation up to 7.5cm) and major levelling, if necessary	Standard seed bed preparation. Remove of perennial weed and encourage germination of weed seed.
15-17	2nd tillage (wet) and minor levelling	Encourage germination of weed after rotovation. A skilled operator is requiring for leveling operation.
22-24	Spray pre-planting herbicide i.e (paraquat, glufosinate or glyphosate at recommended dosage if necessary and follow by 3rd tillage (2-3 days after herbicide spray)	Herbicides spray if there is no water available in the field and high density of weed emergence
DAS*	**Day After Sowing***	
0	Broadcasting of pre-germinated rice seed in rate 100-140kg/ha	Sowing of rice seed is recommended out immediately after land leveling. If water control is good.
3-4	Spray pre-emergence herbicides i.e pretilachlor applied under standing water	To kill or suppress the emergence of weed
	Selection of herbicides depending on	In normal practice, water should be