



# Bio-Ecological Perspective of *Elaeidobius kamerunicus* Related to Oil Palm Fruit Set in Indonesia

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Agus Eko Prasetyo\*, TAP Rozziasha,  
Hari Priwiratama, Sri Wening, Agus Susanto, and  
Roch Desmier de Chenon

INDONESIAN OIL PALM RESEARCH INSTITUTE

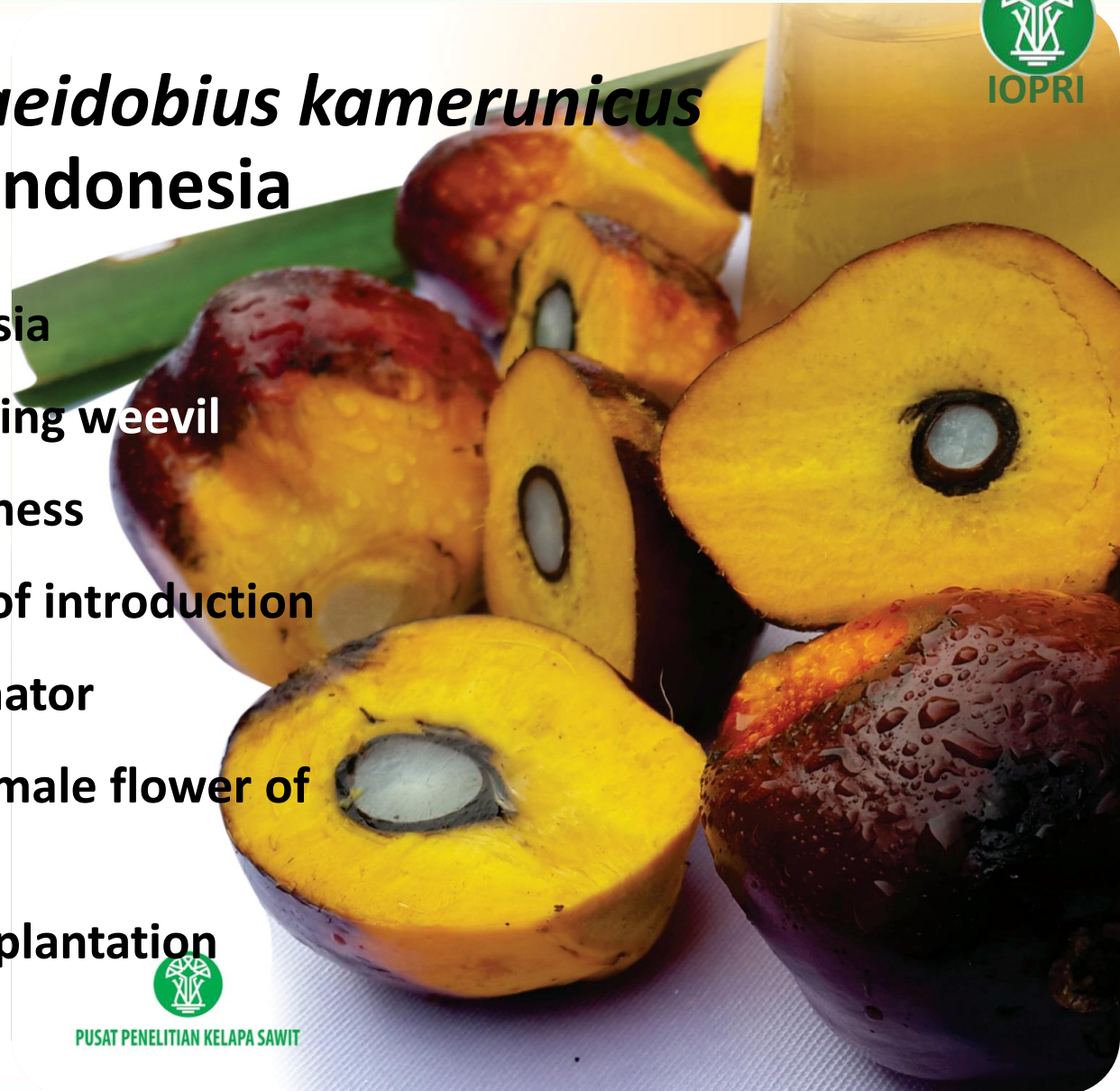
Jln. Brigjen Katamso 51 Medan 20158, Indonesia

\*Phone: +628126210303, e-mail: prasetyo\_marihat@yahoo.com



# Bio-Ecological Perspective of *Elaeidobius kamerunicus* Related to Oil Palm Fruit Set in Indonesia

- ✧ The dynamics of oil palm fruit set in Indonesia
- ✧ Impact of insecticide application on pollinating weevil
- ✧ Decline of the pollinating weevil aggressiveness
- ✧ Biology of pollinating weevil after 30 years of introduction
- ✧ The role of *E. kamerunicus* as oil palm pollinator
- ✧ Visitation of *E. kamerunicus* on male and female flower of several oil palm germplasms
- ✧ Approaches to increase fruit set in oil palm plantation
- ✧ Further challenges and research



PUSAT PENELITIAN KELAPA SAWIT



# History of *Elaeidobius kamerunicus* introduction to Indonesia

**1977**

Research on weevils, R.A. Syed, Lobe Estate Cameroon. *Elaeidobius kamerunicus* selected, among 3 species.

**1980**

June, Malaysia: 2000 pupae sent, 1044 arrival KL, 400 healthy.

**1981**

February, release 2 estates W. Malaysia. One year after full spread. March, release Sabah Pamol.

**1982**

Indonesia introduction, 1983 release

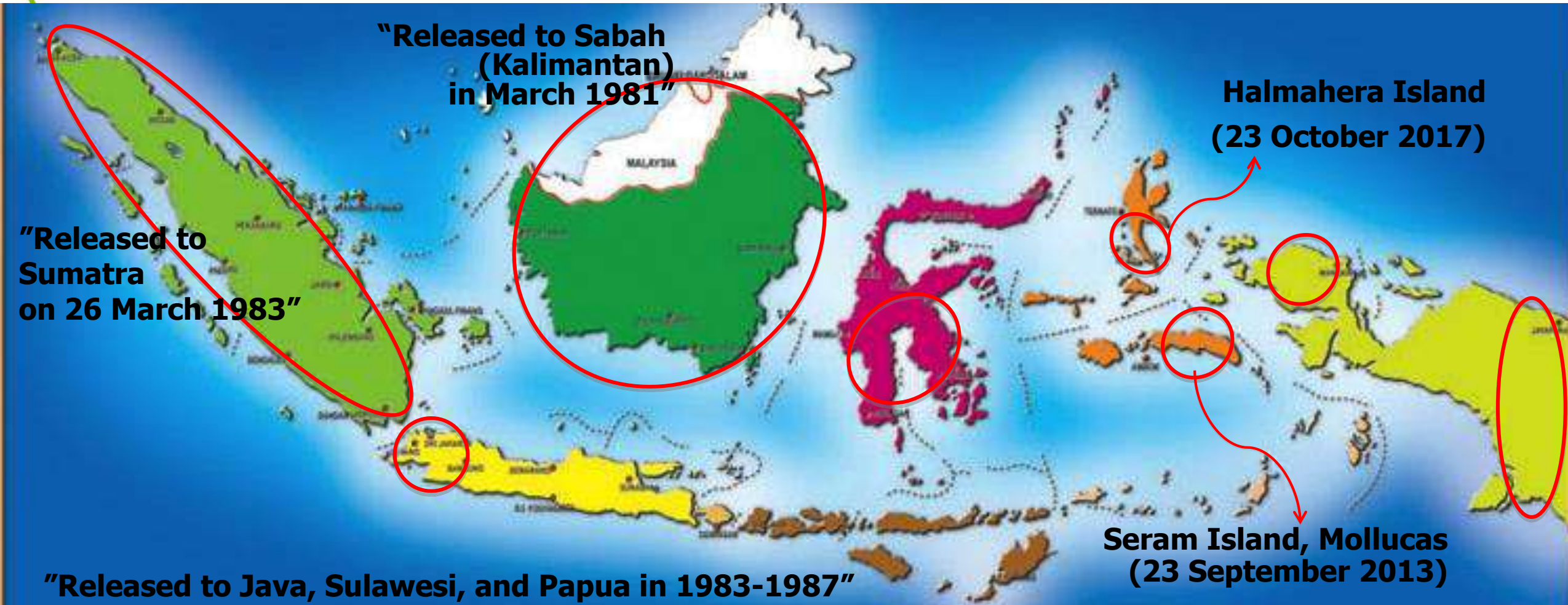
Fruitset 1 year: Malaysia 71-76%, Indonesia 69-80%

**Pollination main challenge to Oil Palm Industry**



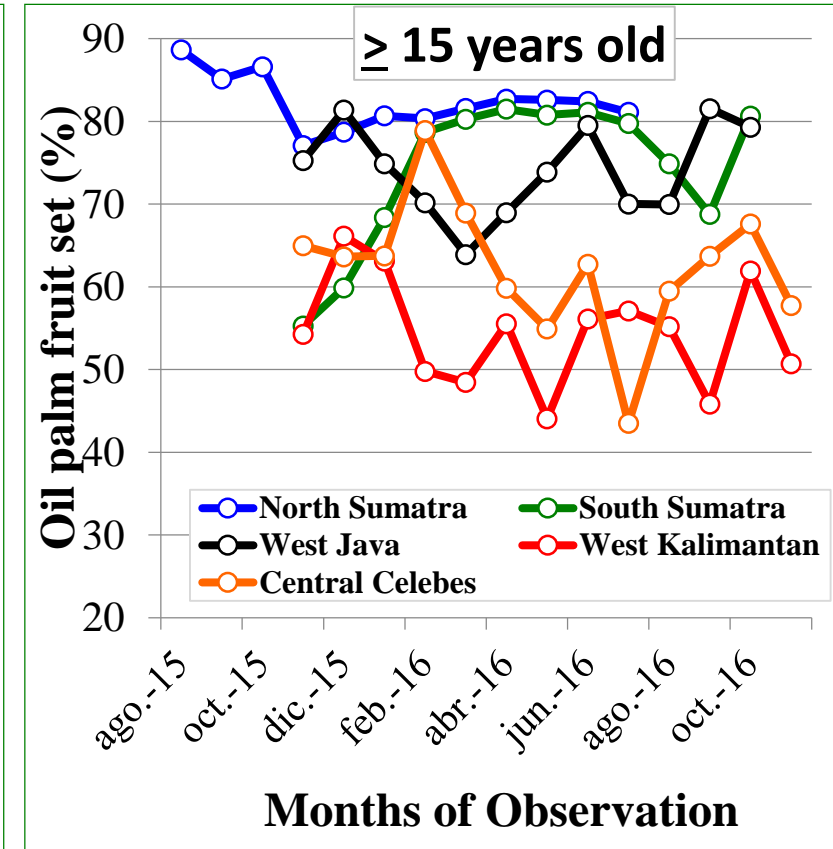
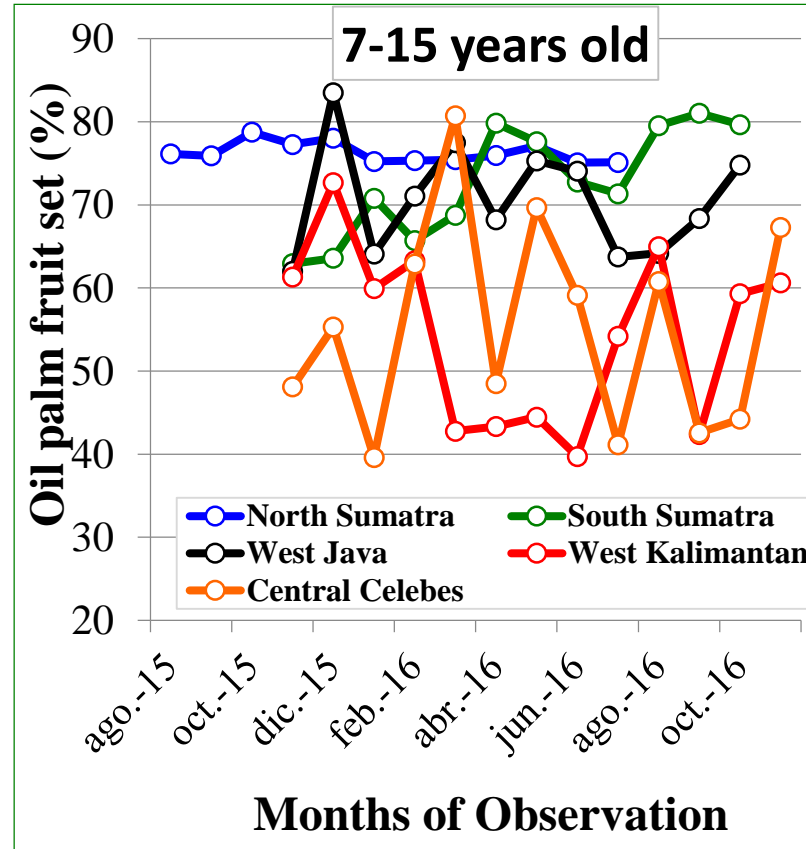
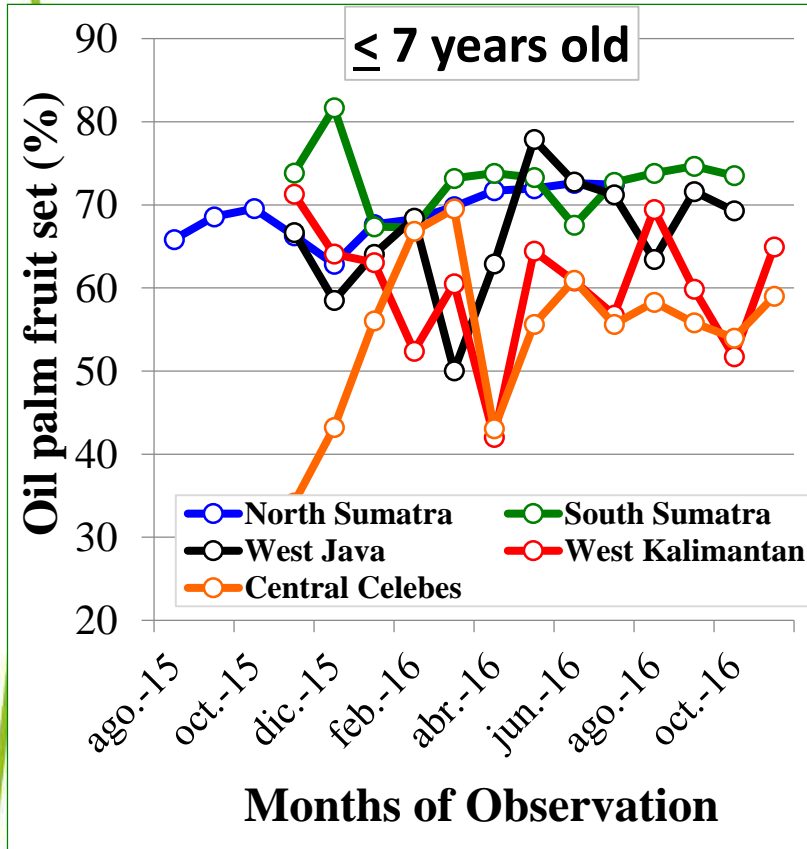
**14 millions ha  
in 2018**

# Distribution of *Elaeidobius kamerunicus* in Indonesia



- Fruitset reported Kalimantan, lowest 12% at 4-6 years planting.
- *Questions* : Lack breeding sites, global climate change, inbreeding depression, natural enemies.

# The Dynamics of Oil Palm Fruit Set in Indonesia



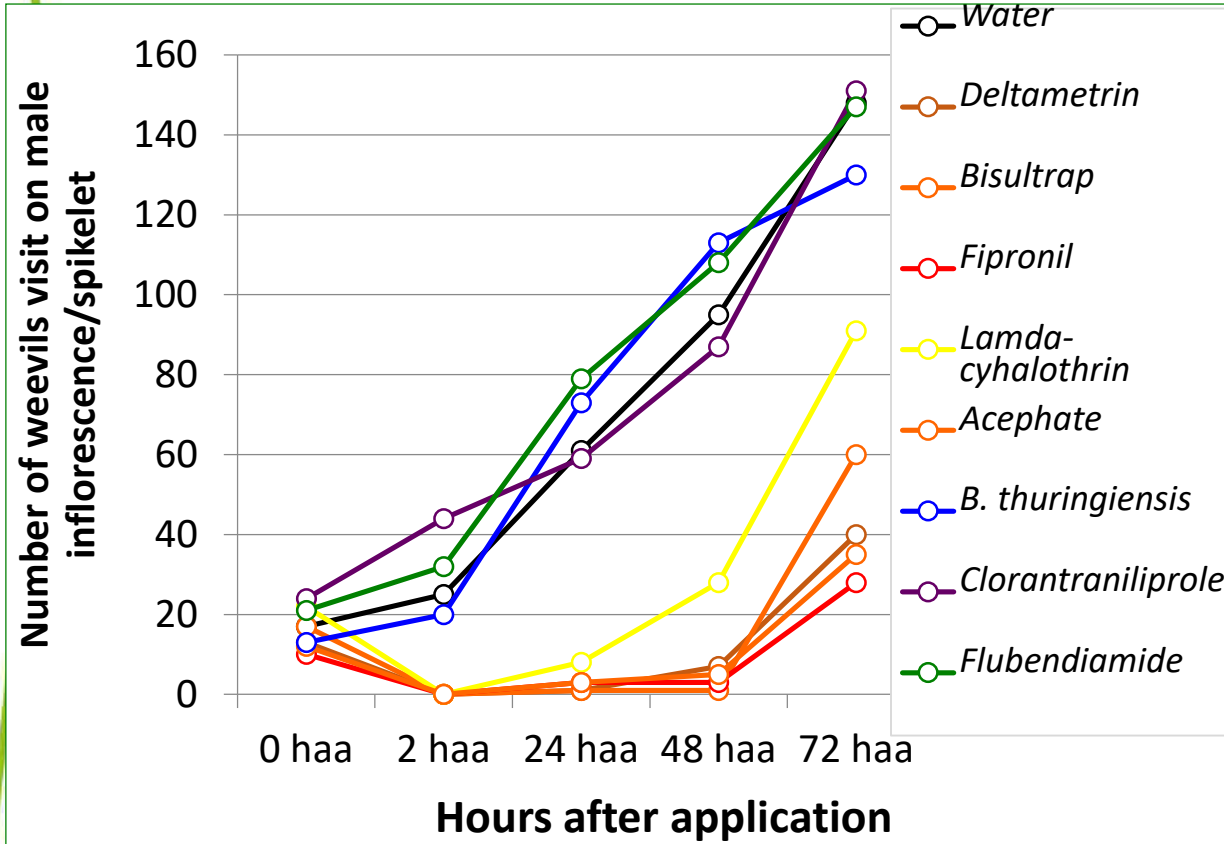
# The Decline of *E. kamerunicus* Population and Fruit Set Caused by Rat Attack

Rats attack on male inflorescences	Oil palm fruit set
East Kutai, East Kalimantan, 2014	
73.45%	39.28%
Pulang Pisau, Central Kalimantan, 2012	
82.76%	33.47%
Kapuas, Central Kalimantan, 2013	
88.23%	12.56%

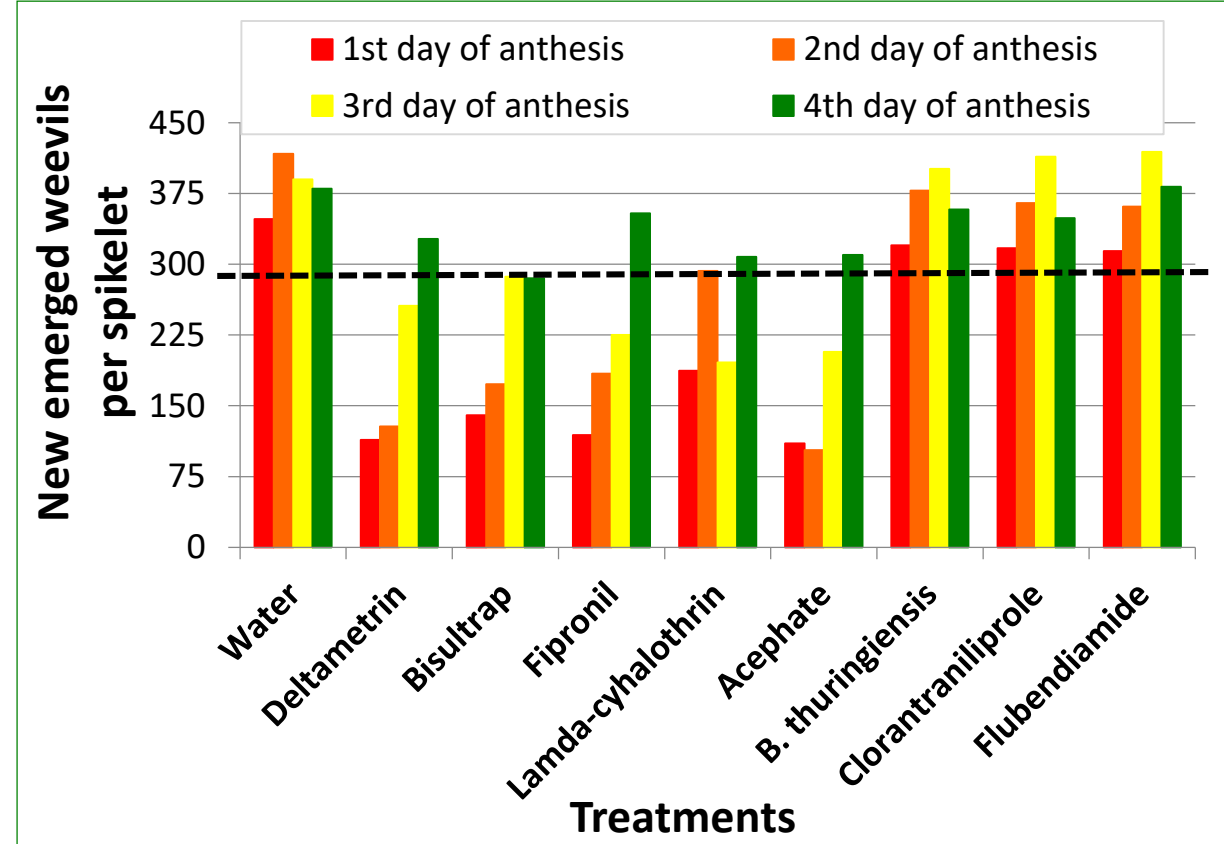


# Impact of Insecticide Application on *E. kamerunicus*

## Spraying to anthesising male inflorescence



## Incubation of male inflorescence until 21 days





# Decline of the pollinating weevil agresiveness

Trials in Central Kalimantan, 2010-2013

## ✧ In Glass House

## ✧ In The Field

54 weevils

29 weevils

**North  
Sumatra**

211 weevils

155 weevils

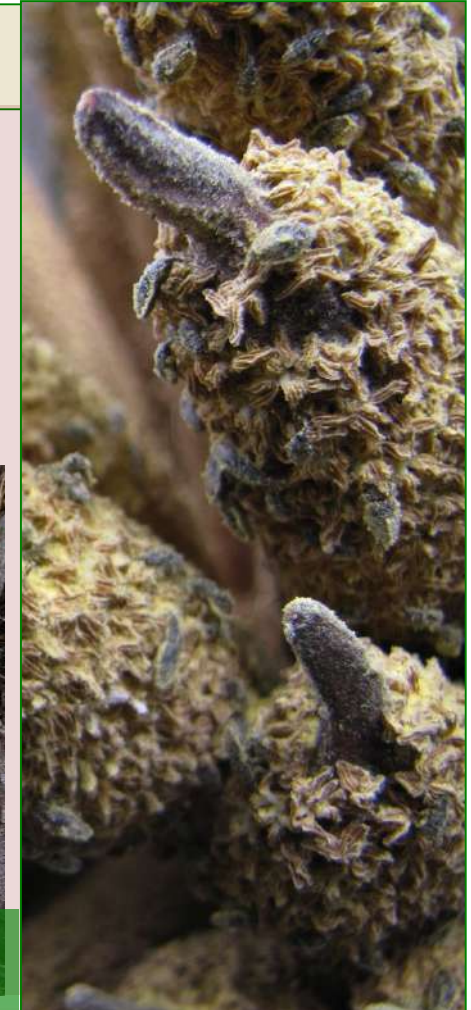
70 weevils

10 weevils

**Central  
Kalimantan**

303 weevils

46 weevils



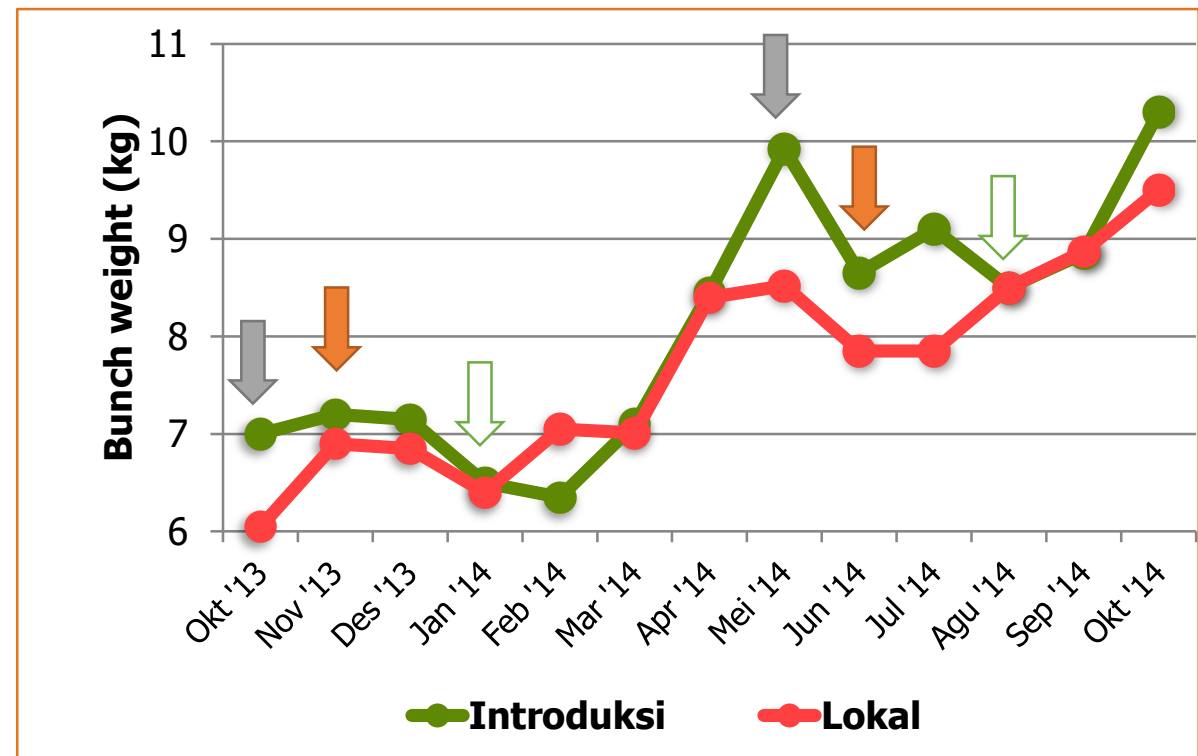
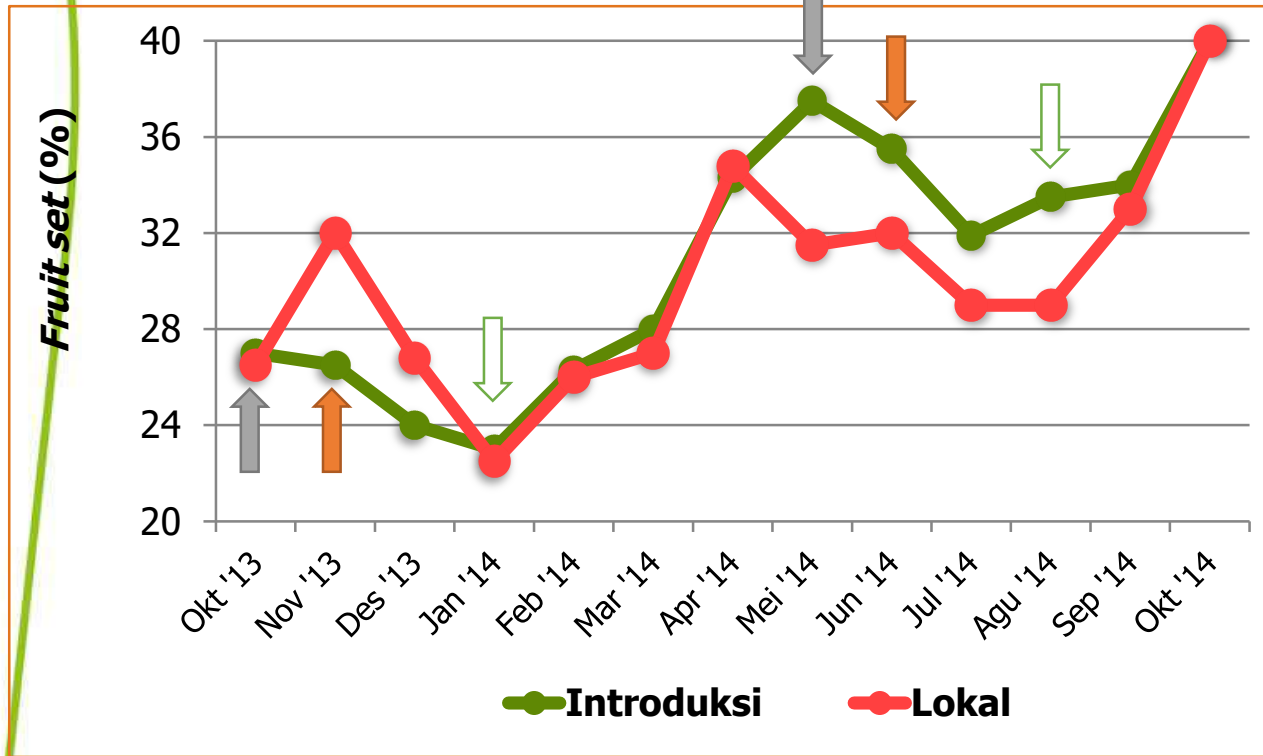
Number of weevils on anthesising male/female flowers

# Introduction of *Elaeidobius kamerunicus* from North Sumatra to East Kalimantan for Increasing Oil Palm Fruit Set

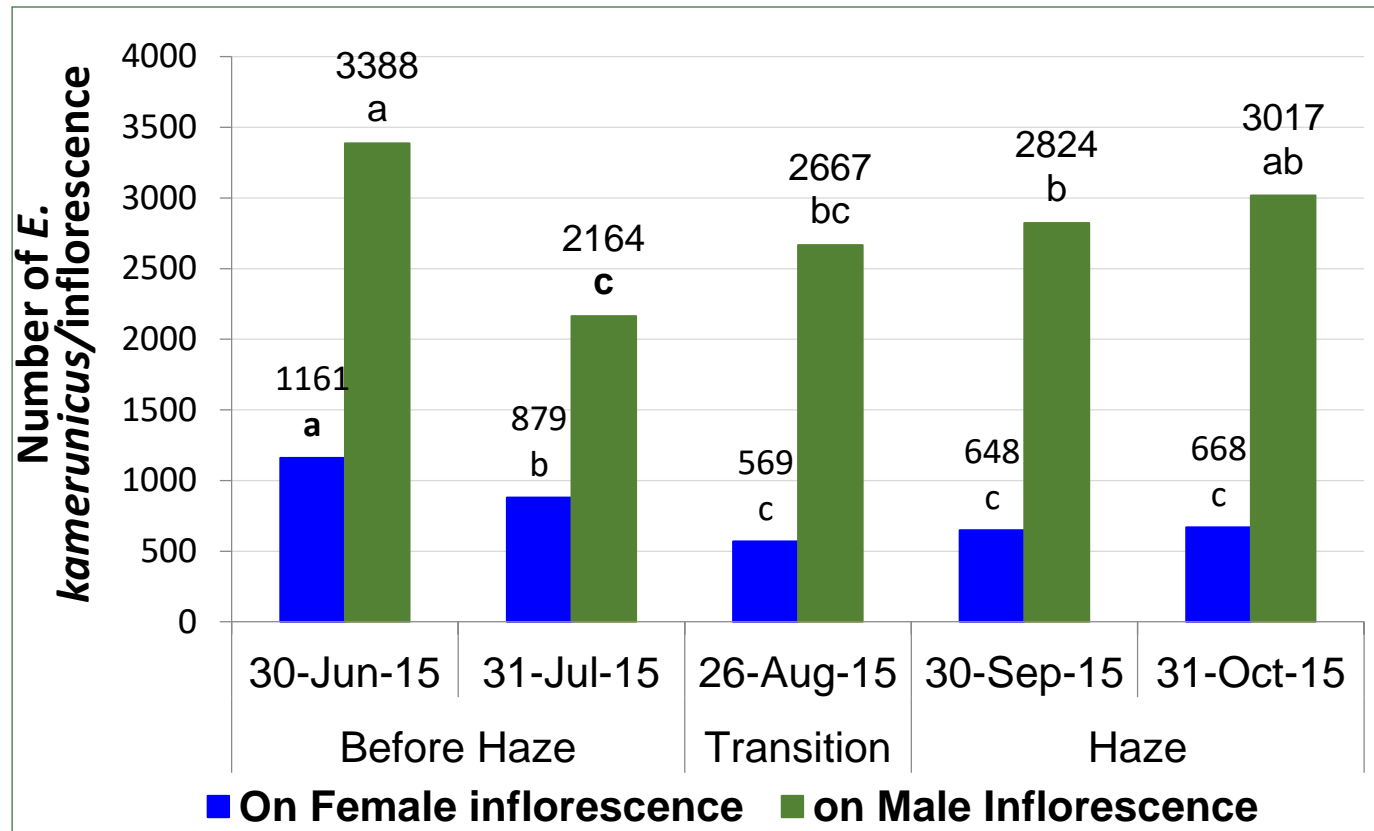


Treatments	Fruit set (%)
0 weevils/ha	45.15 ± 12.33 b
1,000 weevils/ha	61.97 ± 7.31 a
2,000 weevils/ha	59.67 ± 10.20 a
3,000 weevils/ha	61.24 ± 11.41 a

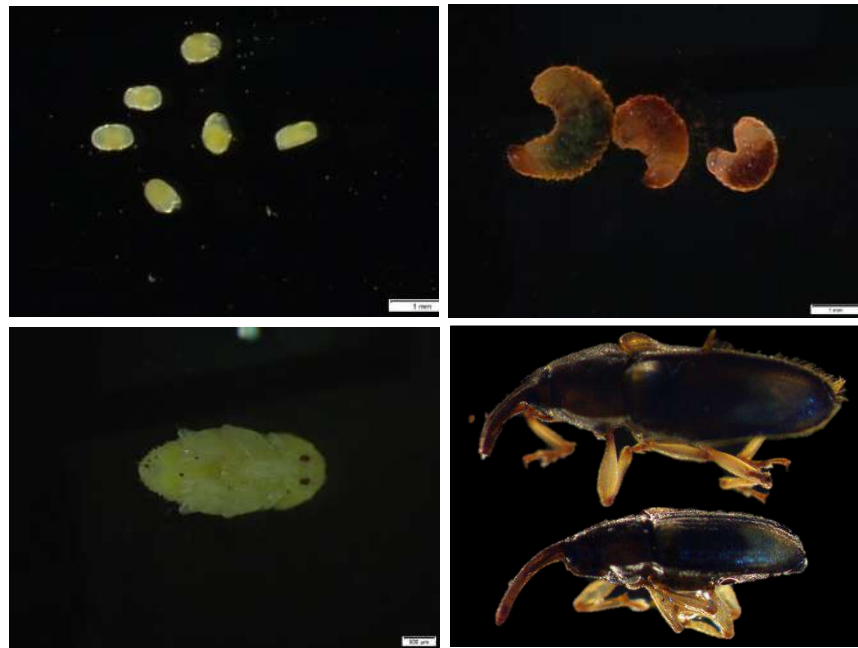
# The Development of Oil Palm Fruit Set and Weight of Bunch After Introduction of *E. kamerunicus* from North Sumatra to Central Kalimantan



# Effect of Haze on *Elaeidobius kamerunicus*



# Biology of *E. kamerunicus* after 30 years of introduction



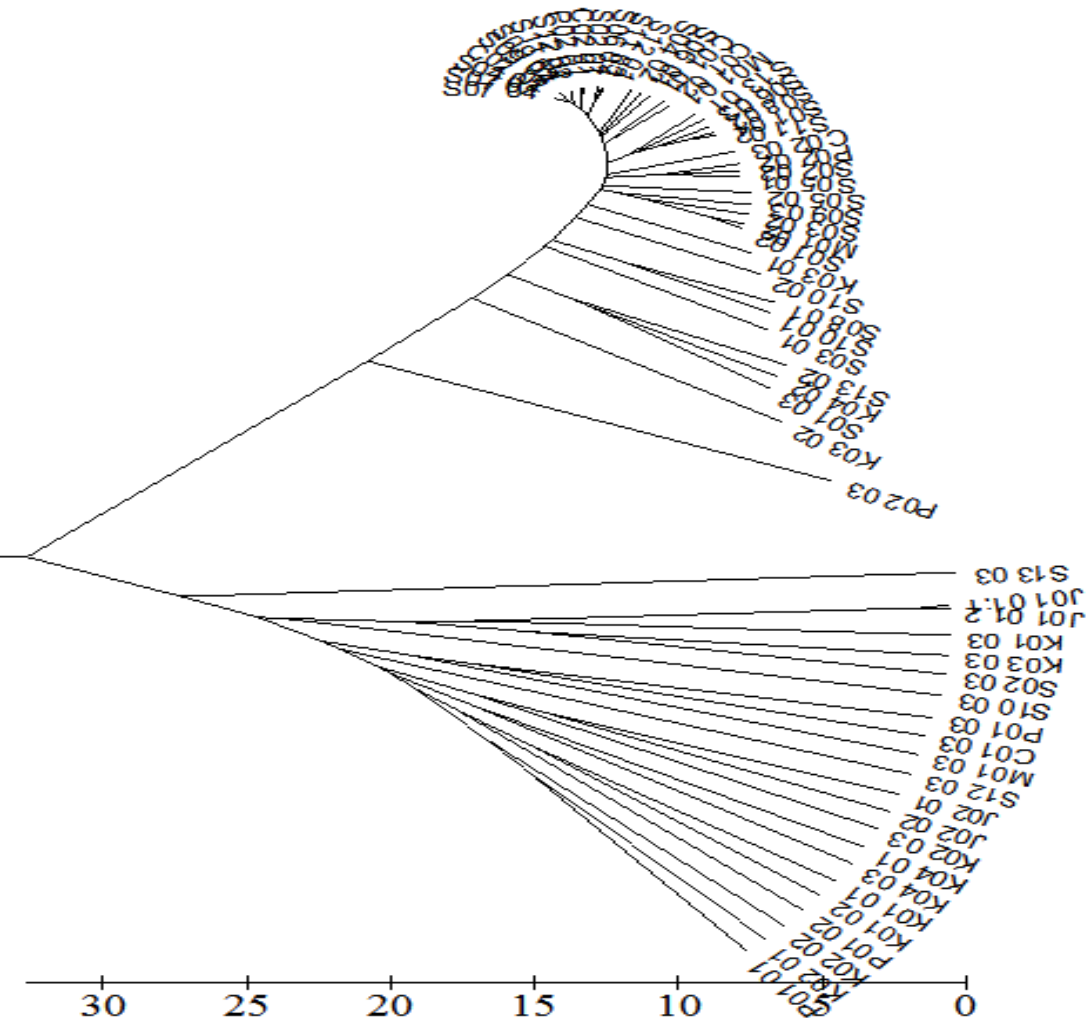
Stages	Incubation period or life time of <i>Elaeidobius kamerunicus</i> (days)		
	In low land	In high land	In Africa (Tuo <i>et al.</i> , 2011b)
Egg	1.01 ± 0.02	2.50 ± 0.05	0.58 ± 0.06
Larvae stage 1	1.05 ± 0.09	2.50 ± 0.06	1.24 ± 0.12
Larva stage 2	1.06 ± 0.11	5.02 ± 0.03	1.08 ± 0.10
Larva stage 3	4.82 ± 1.96	8.50 ± 0.12	4.96 ± 0.11
Pupae	2.35 ± 0.45	10.05 ± 0.03	2.03 ± 0.03
Imago (male)	52.53 ± 5.82	10.78 ± 2.36	27.96 ± 2.99
Imago (female)	37.87 ± 4.79	15.72 ± 3.83	31.22 ± 12.43

# Morphology of *Elaeidobius kamerunicus* in Indonesia

No	Province	Morphology of Male Weevil (mm)								
		Length of body	Width of body	Length of thorax	Width of thorax	Length of abdomen	Length of head	Width of head	Length of rostrum	Width of rostrum
1	Aceh	3.98 gh	1.51 def	0.89 d	1.16 bc	1.16 bc	0.29 de	0.54 efgh	1.06 de	0.24 f
2	North Sumatra	3.84 fg	1.53 f	0.89 cd	1.22 de	1.22 de	0.32 e	0.56 i	0.99 bcd	0.23 cdef
3	Riau	3.52 bcd	1.39 a	0.83 abcd	1.24 def	1.24 def	0.17 a	0.52 bcde	0.96 abc	0.22 bcd
4	West Sumatra	3.40 ab	1.37 a	0.81 ab	1.22 de	1.22 de	0.22 b	0.53 defg	0.93 abc	0.20 a
5	Bengkulu	3.31 a	1.38 a	0.77 a	1.08 a	1.08 a	0.26 cd	0.49 a	0.91 a	0.23 cdef
6	South Sumatra	3.58 cd	1.47 bcde	0.85 abcd	1.08 a	1.08 a	0.30 e	0.51 abcd	0.95 abc	0.23 cdef
7	Bangka Belitung	3.90 fg	1.46 bc	0.89 d	1.29 gh	1.28 gh	0.20 ab	0.52 bcde	0.95 abc	0.21 bc
8	Lampung	4.09 h	1.51 ef	0.84 abcd	1.31 hi	1.31 hi	0.17 a	0.55 ghi	0.99 cd	0.23 ef
9	Banten	3.40 ab	1.37 a	0.82 abcd	1.19 cd	1.19 cd	0.19 ab	0.49 a	0.94 abc	0.19 a
10	West Java	3.50 bc	1.38 a	0.81 abc	1.22 de	1.22 de	0.19 ab	0.51 abc	1.04 de	0.21 ab
11	West Kalimantan	3.84 fg	1.48 bcde	0.88 bcd	1.33 i	1.33 i	0.19 ab	0.55 hi	1.06 de	0.23 cdef
12	Central Kalimantan	3.66 de	1.44 b	0.86 bcd	1.28 fgh	1.28 fgh	0.19 ab	0.54 fgh	1.07 e	0.23 def
13	East Kalimantan	3.63 cd	1.45 b	0.84 abcd	1.25 efg	1.25 efg	0.19 ab	0.54 efgh	0.99 cd	0.22 bcd
14	South Kalimantan	3.86 fg	1.49 cdef	0.85 bcd	1.13 b	1.13 b	0.26 cd	0.51 abcd	0.94 abc	0.23 cdef
15	Central Sulawesi	3.60 cd	1.40 a	0.85 abcd	1.24 def	1.24 def	0.20 ab	0.53 cdef	1.00 cd	0.21 ab
16	Southeast Sulawesi	3.77 ef	1.47 bcd	0.85 bcd	1.25 efg	1.25 efg	0.23 bc	0.53 cdef	0.92 ab	0.23 cdef
17	Papua	3.87 fg	1.40 a	0.86 bcd	1.13 b	1.14 b	0.28 de	0.52 bcde	0.94 abc	0.24 f

No	Province	Morphology of Female Weevil (mm)								
		Length of body	Width of body	Length of thorax	Width of thorax	Length of abdomen	Length of head	Width of head	Length of rostrum	Width of rostrum
1	Aceh	3.52 efgh	1.29 ef	0.75 def	1.02 bcd	2.01 d	0.25 de	0.52 d	1.36 f	0.19 ab
2	North Sumatra	3.19 bc	1.36 g	0.76 ef	0.97 abc	2.13 e	0.28 e	0.52 d	1.48 g	0.20 bc
3	Riau	3.28 bcd	1.18 a	0.67 a	1.01 bcd	1.81 ab	0.20 abcd	0.49 b	1.19 ab	0.17 ab
4	West Sumatra	3.26 bcd	1.24 bcd	0.72 abcde	1.02 bcde	1.86 abc	0.19 abcd	0.51 cd	1.34 ef	0.18 ab
5	Bengkulu	2.88 a	1.19 ab	0.68 ab	0.91 a	1.86 abc	0.19 abcd	0.46 a	1.15 a	0.19 ab
6	South Sumatra	3.35 cde	1.24 cde	0.71 abcde	0.90 a	1.84 abc	0.04 bcd	0.45 a	1.31 def	0.19 ab
7	Bangka Belitung	3.55 fghi	1.20 abc	0.69 abc	1.00 bcd	1.83 abc	0.23 bcde	0.45 a	1.19 ab	0.17 a
8	Lampung	3.70 i	1.26 de	0.71 abcd	1.10 e	1.90 bc	0.14 a	0.50 bcd	1.25 bcd	0.18 ab
9	Banten	3.34 cde	1.19 abc	0.74 cdef	0.97 abc	1.86 abc	0.15 a	0.48 b	1.27 d	0.17 a
10	West Java	3.37 cde	1.21 abcd	0.70 abcd	0.99 bcd	1.77 a	0.16 ab	0.49 bc	1.29 de	0.17 a
11	West Kalimantan	3.51 efg	1.24 bcd	0.72 abcde	1.07 de	1.91 bc	0.18 ab	0.50 bcd	1.28 de	0.23 d
12	Central Kalimantan	3.37 cde	1.25 cde	0.73 abcdef	1.05 cde	1.93 cd	0.17 ab	0.52 d	1.31 def	0.22 cd
13	East Kalimantan	3.25 bcd	1.21 abcd	0.73 bcdef	1.01 bcd	1.84 abc	0.15 a	0.50 bcd	1.31 def	0.18 ab
14	South Kalimantan	3.68 gi	1.31 f	0.74 bcdef	0.96 ab	1.92 cd	0.19 abcd	0.49 bc	1.31 def	0.19 ab
15	Central Sulawesi	3.14 b	1.19 ab	0.77 f	1.07 de	1.84 abc	0.19 abc	0.48 b	1.27 d	0.17 ab
16	Southeast Sulawesi	3.33 cde	1.21 abcd	0.70 abc	1.01 bcd	1.85 abc	0.18 ab	0.49 bc	1.20 abc	0.17 ab
17	Papua	3.40 def	1.26 de	0.73 bcdef	0.91 a	1.93 cd	0.25 cde	0.49 bc	1.26 cd	0.19 ab

# Molecular Characterization of *Elaeidobius kamerunicus* in Indonesia



Code	Province
J01-(01-02)	West Java
J02-(01-02)	Banten
K01-(01-03)	West Kalimantan
K02-(01-03)	South Kalimantan
K03-(01-03)	Central Kalimantan
K04-(01-03)	East Kalimantan
M01-(01-03)	Malaysia
P01-(01-03)	Papua (1)
P02-(01-03)	Papua (2)
C01-(01-03)	Central Sulawesi
C02-(01-03)	Southeast Sulawesi
S01-(01-03)	Aceh
S02-(01-03)	Bengkulu
S03-(01-02)	Jambi
S04-(01-02)	Lampung
S05-(01-02)	Riau
S06-(01-03)	Riau
S07-(01-02)	South Sumatra (1)
S08-(01-02)	South Sumatra (2)
S09-(01-03)	West Sumatra
S10-(01-03)	North Sumatra (1)
S11-(01-03)	North Sumatra (2)
S12-(01-03)	North Sumatra (3)
S13-(01-03)	North Sumatra (4)



# The role of *E. kamerunicus* as oil palm pollinator

- Treatments: (a) 250 male weevils; (b) 250 female weevils; (c) 125 male and 125 female weevils. 9 replicates.
- Using new emerged weevils, selected in the morning (06.00 am), sprayed by oil palm pollens (viability > 80%) before release.
- Female inflorescence: covered min. 5 days before anthesis (blooming) and release the treatment weevils (with pollens) at anthesis.



Treatment (weevils)		fruit set (%)	Fruit to bunch (%)	Bunch weight (kg)
male	female			
250	0	41.01 c	43.60 c	17.37 c
0	250	78.97 a	61.28 a	23.62 a
125	125	64.92 b	56.67 b	21.44 b
0	0	0.06 d	0.02 d	6.25 d

The different letter in the same column shows a significant difference between treatments with Duncan test at 95% significance level



# The role of *E. kamerunicus* as oil palm pollinator

Weevils		Fruit set (%)		
male	female	Top spikelet	middle spikelet	Base spikelet
250	0	36.62 a	46.51 a	36.37 a
0	250	79.70 a	79.32 a	80.95 a
125	125	60.65 b	70.54 a	62.93 a



**9 quadrans:**

Spikelets: top (green), middle (red), and base (blue).

Weevils		Fruit set (%)		
male	female	Outer fruits	Middle fruits	Inner fruits
250	0	67.68 a	38.06 b	13.75 c
0	250	85.86 a	83.77 a	70.34 b
125	125	69.23 a	65.50 ab	59.39 b



Fruits: outer (green), middle (red), inner (blue).

The same letter in the same line shows not significant difference between parts of fruit set with Duncan test at 95% significance level

# The Weevil's Visit on Anthesising Male and Female Inflorescence

Oil palm inflorescence	Number of caught weevils (weevils)		Weevil's sex ratio	
	Male	Female	Male	Female
Male (per spikelet)	74	122	1	2
Female (per yellow sticky trap)	30	129	1	4



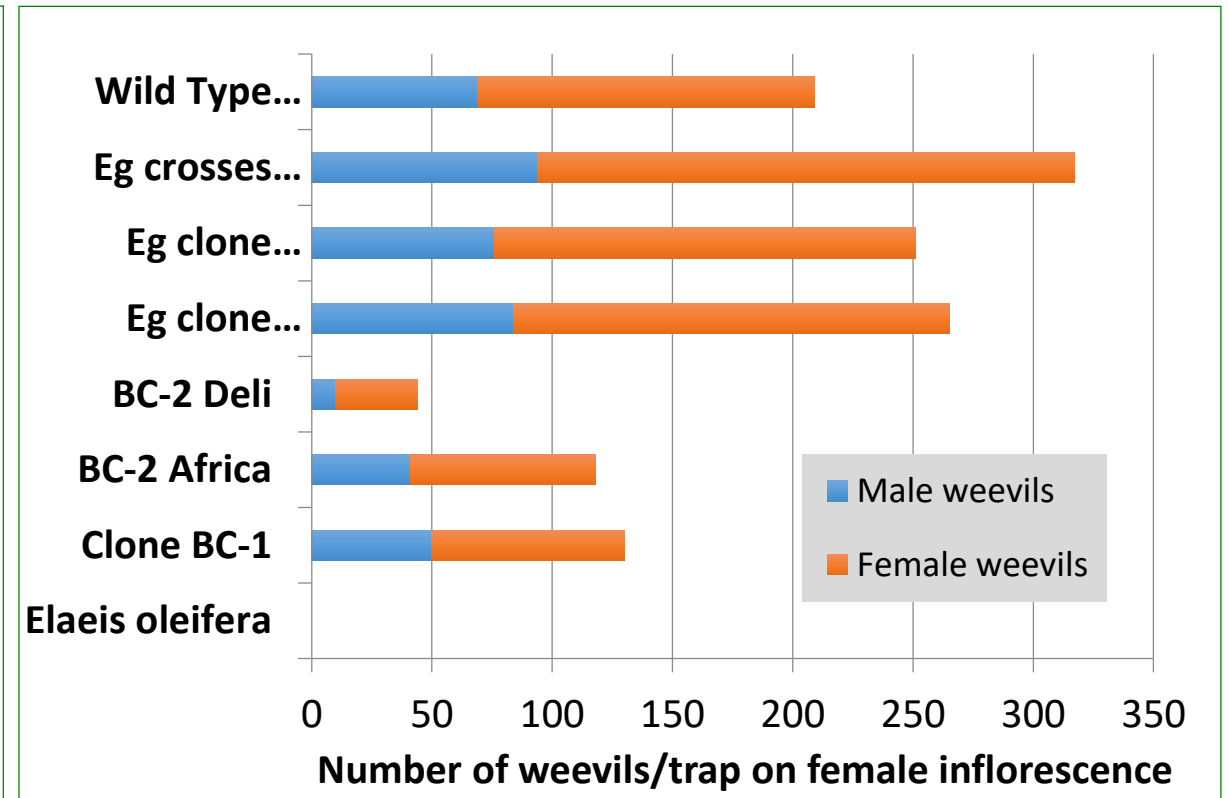
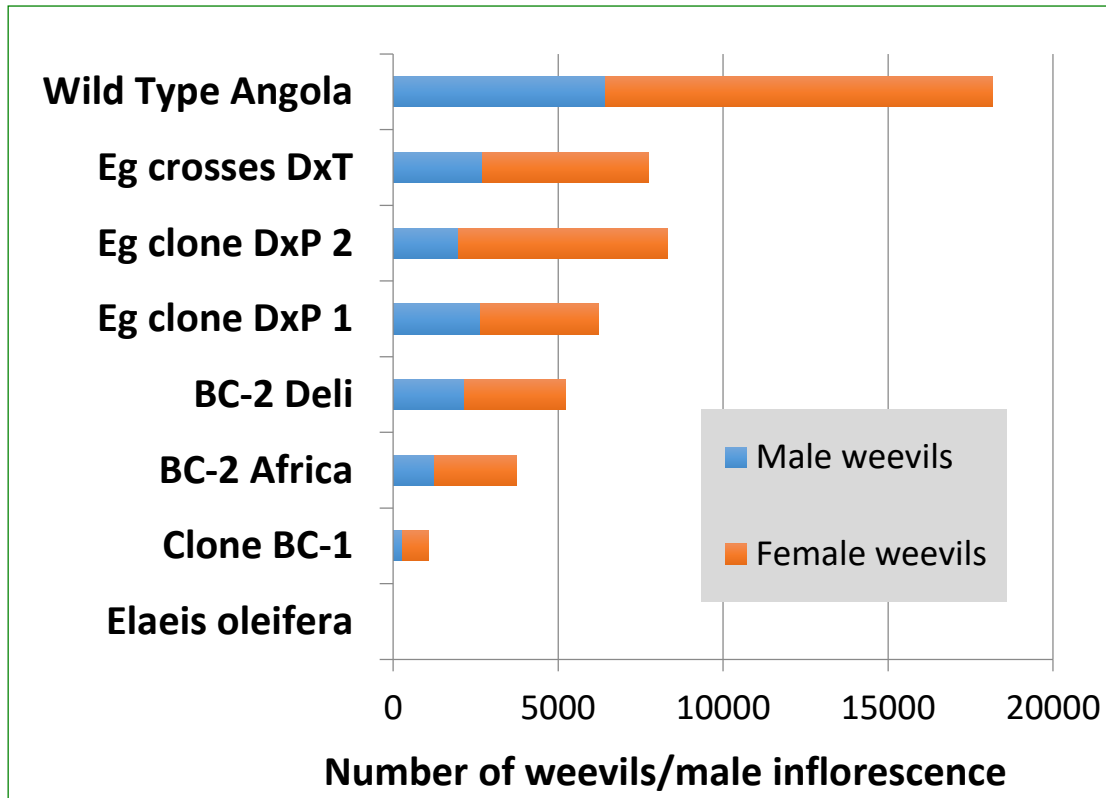
It is clear that the *Elaeidobius* are not coming to the female flowers by “deception” as it is written but looking for exudates. This matter needs investigations.



The weevils bring pollens



# Visitation of *E. kamerunicus* on Male and Female Flower of Several Oil Palm Germplasms



# Approaches to increase fruit set in oil palm plantation

- *Human-Assisted Pollination*  
→ Easy on young mature palms, **but costly**



**Blind Pollination**

# Approaches to increase fruit set in oil palm plantation

- *Hatchery System*

→ Increase population of *E. kamerunicus* through the introduction of post-anthesis male inflorescences, is capable of increasing the fruit set in early mature oil palm by 30.11% in average and protect the larvae from rats attack, **but not effective in oil palm with high sex ratio**



# Approaches to increase fruit set in oil palm plantation

## • *Hatch-Carry System*

→ Improved by direct pollen spraying onto the weevil emerged, increase the fruit set 22.09-31.13%. **However, the method demand for intensive supervisions due to installation of the boxes were inside the block.**



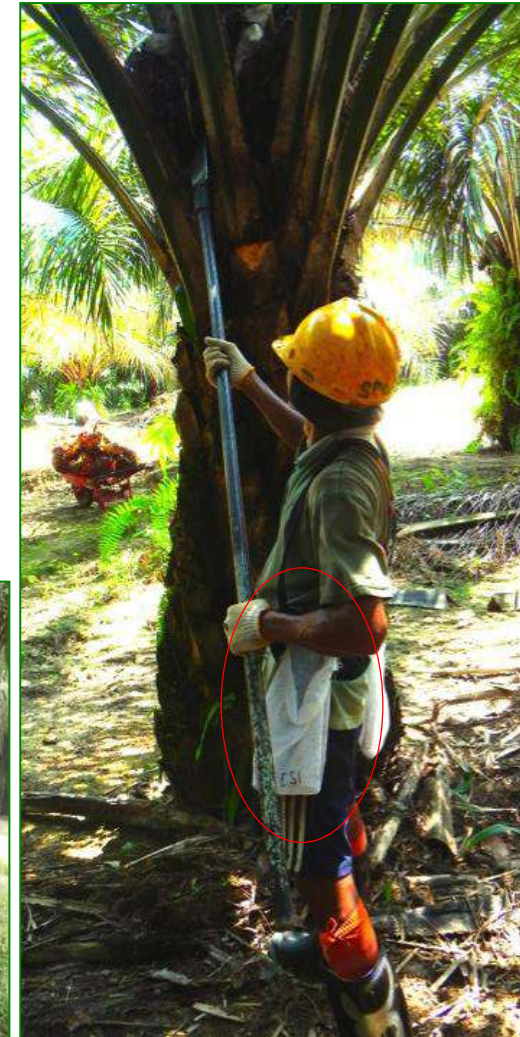
Jarak dari kotak	Fruit set (%)
10 m	88.61 a
100 m	87.38 a
200 m	82.50 a
300 m	67.58 b
400 m	62.22 b
<i>Aspol</i>	84.50 a



# Approaches to increase fruit set in oil palm plantation

## • *Hatch-Carry Mobile System*

→ For ease of application and supervision, the hatching boxes are placed in group near the estate office. **In the early morning, supervisor collects the weevil bag and distributes the bag to harvesters before leaving the office. The harvester then releases the weevil in the planting block where harvesting take place.** The implementation of this mobile technique was able to increase fruit set to 16,09%-26,69%.





# Approaches to increase fruit set in oil palm plantation

- **KAIROMIX**

→ In some cases, there are planting blocks where female flowers are abundant and male flowers present in adequate proportion but still has low fruit set. In such cases, the use of attractant to attract *E. kamerunicus* weevils such as Kairomix is essential.

→ Kairomix is a commercial synthetic estragole, packed in a dispenser sachet. The applications of Kairomix at 2-4 sachset/ha increase weevil activity and then visit to female flower, and has proved to increase oil palm fruit set up to 20% (Prasetyo dan Susanto, 2015).



# Further challenges



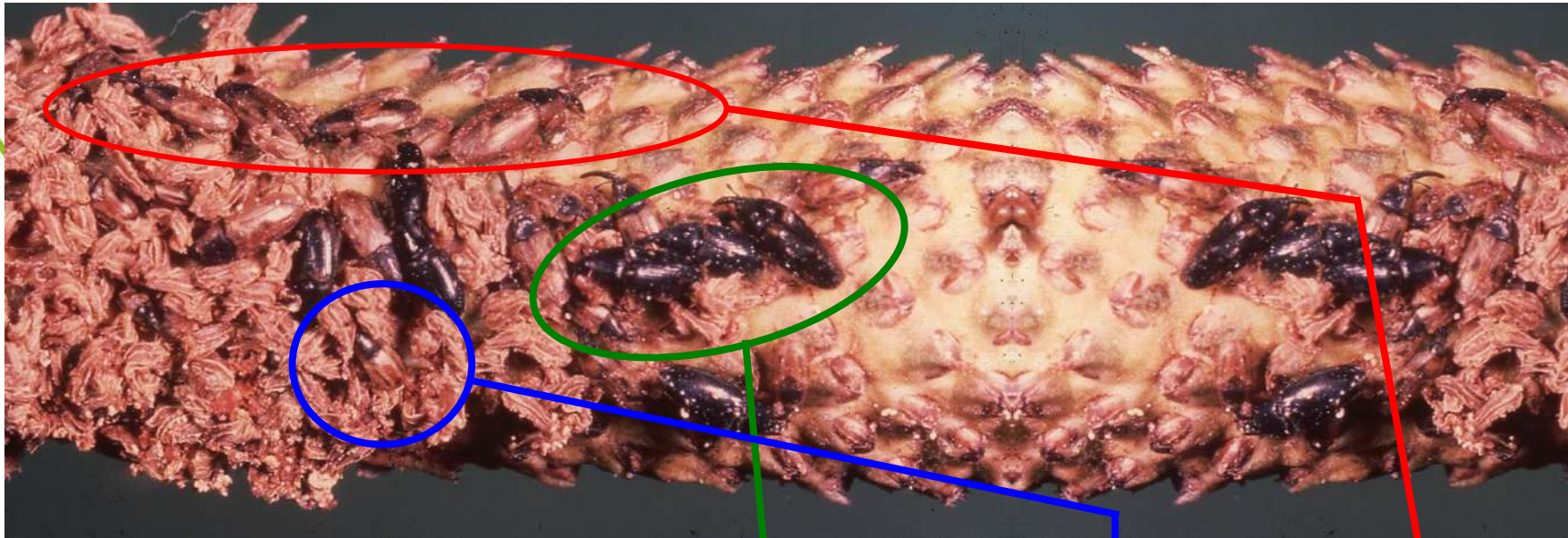
*Elaeis guineensis*



*Elaeis oleifera*  
Ulatok Simunbobok

*Elaeis oleifera*





Rainfall	Cameroon	<i>E. kamerunicus</i>	<i>E. subvittatus</i>	<i>E. plagiatum</i>
3000 mm	Lobe Estate	64%	21%	12%
3300 mm	La Dibamba	74%	18%	8%
10000 mm	Idenau Cr	86%	7%	7%
2000 mm	Modoni Cr	12%	47%	36%
2000 mm	La Mé Cl	9%	58%	31%





Improvement fruit setting: Sterile palms, Assisted pollination, Hatch & Carry technique, Kairomix, etc → **Not possible for long term.**

**“Necessary to recreate a pollinator complex similar of the one in West Africa”**

*E. kamerunicus* more active rainy period, *E. plagiatus* & *E. subvittatus* more dry period. Later population species in alternate balance according successive climate variations.



# 1 Saw it Great

Indonesian Oil Palm Research Institute (IOPRI)

