Progress Report on Yield Improvement Policy Implementation

1. Introduction

Golden Agri-Resources Ltd (“GAR”) launched a Yield Improvement Policy (“YIP”) on 15 February 2012. The YIP is jointly developed with The Forest Trust (“TFT”) with inputs from stakeholders like Greenpeace, and applies to GAR's total cultivated area including smallholdings.

The YIP is part of GAR's holistic approach to sustainability, which includes the Forest Conservation Policy (“FCP”) and a Social and Community Engagement Policy (“SCEP”) launched in February and November 2011 respectively.

The policy leverages technology and innovation to improve crude palm oil (“CPO”) yield. Increasing productivity enables GAR to produce more palm oil from less land, hence reducing the impact of the palm oil industry on the environment. Higher yields also help improve the livelihoods of smallholders and at the same time alleviate the pressure to open new land.

Under the policy, the Company aims to achieve by 2015 an average CPO yield of 5.8 tonnes per hectare from oil palm trees in the prime age of 7-18 years. This is a 12% increase from the 2010 level.

Chart 1: GAR CPO yield target for oil palm trees in prime age stage

	2010 (Actual)	2015 (Target)
Nucleus	5.2	5.8
Plasma	5.0	5.6
Average	**5.2**	**5.8**

GAR is committed to taking a multi-stakeholder approach toward developing and implementing the YIP. This will include ongoing consultations with the Government of Indonesia, palm oil associations, academics, research institutions, civil society organisations, key players in the Indonesian palm oil industry and local stakeholders. The consultations are aimed at providing a platform for all stakeholders to share experiences and challenges with regards to increasing productivity in the palm oil industry in order to move the industry forward in sustainable palm oil production.

2. Key performance areas

For our first progress report on the YIP, we are evaluating and reporting our performance against the policy in the following areas:

2.1 CPO yield
  a. Average CPO yield for GAR
  b. Average CPO yield for smallholders
  c. Average CPO yield for oil palm trees in prime age stage

2.2 Planting material
  a. Conventional breeding
  b. Tissue culture
  c. Biotechnology

2.3 Soil fertility and mineral nutrition management
  a. Organic fertilisers
  b. Chemical fertilisers

2.4 Pesticide use and natural pest control
  a. Biopesticides
  b. Chemical pesticides

3. CPO Yield

The policy builds on our early success of improving yield, which has been consistently above the Indonesian industry average for many years.

3.1 Average CPO yield for GAR

GAR has been leading the industry in palm oil productivity.

In 2012, GAR achieved record production of fresh fruit bunches (“FFB”), with an average CPO yield of 5.26 tonnes per hectare. This strong performance was supported by favourable weather conditions and expansion of mature areas. Production in 2013 was impacted by the palm tree’s biological cycle following the bumper crop in 2012 and dry weather in certain areas of our plantations.

Chart 2: GAR CPO yield compared to the Indonesian industry (tonnes/ha)

Year	2010	2011	2012	2013
GAR	4.70	5.02	5.26	4.76
Indonesian Industry[1]	3.88	3.94	4.05	4.01

[1]*Source: Oil World Annual 2014. ISTA Mielke GmbH, Germany* *www.oilworld.de*

3.2 Average CPO yield for smallholders

Our ongoing collaboration with smallholders has been successful.

In 2012, the CPO yield of our smallholders reached a record 5.51 tonnes per hectare.

Chart 3: GAR smallholder CPO yield compared to the Indonesian smallholder average (tonnes/ha)

Year	2010	2011	2012	2013
GAR smallholders	4.92	5.42	5.51	4.65
Indonesian smallholders[1]	3.33	3.29	3.24	3.29[2]

[1]*Source: Indonesian Palm Oil in Numbers 2013, Indonesian Palm Oil Commission*
[2]*Preliminary figure*

3.3 Average CPO yield for oil palm trees in prime age stage

In 2012, the yield of oil palm trees in prime age reached an average of 6.06 tonnes per hectare, exceeding our 2015 target of 5.80 tonnes per hectare by 4%. The yield decreased to 5.58 tonnes per hectare in line with the lower FFB production in 2013 as mentioned in section 3.1.

Chart 4: GAR CPO yield for oil palm trees in prime age (tonnes/ha)

Year	2010	2011	2012	2013	2015 (Target)
Nucleus	5.23	5.62	6.21	5.58	5.80
Plasma	5.02	5.54	5.71	4.78	5.60
Average	**5.16**	**5.60**	**6.06**	**5.36**	**5.80**

4. Planting material

In the palm oil industry, planting material is recognised as the most critical factor in maximising yield potential. International Cooperation Centre in Agronomic Research for Development (“CIRAD”), a French research organisation specialising in tropical crops, estimated that the industry’s palm oil breeding programme has resulted in a yield potential increase of 10% per decade between 1960 and 2000.

GAR has been using the high-yielding Dami Mas seeds in new plantings and replantings since 2002, which will help boost production growth. As at end 2013, 38% of our total cultivated area used Dami

Mas seed.

The high-yielding Dami Mas seeds were developed through stringent and robust breeding experiments conducted by SMART Research Institute (“SMARTRI”). Producing our own Dami Mas seeds also provides seed security and genetic purity in our seed supply.

Besides yield potential, GAR recognises the importance of improving disease resistance, drought tolerance and nutrient efficiency to enhance the sustainability of the palm oil industry.

GAR embarked on its oil palm breeding programme in early 2000. Our oil palm breeding and selection programme employs three main approaches: conventional breeding, tissue culture and biotechnology. The results of some of our breeding trials are described in sections 4.1 and 4.2 below.

4.1 Conventional breeding

GAR’s conventional plant breeding programme involves the introduction and introgression of novel genes from other genetic sources to boost the genetic biodiversity of palms. As part of the programme, we have acquired wild germplasms from Cameroon and Angola. These accessions have been planted in the fields and have started to bear fruit bunches. Our research scientists are monitoring and studying the genetic variations in these populations and are confident that some novel traits of oil quality, growth habits (such as slow vertical growth), disease and drought tolerance will be discovered and later used in our oil palm improvement programme.

The main objectives of our breeding programme are to develop oil palms that are hardier and more disease- and pest-resistant. Currently, Basal Stem Rot disease caused by the fungal pathogen Ganoderma sp. is the only disease threatening the oil palm industry in Southeast Asia. Higher incidences of this disease have been observed in successive replantings of oil palm. GAR has not spared any breeding efforts in its search for a Ganoderma-tolerant oil palm variety. Screening of our mother palms through the artificial inoculation technique has enabled us to select candidate mother palms for the production of Ganoderma-tolerant palms.

In August 2013, GAR produced candidate Ganoderma-tolerant seeds following more than seven years of intensive research involving extensive screening of germplasm through the artificial inoculation technique followed by validations in the field. Stringent selection criteria were employed to identify progenies of a high and consistent index of tolerance. These seeds will be used in areas showing endemic symptoms of Ganoderma infection. Long-term observations for field validation are being carried out.

4.2 Tissue culture

GAR’s tissue culture programme which was initiated in 2007 has been encouraging, yielding our first semi-commercial planting of oil palm clones in 2011. These clonal palms have now begun bearing fruit bunches. Out of 3,046 ramets (seedlings) from 26 clones planted in a series of three trials in 2011, only three cases of slight mantled fruit abnormality have been encountered. The abnormality syndrome has been the bane of oil palm tissue culturists in the past.

By end 2013, around 1,200 ha of our estates have been planted with clones at various locations in order to test their performance in semi-commercial conditions, in areas such as abnormality, productivity and adaptability to the environment.

In November 2013, the Company officially launched a new laboratory near Jakarta, dedicated to tissue culture and research in biotechnology.

4.3 Biotechnology

We have been an active participant in the Oil Palm Genome Project (“OPGP”), a worldwide initiative by a consortium of 16 reputable research organisations from seven countries. The project uses molecular biology as a tool to support conventional breeding. The main objective is to map the entire genome spectrum of oil palm varieties, including identification of specific traits such as disease resistance, drought tolerance, superior quality oil and high yield.

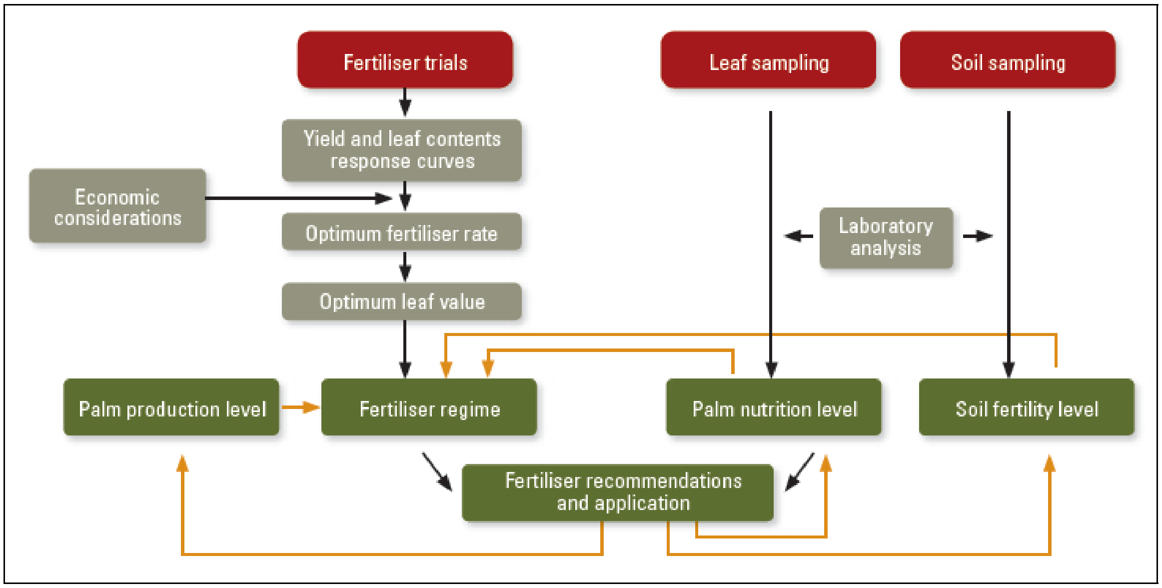
The first phase of the project started in 2009 and has produced terabytes of DNA information. Bioinformatics is used to decipher these data to provide useful information for biotechnology and plant breeding. OPGP will be entering its second phase in 2014.

As an active participant in OPGP, we have formed a dedicated team in our biotechnology division, and our staff have been involved in related research activities in Spain and France. Our participation in the project has helped the Company make advances in the biotechnology field, ultimately providing the tools and solutions for the implementation of molecular assisted selection. A breeding cycle of the perennial oil palm takes about 10 years and an average yield increase of 10% per cycle has previously been reported. The new biotechnological tools will ensure more rapid and better advancements in the sustainability of the oil palm, with higher yields complemented with improvements in other secondary oil palm traits.

5. Soil fertility and mineral nutrition management

GAR implements best agricultural management practices that maintain and enhance soil fertility through a comprehensive mineral nutrition management plan. The objective is to minimise the quantity of fertiliser applied, while still enabling the oil palms to attain their full productive and economic potential, and to reduce the associated risk of soil degradation posed by agricultural practices.

Chart 5: GAR's mineral nutrition management system



The evaluation of soil fertility includes considerations of the physical, chemical and biological components of the soil, and most importantly the interactions among these three key components. Scientific knowledge on the interactions of the three components is currently scant, hence comprehensive appraisal of the overall fertility of the soil and its trend is lacking.

To further improve the nutrition management in our plantations, SMARTRI has embarked, on a dedicated research programme for a holistic approach of soil fertility evaluation, in collaboration with CIRAD.

The objective of the research programme is to minimise the use of mineral fertilisers while still optimising the yield performance of the palms. One main outcome is to develop an indicator for global detailed soil fertility status. The findings will be useful, for instance, in optimising the application of organic fertilisers generated from the recycling of our organic by-products including palm oil mill effluent ("POME") and empty fruit bunches ("EFB"). Although the recycling of organic by-products has been integrated in our soil fertility and mineral nutrition management system, we believe that there is room for improvement. Our hypothesis is that a synergy of efficient organic and mineral fertilisations will improve overall mineral nutrition management.

In 2012, we took the first step to investigate the spatial variability of several parameters of soil fertility and their relationships. Analysing the biological component of soil fertility, the abundance and taxonomy of soil biota (macro-fauna such as earthworms, nematodes, and microbial communities) has been studied in relation with the physical and chemical traits of the upper layers of the soil in two mineral nutrition management systems – a full mineral fertiliser usage and the organic waste recycling of EFB. This is an important step as such knowledge is necessary for subsequent studies to be interpreted without bias.

The results confirm the spatial variability of several chemical and physical characteristics of the soil, while other physical properties tested during the study were relatively homogeneous. In addition, we discovered that the application of organic products results in a change of this spatial variability, with more earthworms found underneath the EFB applications area, while in a conventional system, earthworms are dominant in the circle close to the palm trunk. However, there is an evolution with time based on the decomposition process of the EFB after their application on the soil. An additional finding of the study indicates that based on a standard qualification index used by scientists, the nematode population can be characterised as “more mature” in the EFB area compared to conventional management. The consequence of these differences for soil fertility remains to be studied.

5.1 Recycling of production wastes as organic fertilisers

GAR recycles almost all the biomass and organic by-products (pruned fronds, EFB and POME) from our plantations and mills as organic fertilisers. This practice is fully integrated in our fertiliser management plan, and helps reduce the use of mineral fertilisers by about 12-13 % in overall quantity.

- **EFB** are primarily applied as extra soil amendments (or soil conditioners) when the original soil fertility is poor. The remaining EFBs are used in the field as a substitute for mineral fertilisers.

- **POME** is applied in the field as a substitute for mineral fertilisers.

- **Composting of EFB and POME** is also applied in the field as a substitute for mineral fertilisers. About 6% of EFB and 6% of POME produced have been converted into compost which is subsequently applied in the field as a substitute for mineral fertilisers.

Chart 6: Recycling of organic by-products as organic fertilisers

Waste	Quantitiy produced (tonne or m^3)				Quantity recycled (tonne or m^3)			
	2010	2011	2012	2013	2010	2011	2012	2013
EFB	1,875,000	2,000,000	2,240,000	2,115,000	1,500,000	1,800,000	2,050,000	1,945,000
POME	6,000,000	6,100,000	6,900,000	6,545,000	4,500,000	6,000,000	6,750,000	6,480,000

Currently, we are monitoring 14 experiments either at the nursery stage or in the field to optimise the use of organic by-products from our mills. There are another 12 experiments being carried out to study the impact of these by-products (either applied fresh or after co-composting) on the performance of the oil palms and the quality of the soils under different application conditions.

Co-composting of EFB and POME is an attractive solution for waste management and chemical fertiliser substitution. However, nutrient losses are observed during the composting process (when calculating the nutrient balance during process). We are investigating this nutrient loss in order to optimise the efficiency of the composting technique.

5.2 Commercial organic products

As part of our efforts to reduce the use of mineral fertilisers, GAR is committed to using organic products when their cost, quality and quantity available in the market meet the company’s requirements of achieving high and sustainable productivity.

SMARTRI has been testing a range of organic products as a substitute for mineral fertilisers or at least to increase the efficiency of mineral fertiliser when used in combination.

To date, we have tested nine commercial products in experiments in commercial trials conducted either in nurseries or in the field. These products include humic acid fertilisers, commercial bio-fertilisers containing soil-borne microbes as well as commercial organic products derived from organic wastes. To date, none of the trials involving humic acid fertilisers and bio-fertilisers have shown positive results, while the organic waste products have inconsistent effects on the performance of the palms. We are conducting further tests and evaluation to confirm these findings, while also testing new products.

5.3 Chemical fertilisers

The use of organic by-products alone is usually not sufficient to maximise the potential of the palms as the palms require a different balance and amount of nutrients compared with what the biomass and by-products contain. Consequently, site specific management is required to adjust the rates, and occasionally, the combination of organic and inorganic fertilisers based on the results of a network of reference fertiliser trials.

Since 1996, the Company has adopted a more scientific and comprehensive methodology for establishing the annual fertiliser regime of the palms, combining close monitoring of the mineral nutrition status of the palms with scientific field experimentation. The type of fertilisers used was adjusted to the condition of the palms and the suitability of the land.

This site-specific fertiliser application plan involved foliar (leaf) and soil samplings together with general field condition assessment, to analyse the status of each 30-hectare block of our estates and to ascertain the optimum nutrients required.

As part of our commitment to reduce the use of mineral fertilisers, the type of fertiliser applied is based strictly on the nutritional status of the palms, monitored annually through leaf tissue analysis. Typically, soluble fertilisers are used when the nutrient levels in the palms are sub-optimal as nutrients are readily available to enhance uptake by the palms, and less soluble forms with slower release of nutrients when high leaf nutrient levels are observed. Optimal levels are determined through a network of reference trials.

6. Pesticide use and natural pest control

Since the early development of our operations, we have advocated the use of an Integrated Pest Management ("IPM") approach on our plantations to minimise the use of pesticides and mitigate the possible impact of pest control on the environment. IPM is an environmentally sensitive approach to pest management that combines cultural, mechanical, biological and chemical means to control pests while minimising economic, public health and environmental risks.

Pesticide use is minimised throughout all growth phases of the palms. The preferred method is to deploy biological controls. Chemical fungicides are only used in nurseries, Chemical insecticides and rodenticides are deployed only to control outbreaks of infestation when biological controls are not successful. In such cases, these products are used carefully in compliance with national laws. Most pesticides used are chemical herbicides as part of our weed control and management. To minimise the use of herbicides, they are applied according to our stringent standard operating procedures based on temporal, spatial and product selectivity:

- **Temporal selectivity**

  Application is done at a specific time based on weed growth and weather conditions to reduce the number of applications to once to thrice a year depending on the type of herbicide.

- **Spatial selectivity**

  Only the circle of the palms and harvesting path, or about 20% of the soil surface, are sprayed to control certain noxious weeds such as woody re-growth and ferns such as Stenoclena.

- **Product selectivity**

  The type of herbicide (or active ingredient) used is chosen to make an application compatible with conserving an under-storey of plants to cover the soil (see section 6.2 for additional information).

6.1 Biopesticides

The use of biopesticides as part of our IPM programme helps us reduce the use of conventional pesticides.

Biopesticides are pesticides derived from natural materials such as animals, plants, bacteria and certain minerals. They are usually inherently less toxic than conventional pesticides and generally affect only the target pest and closely related organisms, in contrast to broad spectrum conventional pesticides that may affect organisms as different as birds, insects, and mammals. Also, biopesticides often decompose quickly, thereby resulting in lower exposures and mitigating the pollution problems caused by conventional pesticides.

In the last three years, our use of biopesticides has been adjusted according to pest situations in the field.

Chart 8: Biopesticides used in GAR plantations

Type of biopesticides	Quantity used (kg)			
	2010	2011	2012	2013
Bacillus thuringiensis	94	8	107	16
Cordyceps	2,929	559	841	5,943
Mycorhyza	106,460	95,094	80,263	91,063
Trichoderma	58,336	46,136	128,015	131,236
Virus	37	0	0	0
Total	167,856	141,797	209,226	228,258

6.2 Chemical pesticides

We use only approved and registered agrochemicals permitted by the Ministry of Agriculture. Pesticides that are categorised as World Health Organization Class 1A or 1B, or that are listed by the Stockholm or Rotterdam Conventions, are not used, except in specific situations identified in national Best Practice guidelines. The use of such pesticides shall be minimised and eliminated as part of a plan, and shall only be used in exceptional circumstances in ways that do not endanger health or the environment.

We are committed to implementing tight control over the use of such chemical pesticides. We have been researching and applying alternative methods to protect palms from weeds, pests and diseases in order to reduce herbicides, rodenticides and insecticides.

Our strategy to reduce and eventually phase out pesticides such as paraquat is based on a three-phased approach:

1) Scientific field trials to test new methodologies and/or active ingredients;
2) Pilot projects to test the feasibility of such new methodologies or approach;
3) Commercial roll-out upon achieving positive results.

Several research programmes are dedicated to seeking new ways to reduce the use of pesticides.

- A new approach tested by the company to help reduce the quantity of pesticides used is based on a higher level of weed selectivity when using such products. While positive results have been achieved at a small scale research level, less promising results have been observed so far at a pilot project on a larger scale. Training of field workers is required to implement this approach more effectively. New tests are being planned.

- New molecules, known to have a lower environmental impact, and biological alternatives are being tested as substitutes for pesticides. Studies on this are ongoing.

We also study the use of rodenticides. Over the last 20 years, GAR has made use of the “eco-service” of barn owls in its plantations to control the population of rats. While a very high success rate of this practice is observed in most parts of Sumatra, barn owls are either less efficient or have difficulties in settling down in immature palm plantations as well as in several other regions.

A comprehensive study on managing the rat population in our plantations was initiated several years ago in collaboration with CIRAD, with support from Besançon University in France, which specialises in rodent studies, and the Museum of Natural History of Paris. By characterising the type and population of rats, the study seeks to identify other natural predators, in particular small carnivores that could contribute to rat control. Our preliminary findings indicate that naturally occurring small carnivores could play a significant role in the control of the rat population in some regions. We are now studying the importance of the habitats of such predators within our plantations. Camera traps have been installed in our plantations to identify and quantify such predators, as well as the level of fauna biodiversity in plantations.

We are also studying the efficiency of ecosystem services provided by several beneficial plants in controlling herbivores (e.g. leaf-eating caterpillars). Preliminary findings indicate a decreasing positive impact of the beneficial plants with increasing distance from these plants. These findings will help us test new field practices to optimise the use of these plants.

Chart 9: Active ingredients in pesticides used in GAR’s plantations

Type of pesticides	Quantity used per year (kg or litre/ha)				Quantity used per year (kg or litre per tonne of CPO produced)			
	2010	2011	2012	2013	2010	2011	2012	2013
Acaricides[1]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fungicides[1]	0.004	0.008	0.005	0.005	0.001	0.002	0.001	<0.001
Herbicides	0.327	0.397	0.510	0.471	0.076	0.084	0.097	0.084
including Paraquat	*0.083*	*0.100*	*0.133*	*0.115*	*0.019*	*0.021*	*0.025*	*0.020*
Insecticides	0.001	0.001	0.002	0.005	<0.001	<0.001	<0.001	<0.001
Rodenticides	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total	0.333	0.407	0.518	0.481	0.077	0.086	0.098	0.086

[1]*Used only in nurseries*

In 2012, the use of herbicide including paraquat increased to 25 grams per tonne of CPO produced, up from 21 grams per tonne of CPO produced in 2011. We resorted to using paraquat to eliminate a severe outbreak of woody weeds in remote West Kalimantan. Coupled with an acute labour shortage, our standard manual weed control methods did not achieve satisfactory results during the outbreak.

For the medium and long term, to reduce the use of chemical pesticides, we will continue our research and adoption of breeding methods to ensure that our oil palms are hardier and more disease- and pest-resistant.

7. Conclusion

We are committed to continuous improvement as best practices evolve. We adopt an open learning approach to develop and share these developments with our smallholders.

In particular, we recognise the concerns over the use of chemical fertilisers and pesticides. Over the long term, through collaborating with national and international institutions, we will continue to research and investigate ways to phase out the use of such chemicals. We will then implement these solutions together with other key players in the industry.

We commit to evaluating and reporting our performance regularly against our YIP in an open manner through our website, annual sustainability report and ongoing engagements with key stakeholders.

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