AAR NEWSLETTER

OCTOBER 2015

Inside…

A Message from the Editor

As I skimmed through the past AAR newsletters, I came to know that over the last 28 years, AAR's Editorial Team has produced 60 issues with the current one marking the 61st issue. Hence, it gives me great honour to be able to contribute to this issue and to be apart of its history. With every issue, we have shared scientific articles written by our fellow colleagues (both past and present). All of the articles consist of published works and hence exemplifying our commitment to carry out research in agricultural crop sciences but importantly, in sharing our findings amongst our readers. For this current issue, we have selected two articles. The first, written by Chen Zi Yan, covers the application of UAV captured images and the development of an in-house computer system (CAPTURS), enabling automation of palm counting. Without a doubt, the advancement of technology has revolutionised our lives and it continues to do so. CAPTURS is capable of improving palm counting productivity by 60-fold compared to the current method of manual palm counting (from the ground). Our 2nd issue, written by Cheah Li Wen, covers carbon stocks in the oil palm ecosystem – a topic deemed important in today's current affairs pertaining to oil palm sustainability. I hope you enjoy our selection of papers and if you wish to obtain our past newsletters, you can access them (all 61 issues) via our website (http://www.aarsb.com.my/aar-newsletters).

Ezwan R.

" To be Internationally Recognized as the Premier Centre for Research & Development offering excellent Products and Services in Tropical Plantation Tree Crops"

Acknowledgement

The editorial team wishes to express their gratitude to our contributors who made this issue possible.

CAPTURS : AN AUTOMATIC PALM TREE COUNTING SYSTEM

Chen Zi Yan

Introduction

Accurate palm density records are important for estate managers to monitor the yield productivity of their land and correctly estimate the cost of inputs such as fertilizer. The current practice of palm census is carried out on the ground and physically counting the number of standing palms. However, manual counting in a large plantation can be tedious, costly and slow depending much on the terrain and prevailing weather conditions as well as the availability of reliable workers. The result is subjected to human error and often difficult and near impossible to verify. The availability of Unmanned Aerial Vehicle (UAV) images provides a better alternative.

UAV was initially developed exclusively for military purposes. With the advancement in technology and reductions in prices of both hardwares and softwares, the use of UAV or drones by civilians for applications such as vegetation monitoring is becoming common. Recent developments in UAV technology has also enabled the acquisition of very high resolution optical data or images, possibly finer than 1 cm per pixel, allowing features like buildings, roads, vehicles and individual trees to be visualised clearly.

The need for physical counting on the ground can be partially or completely eliminated while the speed of counting can also be accelerated with the help of high resolution UAV images which clearly details out individual palms for counting purposes. The result can also be easily verified with repeated counting. The productivity can be increased by at least 10-fold compared to physical counting on the ground. To further improve the productivity, image processing techniques such as 'supervised-classification' and 'feature-extraction' can be used to differentiate the object of interest (e.g. oil palm) from other features (e.g. grassland, road and building). By computing the vegetation index of pixels and defining a threshold value to differentiate between the object of interest against background featueres, the palms can then be identified and counted automatically. However, classification and identification of objects on UAV images using pixel based analyses can still be difficult. The limited spectral sensors (confine to RGB and NIR) of available cameras for use with UAV can be a constraint. This is because the spectral responses of some objects, for instance mature leguminous cover crop and oil palm within these spectral bands can be pretty similar. Individual palms with overlapping canopies can also be difficult to differentiate. Moreover, the analysis and processing techniques involved often can only be performed by experienced GIS specialists.

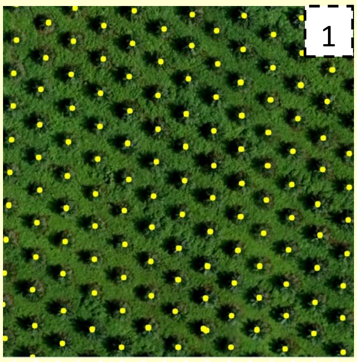
Due to the above limitations, we have developed an in-house computer aided counting system, Computer Aided Palm Tree Visual Recognition System (CAPTURS) which applies pattern recognition techniques to automatically detect individual oil palms on images captured with UAV. CAPTURS has a simple user-interface which can be operated even by those unfamiliar with computers to automate the counting process with high accuracy of close to 99%. Uncounted and double-counted palms in difficult areas i.e. old mature palms or grassy fields can be easily verified and corrected when necessary. Classification through pattern recognition is able to recognize pixels which exhibit certain regularities or patterns and their relationships and group them into an object. The technique is also not hindered by the number of sensors available with the camera used to capture the images.

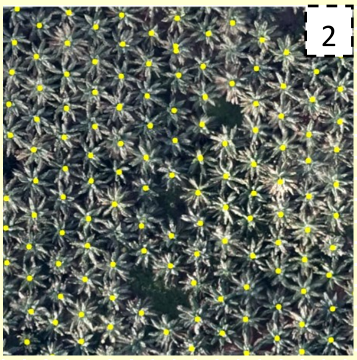
Performance of CAPTURS in Palm Counting

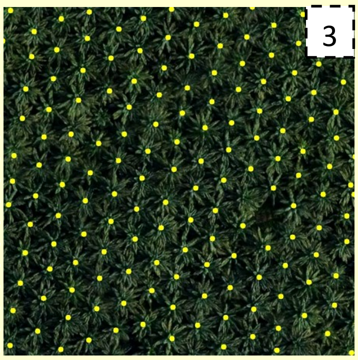
The performance of CAPTURS in palm counting are shown in Table 1. The four images (Figure 1, 2, 3 and 4), covering four different fields of different planting ages were captured using UAV at 15 cm pixel-resolution. The results of the automatic counting were validated by comparing with the results of visual-based manual counting of the images. The accuracy of the automatic counting is as high as 99.9% in the immature field and slightly lower in the mature fields. The system was able to detect oil palm with either dense or overlapping

Table 1: Performance of CAPTURS in oil palm tree counting

Figure	Age of Planting (Year)	Number of trees counted visually	Number of trees counted automatically	Counting accuracy (%)	Correctly spotted by the system	Wrongly spotted by the system	Missed by the system
1	3	4229	4226	99.9	4194	32	35
2	8	3270	3175	97.1	3085	90	185
3	10	4396	4243	96.5	4193	50	203
4	19	4298	4192	97.5	4108	84	190







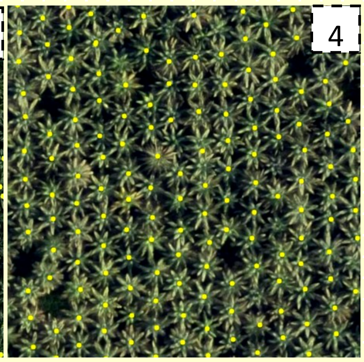


Table 2: Comparison of productivity between different palm counting methods

Method	Productivity (ha/manday)	Accuracy
Physical Counting	5	Moderate to Low
Image-based Visual Counting	100	High
CAPTURS + Visual Verification	300	High

canopies which are not readily discernible with the conventional classification methods. The errors and discrepancies occurred in the counting process were mainly due to poor image quality and abnormal canopy sizes which are either too big or too small. These can be easily verified and corrected manually.

The productivity of automatic palm counting using CAPTURS (with visual verification and correction), including the image processing time is found to be 50 times higher than the manual ground counting, and 5 times higher than the image-based visual counting method.

Conclusion

The new system, as presented in this article can be used for automatic oil palm tree counting on high-resolution UAV images. The accuracy of the counting can be as high as 99.9% depending on the quality of images used. The productivity can be improved to 60 times higher than that of the physical counting on the ground. In line with labour shortages, increasing cost of labour and resources, this automatic counting method is likely a good solution to problems and limitations associated with the conventional physical counting method. The future development of the system will be focusing on automatic identification of canopy size, nutrient deficient palms and possibly nutrient levels of individual palms.

Acknowledgement

The author wish to thank Mr. Tey Seng Heng for his useful comments in the preparation of this article.

POTENTIAL CARBON STOCK AND MANAGEMENT OF CARBON IN OIL PALM PLANTATIONS ON MINERAL SOILS

L.W. Cheah, H.H. Gan, K.J.Goh

Introduction

Oil palm contributes to 33% of vegetable oil and 45% of global edible oil production (Singh *et al.* 2013) despite being cultivated on only 1% of farmed land or 5% of vegetable oil acreage worldwide (Singh *et al.* 2013). This remarkable performance is unmatched by any other oil crops cultivated worldwide. Its advantage as an oil crop lies in its price competitiveness, ease of management, versatility, relatively low conversion to biodiesel and high oil yield.

In view of increasing environmental concerns regarding the expansion of oil palm plantations into new (logged-over or degraded forest) areas, many key players in global palm oil production are now implementing various measures to uphold the central concept of sustainable oil palm production especially in upstream processes. One method is by measuring or estimating carbon stock within the plantation or estate. Data from fertilizer response and maximum yield trials (Kee *et al.* 1999, Teoh & Chew 1988) on mineral soils in commercial plantations were used to estimate the production and stock of carbon (C) contained in oil palm biomass and ecosystem. This paper briefly outlines the main principles behind carbon production and stock within a mature oil palm estate on mineral soil, with emphasis on maximising C stock in plantations within the 25-year economic cycle.

Carbon production

The carbon production of oil palm can be defined as the carbon required for the development of canopy, stem, root, fresh fruit bunches and male inflorescences (Melling *et al.* 2008). The main drivers of carbon production are dry weight of frond 17 and frond production (Goh 1992), which are used in the AAR model to compute the annual production of dry matter. Dry matter of the stem and roots were calculated using mathematical equations, based on assumptions in previous publications (Goh 1992, van Kraalingen *et al.* 1989). The fresh fruit bunches per palm were recorded at about 10 day intervals while male inflorescences per palm were counted quarterly. The carbon concentration of vegetative dry matter and fresh fruit bunches were 47 and 57%, respectively. The latter higher carbon concentration was to account for the oil in fresh fruit bunches. Carbon production in fronds increases rapidly within the first 4 years when the canopy is growing rapidly in size and declining upon canopy closure. Carbon production in stems and roots are constant for mature oil palm. Carbon is also produced in other parts of the palm such as male inflorescences and dead roots although the contribution of these sources to total carbon production is small.

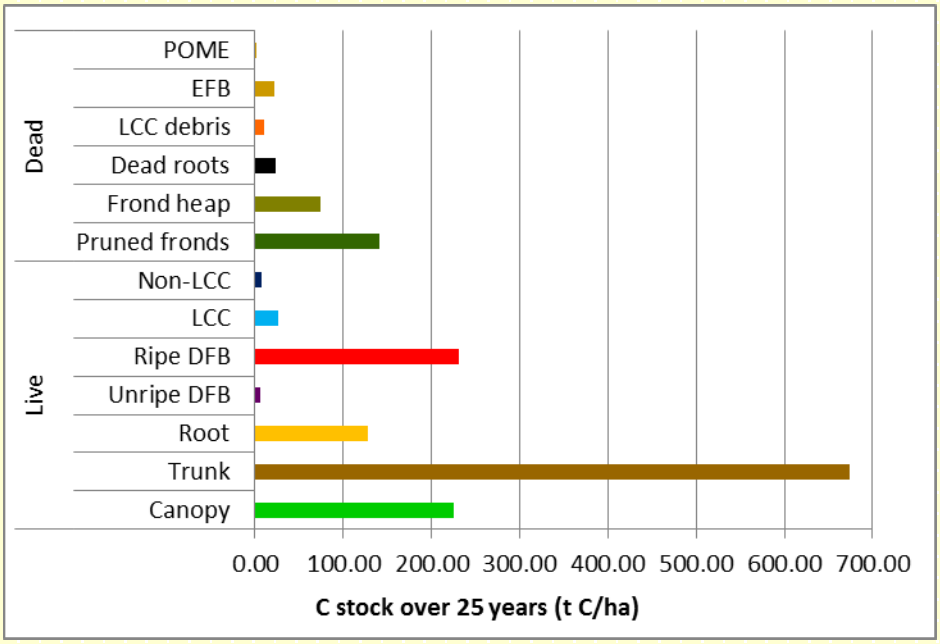
Carbon stock

Carbon stock in agricultural systems is best defined as the amount of carbon contributed by the crop into the stable soil organic carbon (SOC) pool. Unlike annual crops, oil palm does not die down every year. Hence, within its economic lifespan (e.g. 25-30 years for the oil palm), living biomass acts as important stocks before the carbon is returned into the soil upon senescence and decomposition. Many discrepancies exist in the computation of carbon stock within oil palm agroecosystems done by various authors, such as differences in the specific planting density and local environment, inclusion/exclusion of FFB, male inflorescences, frond base biomass (FBB) and non-palm contributors like legumes and groundcover (Henson *et al.* 2012).

Nevertheless, according to our computations, oil palm plantations potentially accumulate up to approximately 1570 t C ha^{-1} over 25 years when good agricultural practices are carried out (**Table 1**). To our knowledge, this amount is unmatched by any other commercial agricultural food crop. However, whether all of this carbon is retained is uncertain, although numerical validations of the AAR carbon model are similar to estimates by other authors. It is important to note that C stock of dry fruit bunches (DFB) should be accounted for because in computing carbon stock in natural

TABLE 1. POTENTIAL CUMULATIVE CARBON STOCK IN AN OIL PALM AGROECOSYSTEM OVER 25 YEARS

Component	C stock (t C ha^{-1})
Canopy	225.40
Trunk	673.72
Root	127.49
Unripe DFB	6.07
Ripe DFB	231.43
LCC	26.70
Non-LCC	7.82
Pruned fronds	141.0
Frond heap	73.51
Dead roots	23.77
LCC debris	9.94
EFB	21.79
POME	0.58
Total	1569.32



*EFB and POME application rate is based on all EFB and POME generated from the ripe DFB produced per hectare

ecosystems, the contribution from reproductive structures is not excluded. The C from FFB is merely transferred into another ecosystem upon harvesting, and not necessarily 'lost' to the atmosphere. The C stock in male inflorescences has not been estimated, but presumably would increase C stock only slightly due to rapid decomposition in the field. The significance of legume C stock is presumed to be only temporary (only within first 4-5 years) as most of the dry matter does not persist for very long except for *Mucuna bracteata* and *Calopogonium caeruleum* (Goh & Chiu 2007, Ng *et al.* 2006).

Oil palm biomass is relatively conserved throughout every planting cycle. Mathews *et al.* (2010) showed that SOC was higher in the second and third cycles (oil palm to oil palm) by 32 and 47% compared to the first cycle (logged jungle to oil palm). A higher buildup of SOC was found in deeper soil layers rather than the top 15cm depth, which could be explained by higher contribution of primary roots, although the rate of increase is slow (Fearnside & Barbosa 1998).

Maximising carbon stock in oil palm plantations

As shown and discussed in the previous sections, incorporation of good agricultural practices (GAPs) such as zero burning, cover crop establishment, retention of non-competitive ground vegetation, terracing and recycling of crop residue will help in

Best management practice for vigorous legume cover (especially *Mucuna bracteata*) during the immature period will maximise return of C into the soil.


Maximizing return of C into the soil via good pruning practices and application of EFB

increasing the amount of carbon produced and retained within plantations. Estates should be maximising carbon input into the fields to reap the benefits of increased SOC. Thus, firstly, zero burning should be practiced where applicable. During replanting, fast growing legume, *Pueraria javanica*, and shade-tolerant legume covers, *Calopogonium caeruleum* and/or *Mucuna bracteata,* should be planted at the optimum density to maximise input of organic matter into the soil. Estates should also be vigilant about pest and disease such as bagworm outbreaks, rhinoceros beetle and *Ganoderma* disease to minimise losses to the canopy and palm stand. The beneficial fern *Nephrolepis biserrata* or low soft grasses should be maintained under mature palm stands by selective-spraying of only noxious weeds. Frond stacking should be preferably widened instead of a narrow band to maximise input of SOC as well as reduce soil erosion and loss of soil C. Wherever practical and economical, estates should also utilise mill by-products as fertiliser supplements or substitutes and build-up SOC.

Ripe fruit bunches comprise a significant but mobile of C that moves from the plantation system to other systems (mill and downstream to the

Most of all, the palm growth and production should be maximized as they are the largest C stock and contributor to SOC in the plantation. Further work is however necessary to optimize the conversion of various sources of C to SOC and retain them in the soils preferably within the plantation.

Conclusion

In conclusion, carbon production and stock in oil palms is very large over the economic lifespan and can be quantified using modelling systems such as the AAR model. Further work is needed to better understand and address the existing gaps in knowledge pertaining to the effects of management practices on carbon in other ecosystem components, consequences of biomass removal as well as the carbon chain and C distribution within oil palm biomass and products. Proper management techniques and judicious use of resources to improve carbon input and retention in the soil in daily estate operations will ensure long-term soil fertility, crop productivity and environmental health for the benefit of the plantation industry.

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The author presenting during PIPOC 2013 in Kuala Lumpur Convention Centre.

AAR MEOA Seminar 2015

Growing The Oil Palm : Where are We?

AAR was proud to host a one-day seminar in conjunction with the Malaysian Estate Owner's Association (MEOA). The event which took place on 21st January 2015, was well attended. For the seminar, the elites of AAR sprang into action providing informative presentations covering various topics pertaining to oil palm cultivation. Topics included a review of AAR's breeding programme, nursery management and good agricultural practices, importance of pest and disease management as well as a review of the latest technologies in remote sensing and Biotechnology.

Welcoming of participants.
There were 132 participants!!!

With exhibitions on display, both MEOA participants and fellow AAR researchers were able to interact and gain more information on AAR's pride and joy, the AA Hybrida IS and II semi-clonal seeds, as well as AA Vitroa clonal planting materials.





The seminar kicked off with an introductory speech by the organizing chairman, Mr Wong Choo Kien followed by his talk on AAR's oil palm breeding programme on the production of elite planting materials. A series of other talks followed throughout the course of the day. Mr Kumar and Mr Patrick Ng Hong Chuan stressed on nursery management and good agricultural practices as crucial factors contributing to sustainable cultivation of oil palm. Dr Goh You Keng and Dr Teo Tze Min presented a review of AAR's P&D research while Mr Tey Seng Heng described the application of cutting-edge technology in remote sensing suited for oil palm agro-management. Dr Wong Wei Chee shared some of the molecular works being carried out by her team and its application in plant-breeding, tissue culture and agronomy works. Lastly, Bapak Arif Sugandi, Director of PT AAR Indonesia, addressed the challenges of peat soils for oil palm cultivation.




Q&A session. The responses from the crowd were overwhelming.

The seminar concluded with the closing remarks presented by MEOA's representative, Mr Tan Teo Kim. A post-seminar discussion on rubber, headed by Mr Tey Seng Heng was held after the seminar closing. The seminar ended on a high note.

Meet the Organizing Team

This year, AAR's Sport and Recreational Club (AARSRC) is led by our youthful Mr. Shahril Naim Aminuddin as President, aided by his Deputy, Mr. Cheah Li Wen and fellow committee members. Together they laid out several events to entertain the likes of over 500 AAR employees. We have included some happy and memorable moments of the few events they have organized so far.

AARSRC 2015 BOWLING TOURNAMENT

A bowling tournament was held at Wangsa Bowl, One Utama on 16^{th} May 2015. Pins went flying as our talented bowlers rolled the balls enthusiastically down the lanes. After going through the score cards, the team from Advisory section were victorious and were awarded the Grand Price, 1^{st}-runner up went to the boys from TC Lab and 2^{nd} runner-up went to the GPS/GIS section team led by our veteran En. Samsuddin Saleh. Based on individual scores cards, Azharul from TC Lab proved his mettle by grabbing the Best Male Bowler Award whereas Thilaga from the P&D girls' team won the Best Female Bowler Award! Overall, it was great fun and kudos to all the winners and bowlers.

TC LAB NETBALL TOURNAMENT

On May 18^{th}, the Tissue Culture Section held a netball tournament. Participants were grouped in 4 teams and yes they were very creative with their group names—Green, Red, Purple and Blue Teams! It was great watching them give their best, with each team definitely trying to out-match the other, but alas only one team shall be crowned victorious. By the end of the day, the Blue Team accumulated the highest scores and were jubilant when their team was called out as the victors of the tournament.

In May 2015, our **Team Building Trip** was held at Pagang Island. While it started out on a very positive note with fun-filled activities, the trip ended short due to a very saddened tragedy, where we lost our dear colleague, the late and deeply missed O.K. Hairi Fadlan. Our thoughts are with those he left behind. Goodbye, dear friend.

Ramadan Mubarak! An annual ritual gathering for PT AARI and rightfully so, as we gather together during this auspicious month to share a meal during the month of blessing, mercy and forgiveness through a joyful fast-breaking dinner with family and friends.

SPECIAL ANNOUNCEMENT!!

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Senior Research Officers (SRO)	Research Officer (RO)	Asst. Research Officer (ARO II)
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		Mdm. Mahalachumy a/p Arumugam		
Pn Aspalila bt Abdullah		Mdm. Susan a/p Samuel		

Lab Assistant (Grade III)	Research Assistant (Grade I)	Research Assistant (Grade II)	Research Assistant (Grade III)
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	En. Ahmad Risaudin bin Mamat		
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Encik Muhammad Nazirul bin Rosli	En. Mohd. Azlan bin Ahmad
Mdm. Letchumi a/p Ramasamy	CONGRATULATIONS TO ALL!
En. Mohd. Redzuan bin Mohamad Shah	
Pn. Siti Rahayu bt Supiai	