Chapter 5

General Discussion

In Thailand, weedy rice has emerged as serious threat in some rice fields since 2001 (Maneechote *et al*., 2004) and then spread to cover about 50,000 ha of the central plain in 2006 (Maneechote *et al*, 2007). It was shown that weedy rice is the result of hybridization between crop rice and common wild rice. In the central plain, wild rice and crop rice were often found in close proximity (Chitrakorn, 1995; Jamjod *et al*, 2002). The evidence of gene flow between cultivated and wild rice were observed in Thailand since 1961 by Oka and Chang. As the endosperm of wild rice is normally non-waxy, observation of waxy gene in wild rice populations that grew in close to glutinous rice field in Northern Thailand was interpreted as evidence of gene flow (Oka and Chang 1961). In northeastern Thailand, gene flow from crop rice to wild rice has been shown by brown plant hopper resistance trait of crop rice (Samanwong *et al*., 2005) and DNA markers (Wongtamee *et al*., 2007). Therefore, in the area where crop rice and it's progenitor are grown in close proximity, there are some chances of crossing between them.

Gene flow can be determined by set out the experiment and measure the rate of migration between populations, another is study from genetic evidence of past gene flow by measure variation in populations. By the first method, actual crossing between wild and cultivated rice in the field was quite low, varying from 0% to 2.94

(Song *et al*., 2003; Chen *et al*., 2004). Gene flow between weedy rice and transgenic rice in experimental field were 0.04 -0.09% depends on wind direction (Messeguer *et al.*, 2004). However, natural hybridization rates between weedy rice and cultivated rice have been estimated by the second method and found to range from 1.08% to 52.18% after examining 12,000 seeds collected on red rice plants naturally occurring in fields of six different rice varieties, and determining the incidence of hybrid progeny by isozyme analyses (Langevin *et al*., 1990). In this study, high rates of natural outcrossing were estimated as 13-28% in farmers' rice crop, 18% in weedy rice and 4-5% in wild rice, which were in the range reported by Langevin *et al*. (1990).

From Chapter 2, the criterion for determine the differentiation between cultivated rice and wild rice were established. Morphological characters is easy marker for distinguish between two species. Moreover, DNA analysis is valuable tools and increase the power and resolution for identify hybrids, especially microsatellite markers technique. Successfully uses of morphological, physiological characteristics and DNA evidence for determine hybridization and introgression between cultivated, weedy and wild species were shown in many plant species such as oak (Sánchez *et al*., 2004), *Carpobrotus* spp. (Albert *et al*., 1997;Gallalher *et al*., 1997), sunflower (Rieseberg *et al*., 1990) and rice (Gealy *et al*., 2002; Song *et al*., 2002; Oka and Chang, 1961; Chu and Oka, 1970; Oka and Morishima, 1971; Langevin *et al*., 1990).

Crossability or hybridization between cultivated and wild rice is the first step for assessment gene flow. I was found that the cultivated rice varieties hybridized successfully with local wild rice (Chapter 3, experiment 3.1) same as Naredo *et al*.'s

(1997 and 1998) studies. Seed set from this study were ranging form 6 to 62% while from Naredo's studies (1997) seed set between rice AA genome ranged from 0 to 57%. From the results, highest seed set was found between the high yielding variety (HYVs), SPR1 or CNT1 x wild rice and the F_1 hybrids displayed normal fertility. CNT1 and SPR1 are photoperiod insensitivity varieties usually grown in central plain with 2-3 crops per year. The rest six varieties are usually grown in north and northeast (KDML105, RD6 and RD10) and north (NSPT, SMJ and KDK). Five cultivated rice variety except RD10 are photoperiod sensitivity. In addition, gene flow between two species will be achieved depend on overlapping flowering periods and are at suitable distance, depending on the seed and pollen dispersal ability and the environmental factors such as wind, humidity and biotic factors (pollinators and other animal favoring seed dispersal) (Song *et al*.,2003; Waines and Hegde, 2003; Papa and Gepts, 2004). In this case, synchronization of flowering period is the most importance for successfully of gene flow including high sexual compatibility between two species. In Thailand, wild rice was distributed in all parts with many habitats such as ditch, deep swarm, roadside, longan orchard and near rice field (Chitrakorn, 1998 and Jamjod *et al*., 2002). Wild rice start flowers on the end of September to the beginning of December (Punyalue, 2006). In central plain, high yielding variety, SPR1 and CNT1, usually grow 2 – 3 crops per year on the same land in one year. This will increase the chance of flowering synchronization and crossing between HYVs and wild rice. This was supported by the SPR1 and CNT1 alleles found in wild rice and weedy rice.

Gene flow between cultivated rice and wild rice give high impact for rice gene pool. Cultivated rice is predominate self pollinated crop. Hybrids population

contained high segregation on morphological and physiological characters but wild traits, awning and seed shattering still maintained in population. Weedy rice, which resulting from gene flow between wild rice and cultivated rice, can greatly reduced crop yield and quality (Maneechote *et al*., 2004). This study also provides evidence that weedy rice is the result of hybridization between cultivated rice and wild rice that grows adjacent to farmer's fields (Chapter 4). The finding was consistent with many studies from areas where wild rice and cultivated rice co-exist (Oka, 1988; Chen *et al*, 2004). Moreover, continue outcrossing between cultivated rice and weedy rice was demonstrated by alleles of various varieties which farmers used to grown in the same field (Figure 4.4). About 13-28% outcrossing rates were found for weedy rice and farmers' crop rice which indicates high possibility of gene flow between crop rice and weedy rice. This may lead to the convergent of weedy rice toward crop which will increase difficulty of weedy rice control.

Results from this study have established that weedy rice is emerging as serious threat to rice farming in Thailand. It was also shown that the weedy rice in Thailand is originated by hybridization between cultivated and wild rice. While hybridization between cultivated and wild rice would have been taking place in all the thousands of years of rice domestication, it remains to be explained why weedy rice should suddenly becomes invasive now. The answer to this question should also help to predict if weedy rice should be expected to be a problem in other areas in Asia where cultivated and wild rice grow in close proximity.