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TOWARDS ATTAINING HIGH YIELDS AND LONG TERM SUSTAINABILITY OF SECOND GENERATION OIL PALM REPLANTS ON PEAT IN NORTH SUMATERA, INDONESIA – THE ASIAN AGRI EXPERIENCE

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SUMMARY

Asian Agri's planting of Gen-1 oil palms on peat commenced in 1991. Due to lack of experience with peat, inadequate drainage and zero soil compaction, initial FFB yields were poor peaking at 24 mt/ha, 11 years after planting. Thereafter, FFB yields started to decline and by 18 years, average yield was less than 15 mt/ha. This rapid deterioration in yield was attributed to a significant loss in palm stand due to *Ganoderma* infection and toppling over of palms due to peat subsidence. In view of uneconomical yields, early replanting with superior Gen-2 DxP progenies commenced in 2006. Right from the start, proper land preparation protocol and BMP's for peat were adopted to ensure that history would not repeat itself. Peat compaction was undertaken to minimise future palm leaning and toppling. Greater emphasis and importance was placed on drainage and water management in order to ensure retention of optimum water levels (40-60 cm) throughout the year and minimise peat subsidence. As *Ganoderma* infection was the pre-dominant factor in reducing palm stand in the Gen-1 plantings, a four stage IPM system was introduced to minimise infection risk in the Gen-2 replants. This included intensive land preparation with a certification scheme, planting varieties with a higher disease tolerance, protection with an effective bio-agent and early detection and removal of newly infected palms. IPM was also used for managing other potential pests with emphasis on establishment of an Early Warning System combined with cultural and biological control methods to limit use of chemical pesticides. As nutrition plays a critical role in achieving high sustainable yields, a network of fertilizer trials were also laid down to re-determine the macro and micro nutrient requirements of the Gen-2 progenies on well decomposed peat. Early yields of the Gen-2 replants have been very promising and were 47% higher than Gen-1 plantings over the first 6 years of evaluation. In the earliest 2006 replant, FFB yields of 27 mt/ha have been achieved within 8 years after planting.

Keywords: *Oil palm, peat, sustainability, second generation*

INTRODUCTION

Asian Agri has 6 estates in the Labuhan Batu District of North Sumatera, totalling 22,547 ha of which 19,529 ha (87%) are on peat. Four of the six estates are contiguous and located partly on a peat dome of variable depth. Approximately 9%, 31% and 47% of the peat is shallow (< 1m), moderately deep (1-3 m) or deep (> 3 m), respectively.

All six estates were established from heavily logged over forest and planting of first generation (Gen-1) oil palms on raw fibrous peat commenced in 1991 and continued until 2000. However, due to rapid planting of large acreages, coupled with lack of experience and full understanding of peat, mistakes were made in land preparation. Drainage was not well planned and often inadequate and no compaction of peat was undertaken prior to planting. In addition, the "hole in hole" planting technique was only utilized on a limited scale due to the high water table.

In view of the above constraints, initial fresh fruit bunch (FFB) yields were poor especially on deep peat, peaking at 24.4 mt/ha, at 11 years after planting. Better yields ranging from 26-28 mt/ha were recorded in moderately deep to shallow peat plantings. In general, FFB yields started to decline 13-14 years after planting and by 18 years, average yields were less than 15 mt/ha.

The rapid deterioration in yield was attributed primarily to a significant loss in palm stand due to high *Ganoderma* infection and to a lesser extent, termite attack. Toppling or lodging-over of palms due to peat subsidence and periodic flooding of low lying sections of the peat basin were also contributing factors to loss of palm stand and productivity. After just 15-18 years, in many fields, the initial palm stand of 148-150 palms/ha had been reduced to 70-80 palms/ha.

In view of uneconomical yields, early replanting with superior second generation (Gen-2) DxP progenies was carried out with the hard lessons learnt from the earlier failure kept in mind. Right from the start, proper land preparation protocol and best management practices (BMP's) for peat were adopted to ensure that history would not repeat itself.

Replanting was initiated in 2006 (228 ha) but major replanting only commenced from 2010 onwards. Up to end 2014, a total of 12,649 ha had been successfully replanted.

Unlike the Gen-1 plantings, peat compaction was undertaken in the Gen-2 replants to improve bulk density and anchorage, as a counter measure to minimize palm leaning and toppling. Compaction to a depth of 15 cm was achieved by the use of wide tracked excavators making two runs over the area designated for planting rows and harvesters paths.

Greater emphasis and importance was placed on drainage and all aspects of water management. Peat soil depth maps, topography surveys and drain ability assessments were used to guide drainage planning and improve on the existing water management master plan. To minimise flooding and water logging, new field drains were constructed at 1:8 ratio (drains: planting rows) and where ever necessary, their intensity increased to 1:4. For better water retention, additional weirs (drain blocks) were installed in collection drains for every 20 cm drop in water table elevation. Prior to onset of the dry season, temporary weirs were also installed in main drains and water levels in collection drains raised to ± 20 cm from ground surface. This was to ensure that water levels remained in the optimum 40-60 cm level for as long as possible during the dry season. Water level poles (WLP) were also installed in each collection drain for weekly water level monitoring and the data used for implementing appropriate responses. Subsidence poles (SP) were also installed in represented locations to further monitor the impact of water levels and other factors on peat subsidence.

As *Ganoderma* infection was a predominant factor in reducing palm stand in the Gen-1 plantings, a four stage integrated disease management (IDM) system was introduced to minimize the infection risk and impact of the pathogen on the Gen-2 replants (Figure 1).

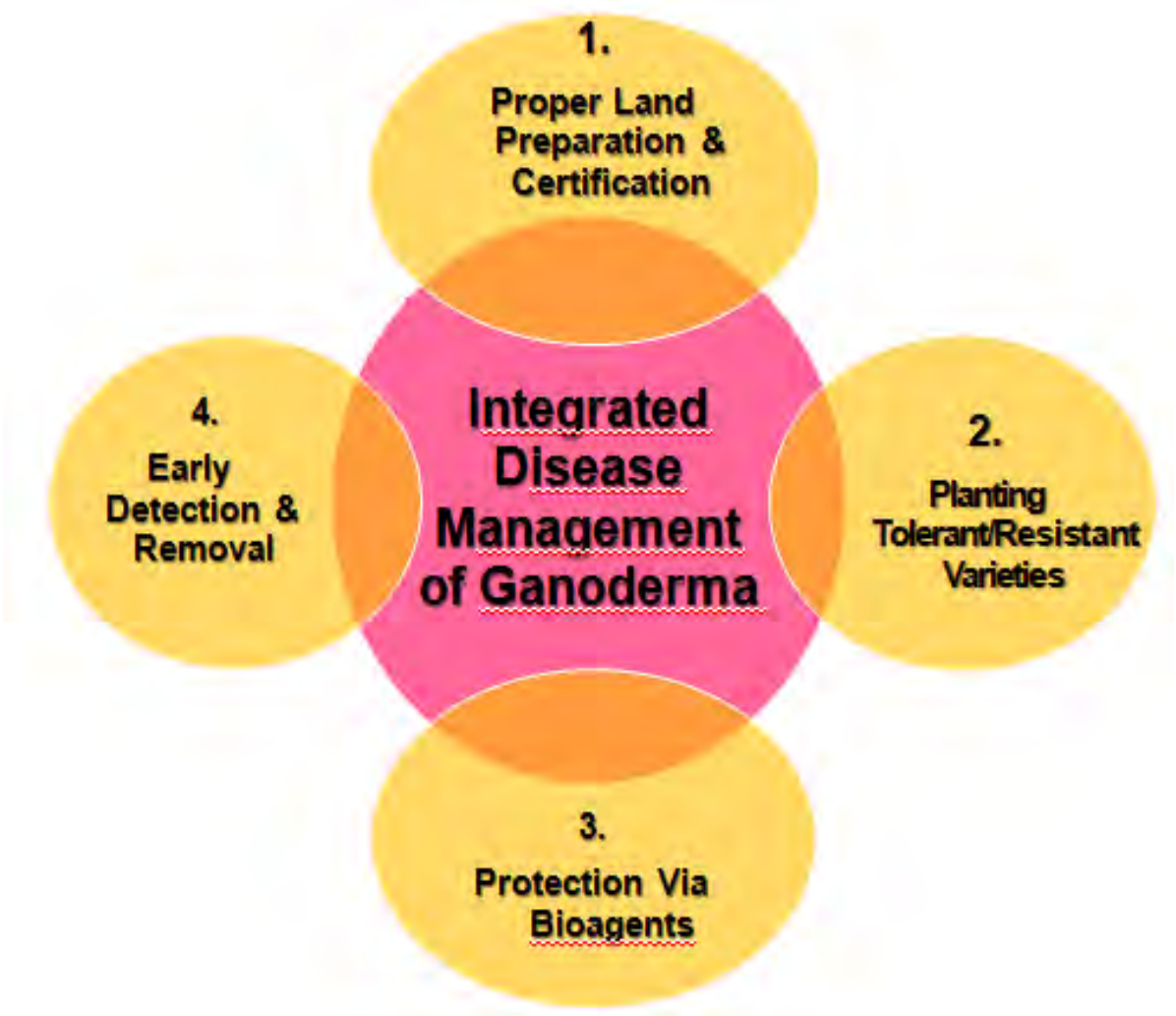

Figure 1: Integrated disease management scheme used in Asian Agri Estates

Stage one involves intensive land preparation with the objective to reduce the residual disease inoculum in the soil. Six months prior to replanting, all identified *Ganoderma* infected palms and dead stumps are dug out to ensure there are no "miss-outs" during the main felling phase. During the latter phase, all remaining palms are felled and their trunks and boles shredded into 10 cm diameter chips by a wide-tracked excavator fitted with a modified chipping bucket. The shredded chips are then spread out in a single layer to facilitate decomposition. Large holes (1.5m width x 1.5m length x 1.0 m depth) are also dug to excavate the remnants of the bole and large roots. The large holes are kept open for a month to expose any residual inoculum to natural UV light prior to being refilled with clean soil. The field is left fallow for a period of six months prior to planting. Planting is only permitted after a field has been certified suitable by a special QC team (certification scheme).

Stage two involves the planting of oil palm varieties with a higher disease tolerance. Both internal and external sources of planting materials are utilized. Since 2011, Asian Agri Research and Development department has screened a total 2,695 DxP progenies and 40 progenies to-date have been identified to have moderate tolerance to *Ganoderma* infection (Figure 2).

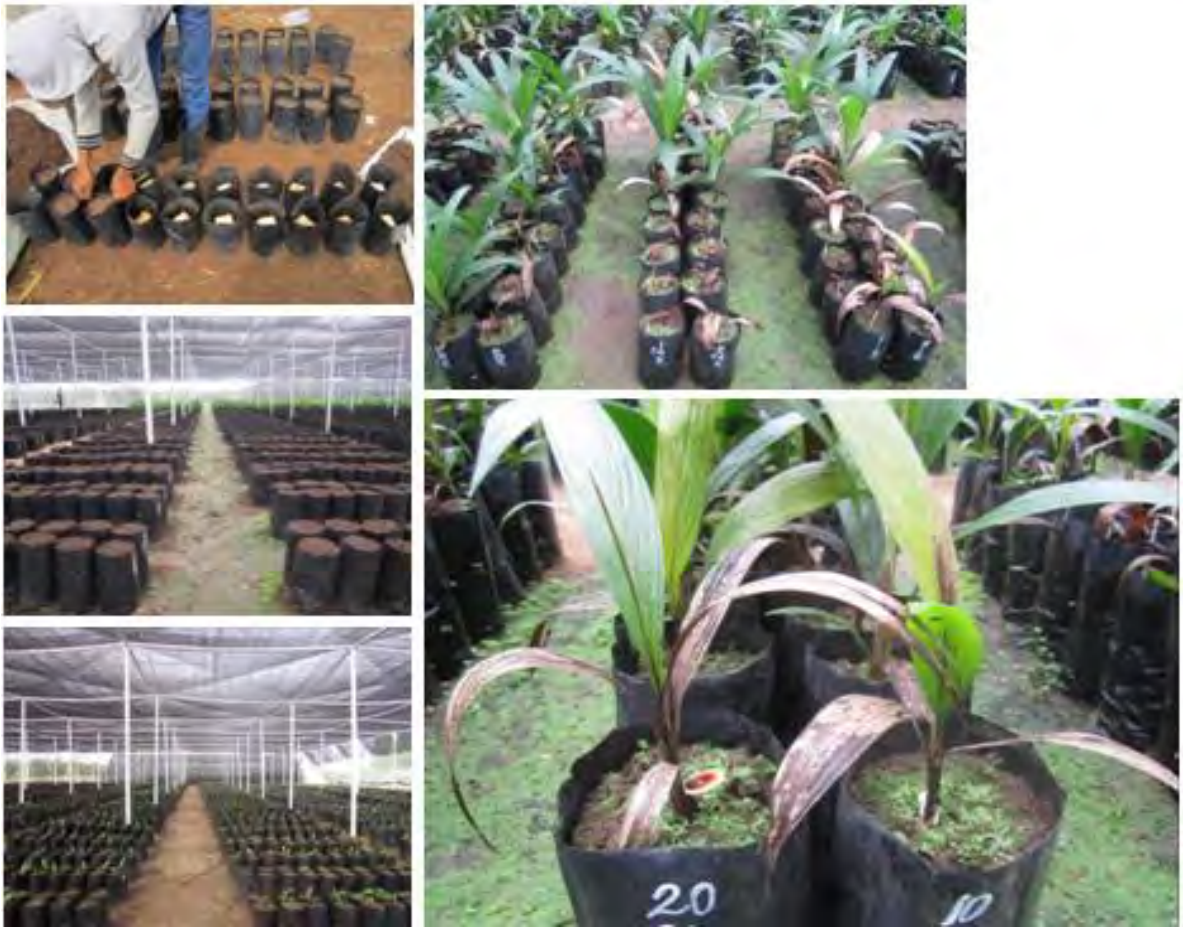

Figure 2: Genetic Screening for *Ganoderma* Resistance

Stage three involves the inoculation and protection of oil palm seedlings with an effective bio-agent. AA R&D has identified and isolated a total of 128 endophytic *Trichoderma* strains which are currently undergoing systematic evaluation in the laboratory, nursery and field for their protective and curative properties. To-date, 4 strains (ET 501, ET 531, ET 537, ET 5119) show good potential, of which ET 501 is being used commercially in AA estates. Inoculation of oil palm seedlings is done in 3 stages i.e. pre-nursery stage, main nursery stage and in the planting holes during field planting of the seedlings.

Stage four of the IDM program involves conducting regular census and early removal of infected palms to prevent build-up of inoculum and spread of the disease. Irrespective of infection levels, a minimum of one census round per annum is carried out in all fields and the census frequency being increased with increasing levels of infection (Table 1). Once an infected palm is detected, it is immediately uprooted. A large hole (1.5m x 1.5m x 1.0m) is dug to remove remnants of the bole and roots. The newly dug hole is left exposed for a month before it is filled with clean soil. The uprooted bole and trunk is cut into five even portions (manual) or shred into 10 cm diameter chips (mechanical) and left in the inter rows to decompose.

Table 1: *Ganoderma* Census Frequency

***Ganoderma* Infection Category**	**Infection Level per Block (30-35 ha)**	**Census Frequency**
Low	Zero infection	1 round/annum
Medium	1-2 palms	2 rounds/annum (6 monthly interval)
High	> 2 palms	3 rounds/annum (4 monthly interval)

Integrated Pest Management (IPM) is also used for managing other potential pests of oil palms planted on peat such as *Oryctes* beetles, termites, *Tirathaba* bunch moth, slugs, rats and other leaf defoliators. Main emphasis is given to the establishment of an early warning system (EWS) together with cultural and biological control methods in order to limit the use of chemical pesticides. The latter includes the planting of beneficial plants along collection roads as habitats for natural enemies, the use of light and fruit traps for trapping moths of leaf defoliators, as well as pheromone traps for controlling the rhinoceros beetle. Barn owls are reared and used for rat control. Naturally occurring viruses and fungi (*Cordyceps, Beauvaria*) are routinely collected, propagated and re-sprayed into the fields to contain outbreaks of leaf defoliators (nettle caterpillars, bagworms), whilst pathogenic isolates of the muscadine fungus, *Metarhizium anisopliae* is currently being evaluated by R&D as a potential tool for Rhinoceros beetle control. Whenever chemical pesticides have to be used, spraying is restricted to specific target sites (e.g. palm Spears for *Oryctes* control) or via selective application techniques (trunk injection, root infusion) to ensure minimum disruption to the eco-system.

As nutrition plays a critical role towards achieving high yields and sustainability of oil palm on peat, two factors required consideration. First, a change in soil fertility due to maturation and mineralization of the peat over time (> 20 years) and nutrient inputs via recycling of the biomass of the Gen-1 plantings (zero burn). Second, the possibility of differential nutrient requirements and optimum nutrient levels of the Gen-2 replants in contrast to Gen-1 planting materials. In view of the above, a network of fertilizer trials has recently been established to determine the macro and micro nutrients requirement of the Gen-2 DxP progenies. For the meantime, available information from in-house Gen-1 trials and the industry, as well as field nutrient surveys are being used to adjust fertilizer programs to maximize palm growth and yields and minimize negative impact on the environment (nitrification and eutrophication).

Another critical factor towards achieving sustainability on peat is improving executive and supervisory staff knowledge, awareness and technical competency on all aspects of peat management (e.g. BMP's suitable for peat, water management, peat subsidence, GHC emission etc). In Asian Agri, this is being done through information and technology transfer via a detailed SOP, field clinics, advisory visits as well as attending relevant workshops, seminars and conferences.

Early yields of the Gen-2 replants have been very promising and are approximately 51% higher than Gen-1 plantings over the same period of time (7 years). In the earliest replant (OP 2006), FFB yields of 27.7 mt/ha have been achieved within 9 years after planting (Table 2).

TABLE 2 : COMPARATIVE PERFORMANCES OF GEN-2 X GEN-1 PLANTING MATERIALS ON PEAT

Planting Materials	Year of Planting	Ha	Average yield/ha (mt ffb) Palm age (years)																			
			3*	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Gen-1	**1991-2000**	**11,718**	**5.1**	**8.5**	**12.7**	**16.1**	**19.7**	**21.3**	**22.9**	**23.6**	**24.4**	**24.2**	**23.0**	**21.6**	**20.2**	**18.5**	**15.6**	**14.5**	**14.5**	**15.0**	**13.6**	**10.6**
Gen-2	2006	228	11.3	19.7	23.7	23.3	25.6	27.3	27.7													
	2010	1,417	11.2	18.4	25.2																	
	2011	2,356	10.7	21.1																		
	2012	2,245	11.6																			
	2006-2012	**6,246**	**11.1**	**20.1**	**25.0**	**23.3**	**25.6**	**27.6**	**27.7**													

* 4-8 months harvesting