II CONGRESO PALMERO MEXICANO
POR UN SECTOR PALMERO COMPETITIVO, PRODUCTIVO Y SUSTENTABLE

VIII CONFERENCIA LATINOAMERICANA RSPO
MÉXICO 2020

CONFERENCIA MAGISTRAL

Thomas Fairhurst

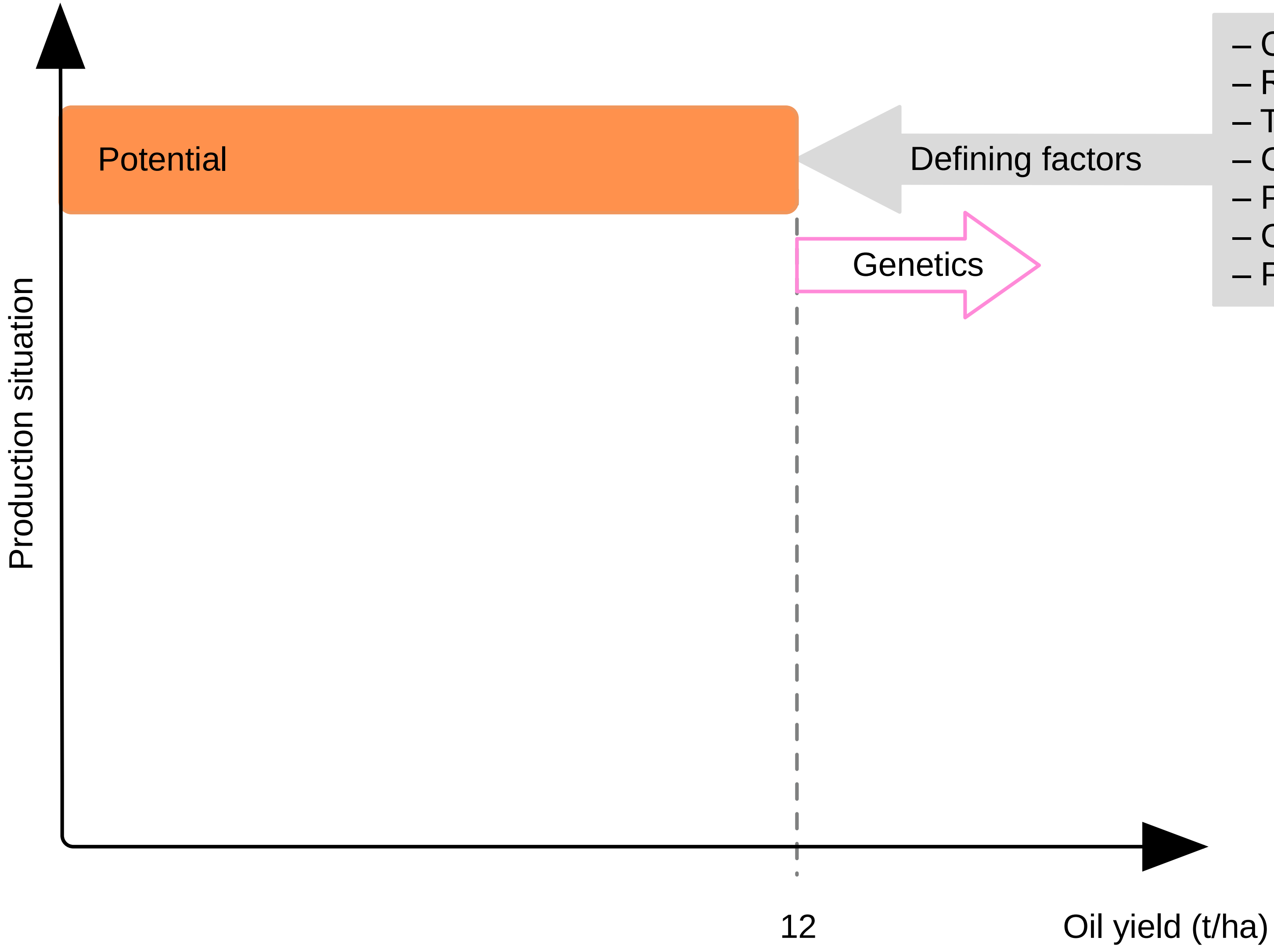
Uso de datos clave para la mejora del rendimiento a la sustentabilidad de la palma de aceite

FEMEXPALMA
Federación Mexicana de Palma de Aceite

RSPO | Roundtable on Sustainable Palm Oil

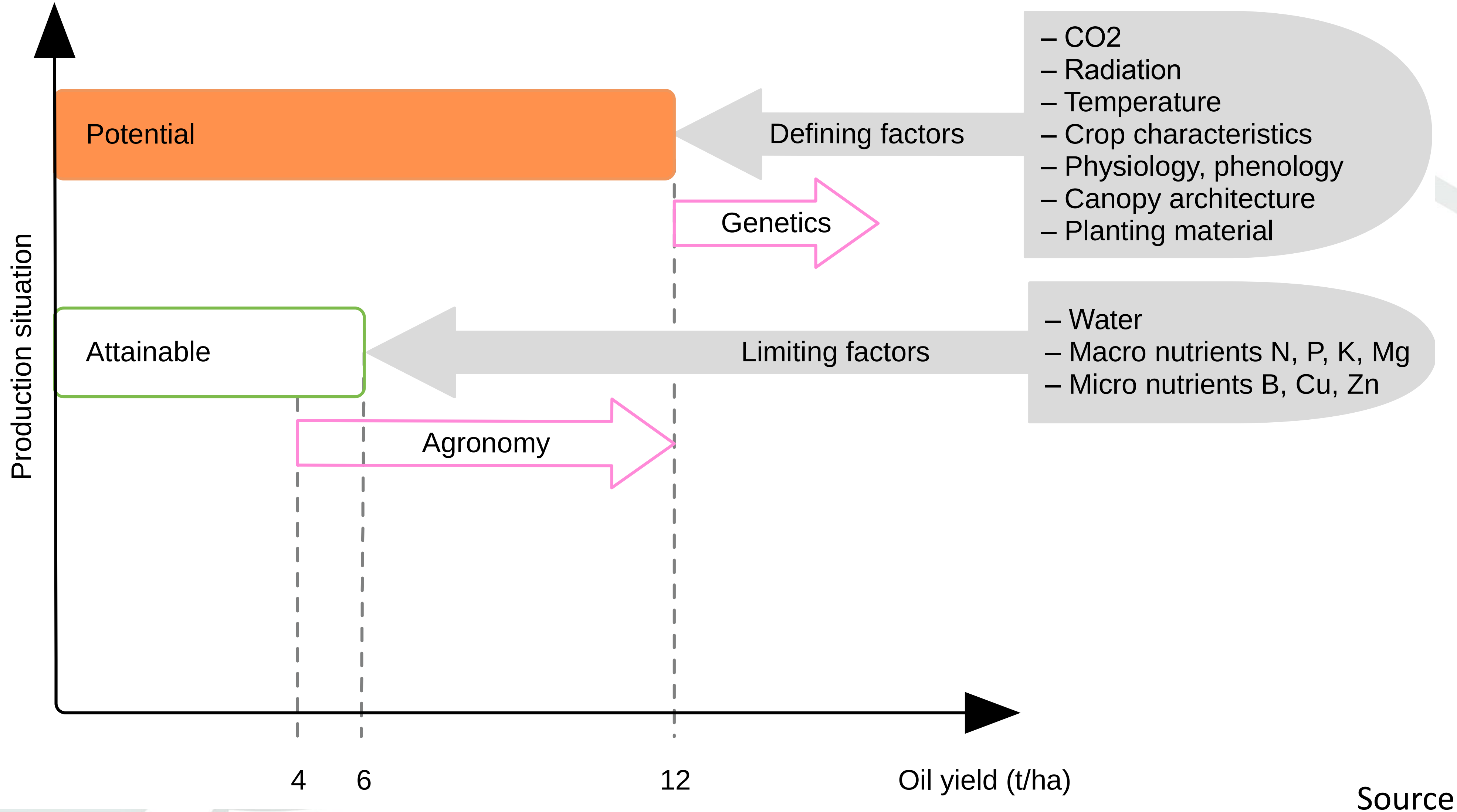
Oil palm physiology

Limitations to yield



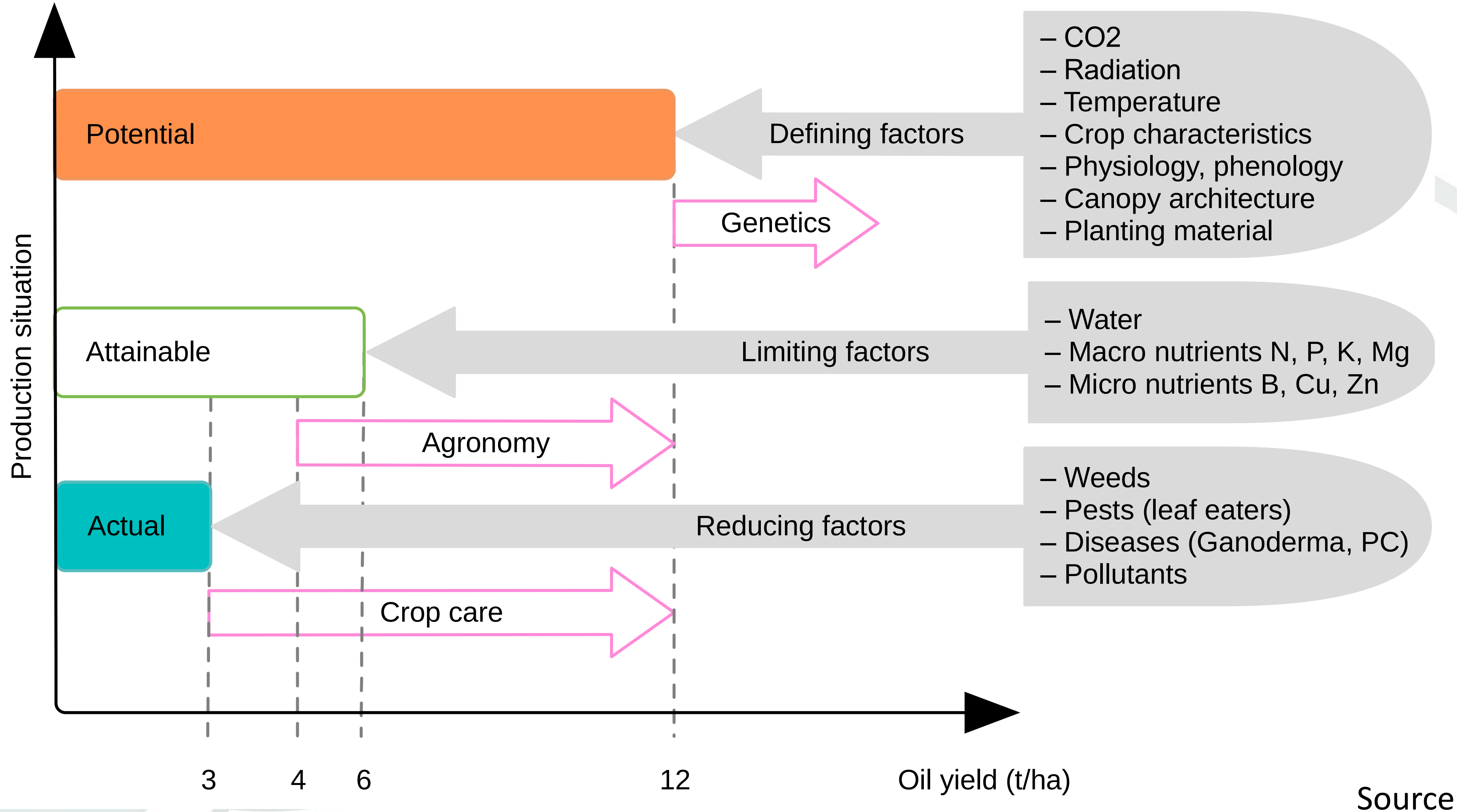
Source: Lovenstein, 2000

Limitations to yield



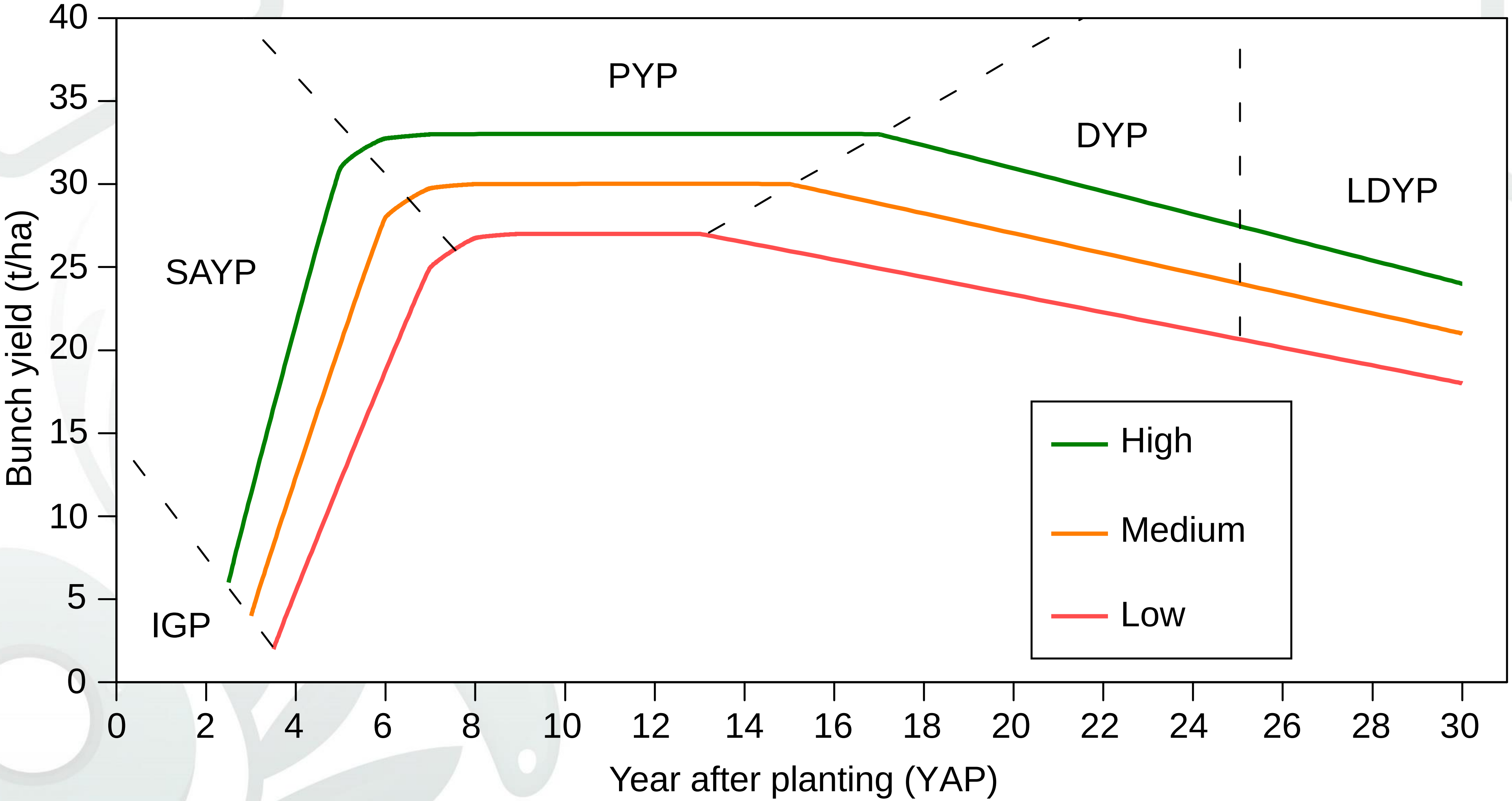
Source: Lovenstein, 2000

Limitations to yield



Source: Lovenstein, 2000

Yield profiles in different environments

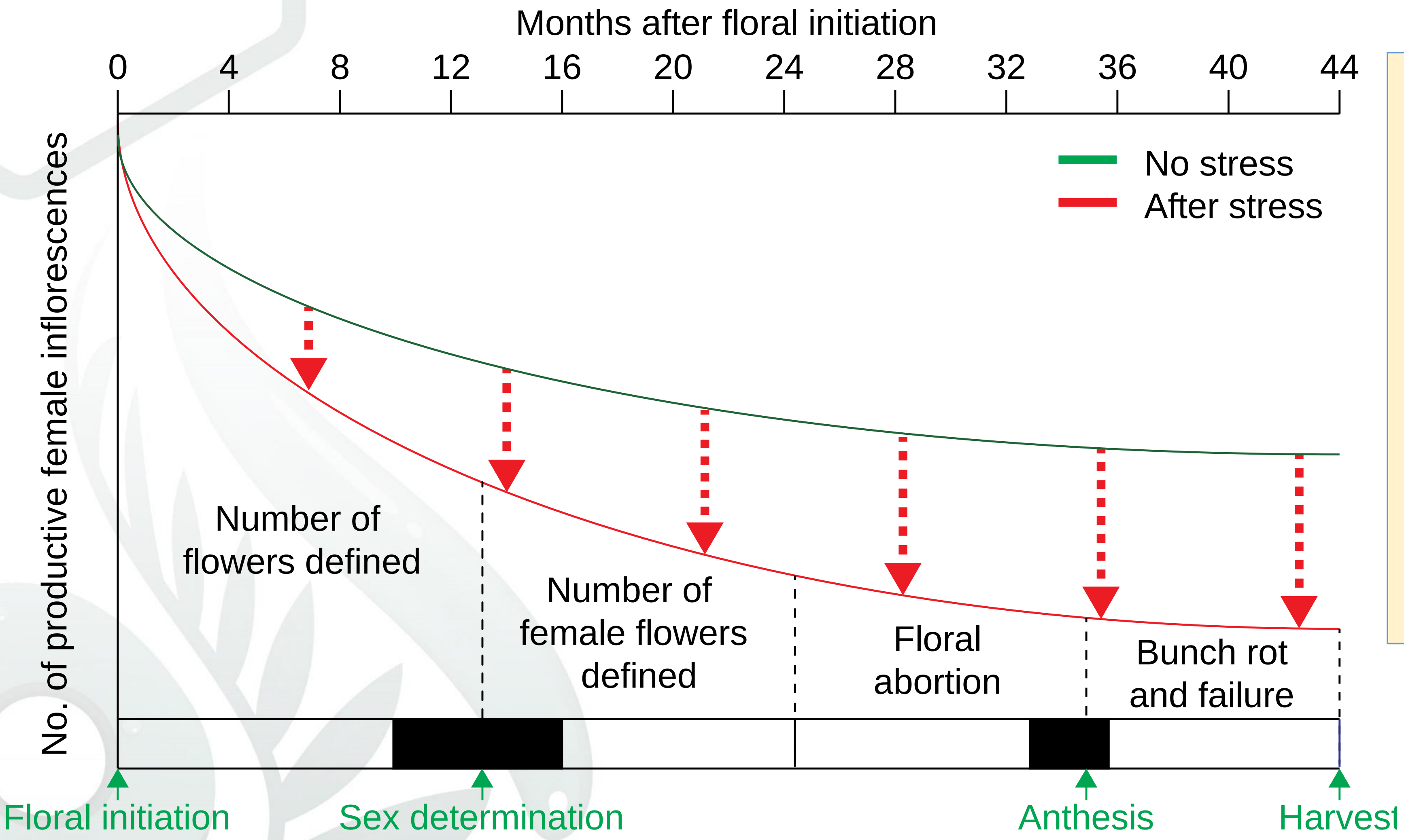


Differences between sites

- Immature growth phase (IGP) duration.
- Steep ascent phase (SAYP).
- Plateau yield phase (PYP) duration.
- Declining yield phase (DYP).

Source: Fairhurst et al, 2019

Stress effects

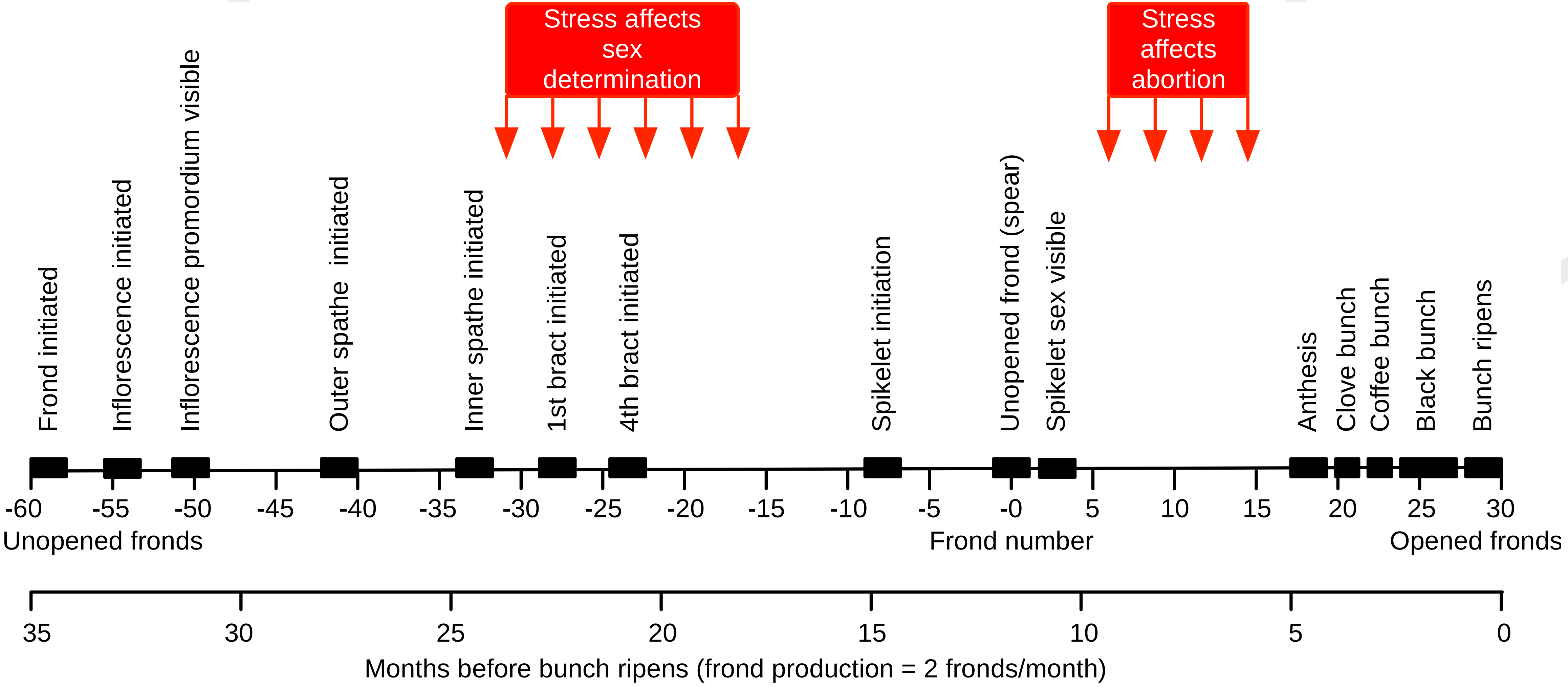


Stress effects

- Sex determination (24–34 months before bunch harvest
- Abortion (10–14 months before bunch harvest).
- Bunch failure (<5 months before bunch harvest)
- **Important to take a long-term view on agronomic management**

Source: Fairhurst et al, 2019

Time lags between stress effects and bunch yield



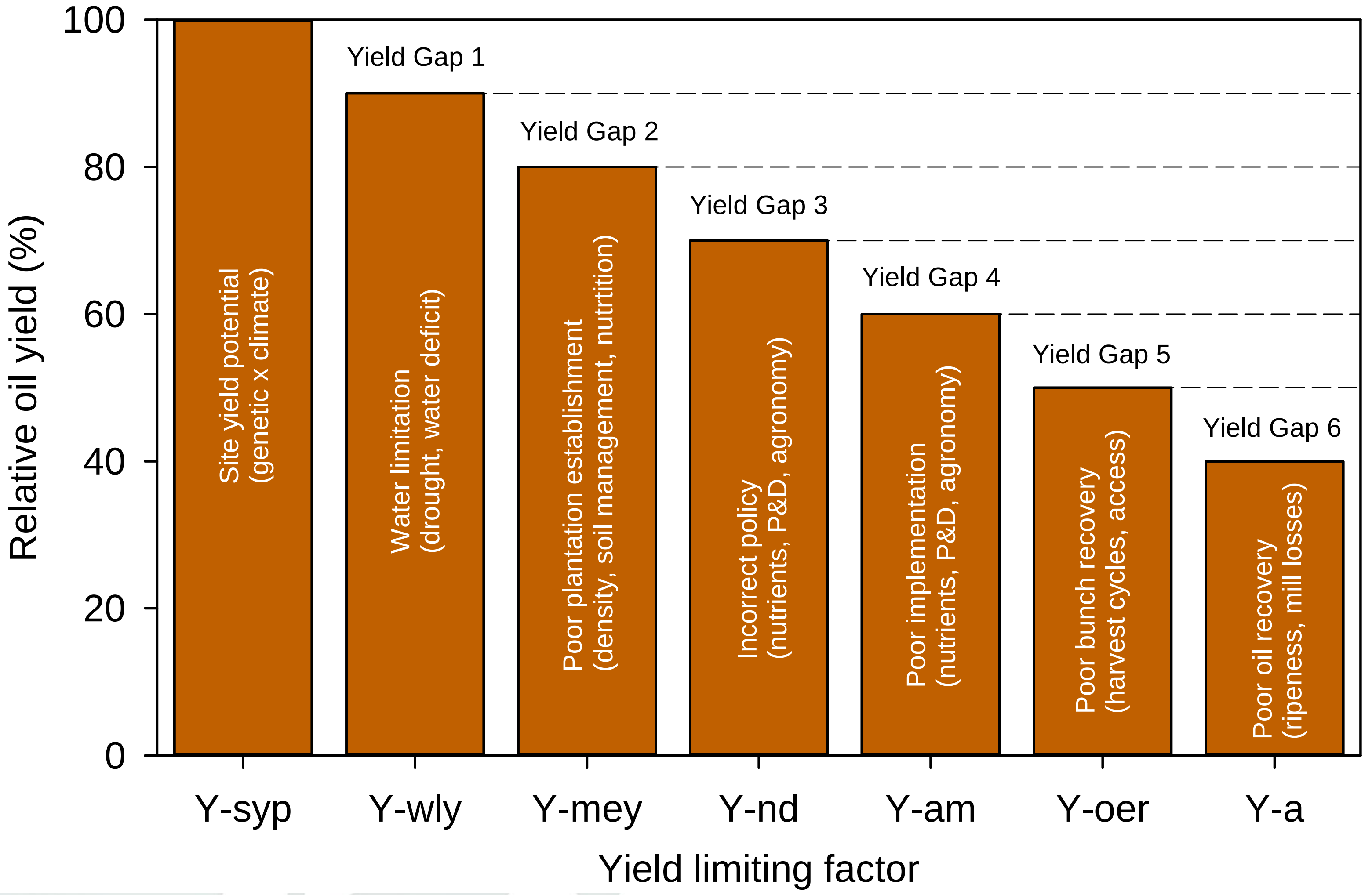
Source: Corley (2016) and Jones (1997)

Palm dissection reveals flowering patterns

Palm dissection

- Perform dissection on palms due to be removed at thinning.
- Identify sex of flowers for the next 30 months (Frond #-20 to Frond #32).
- Relate timing of water deficits to sex determination, floral abortion, and bunch failure.

Yield gap analysis to identify opportunities for improvement

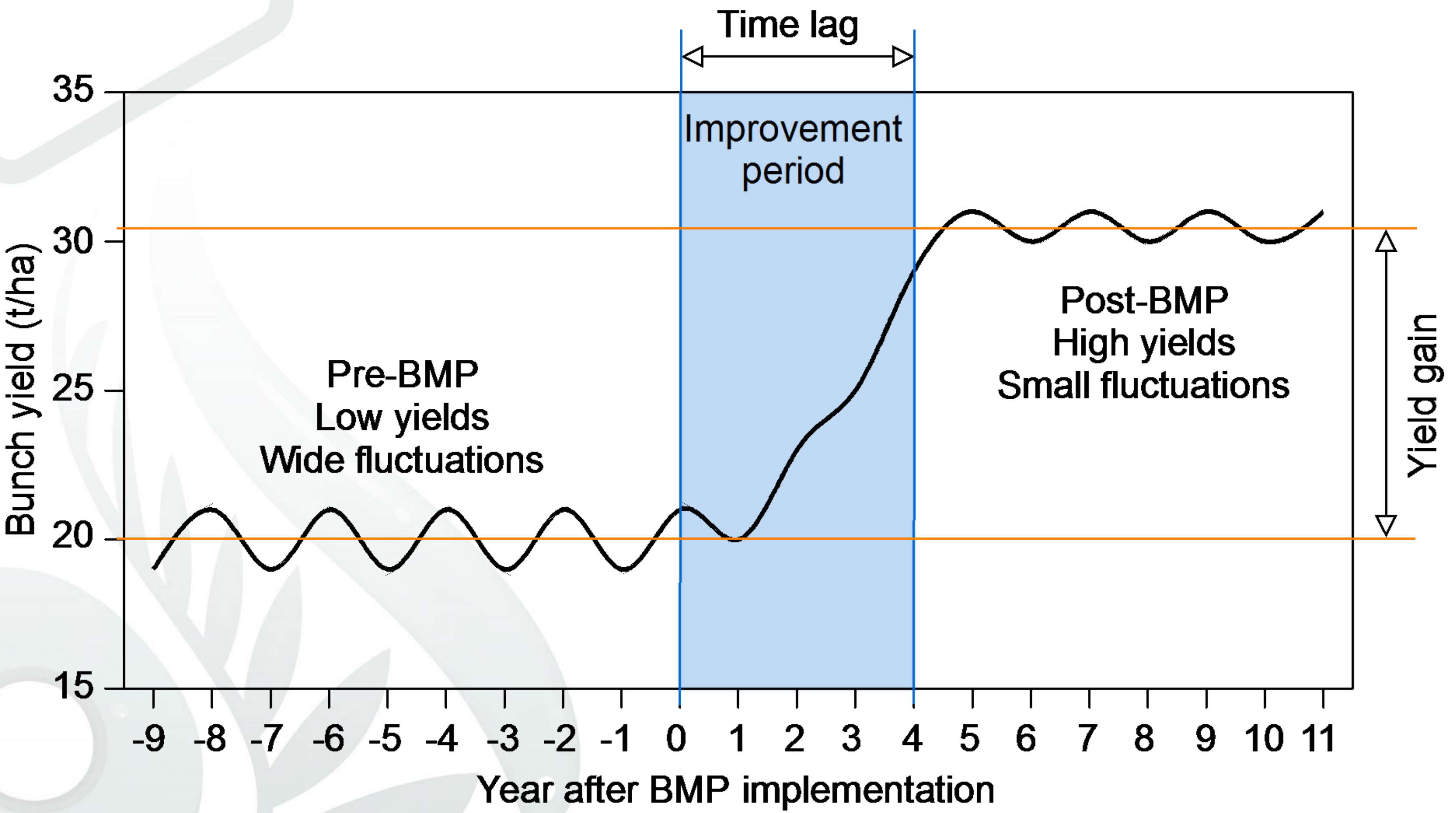


Distinguish between different causes of yield gaps

- Detective work (crop scene investigation)!
- Water stress?
- Establishment?
- Policy on fertilizer and agronomy?
- Implementation of agronomic practices?
- Crop recovery?
- Milling?

Source: Fairhurst et al, 2019

Time lags with yield improvement

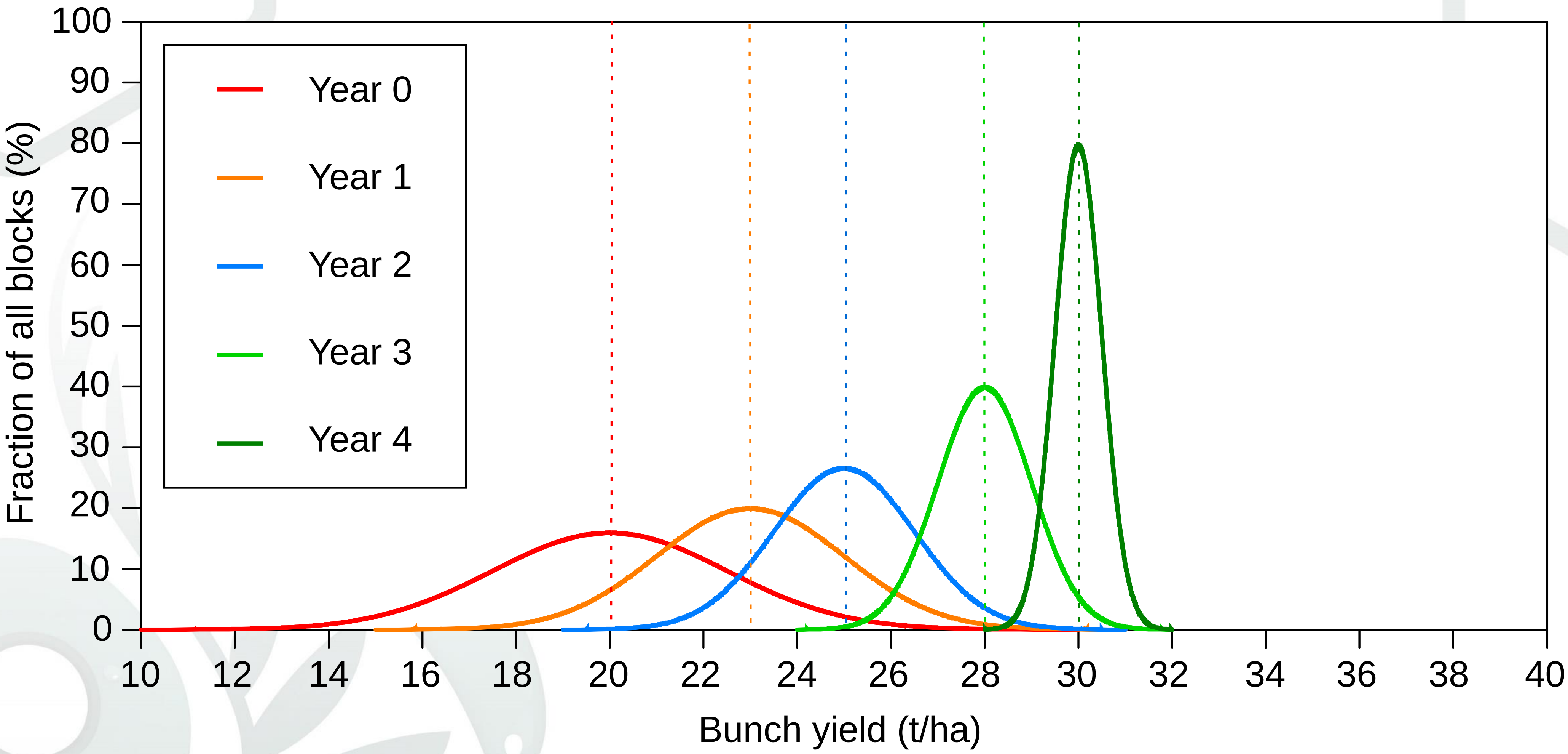


BMP blocks

- Determine site yield potential by implementing best management practices in a few selected blocks.
- **Four years until site yield potential is expressed.**

Source: Fairhurst et al, 2019

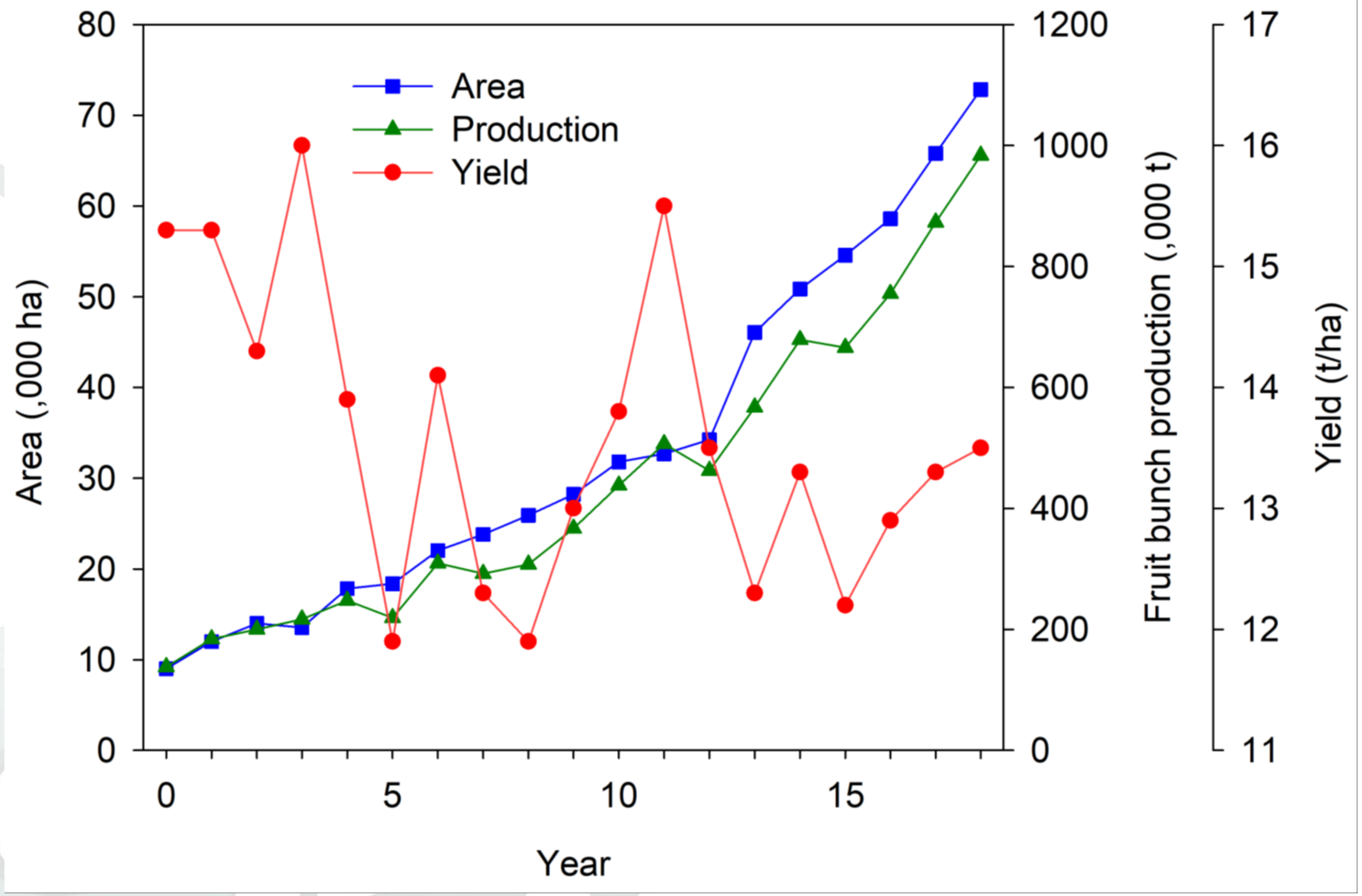
Tracking changes in yield



Source: Fairhurst et al, 2019

Oil palm in Mexico

Production in Mexico



Commentary

- Continuous increase in area planted
- Production increase is driven by area expansion
- Yields are low, erratic and generally declining
- Yield of 13 t/ha fruit bunches at 23% OER equivalent to 3 t/ha CPO.
- **Need for R and D on appropriate practices (fertilizers, agronomy) specific for Mexico**
- **Very careful planning of oil palm developments.**

Source: FAO, 2020

Factors to consider when selecting a site

Climate

- Rainfall suboptimal in quantity and distribution.

Land

- Development of oil palm from grassland.
- Small standing biomass (~10 t/ha) compared with forest (>40 t/ha).

Labour

- Seasonal demand!
- Availability.
- Housing requirement.

Soils

- Very varied (Tabasco, Campeche, Veracruz, Chiapas)
- Importance of site evaluation to check:
  - Soil texture (water and nutrient retention)
  - Soil depth (rooting depth)
  - Slope (º)
  - Soil organic carbon and total nitrogen
  - Soil exchangeable cations
  - Micronutrients

Requirement for a network of experiments

- Interactions between N and K.
- Requirement for P and Mg.
- Estimation of site yield potential.
- Determination of critical leaf levels

Processing

- Peak production related to water deficits.
- Affects milling capacity.
- Affects processing cost.

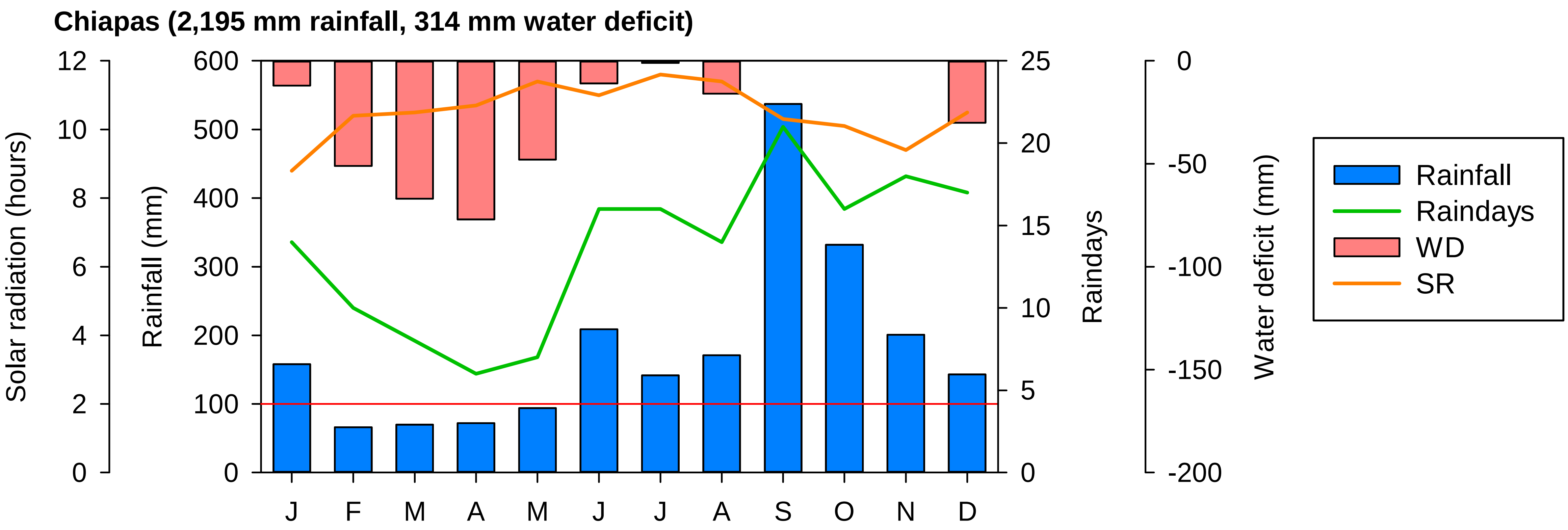
Water management

Three locations in Mexico

Spatial variability in meteorological data

- Three locations
  - Chiapas
  - Campeche
  - Tabasco
- Significant differences in rainfall and water deficits between locations within 130 km^2.
- Impact on yield potential
- Opportunities for irrigation?
- Impact on milling requirements.
- Impact on seasonality of labour demand.

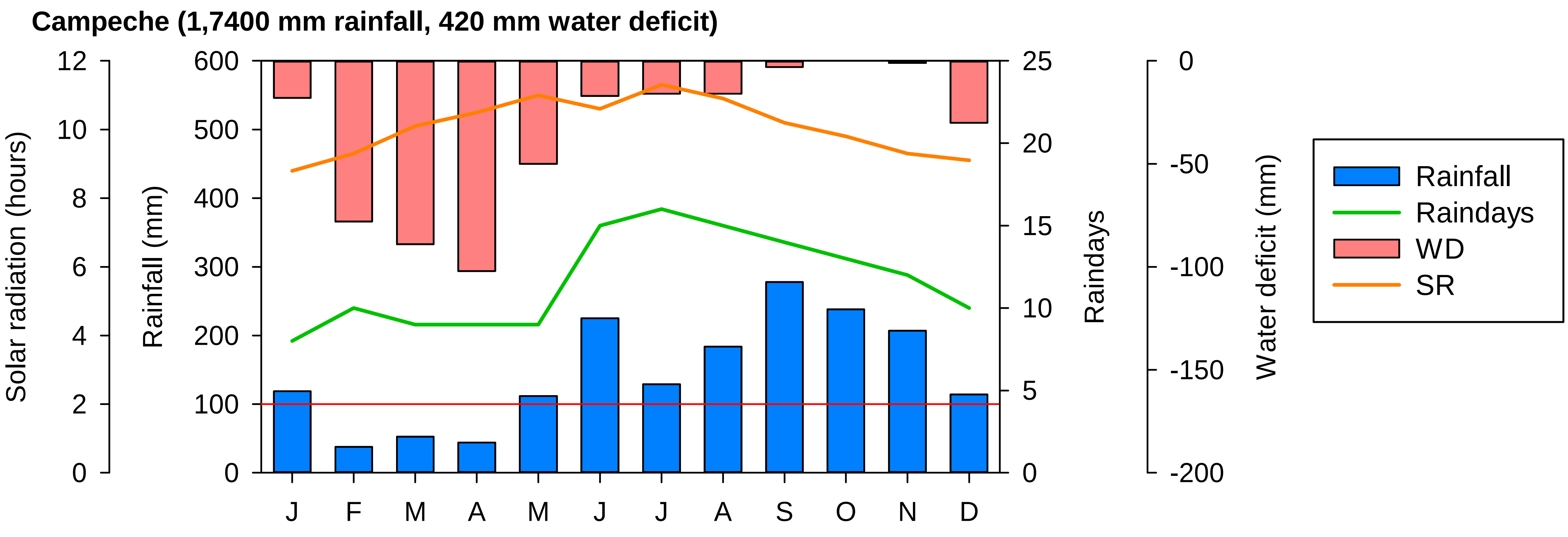
Chiapas



- Four months with <100 mm rainfall, WD 124 mm/year

- Less solar radiation during wet season (cloud cover)

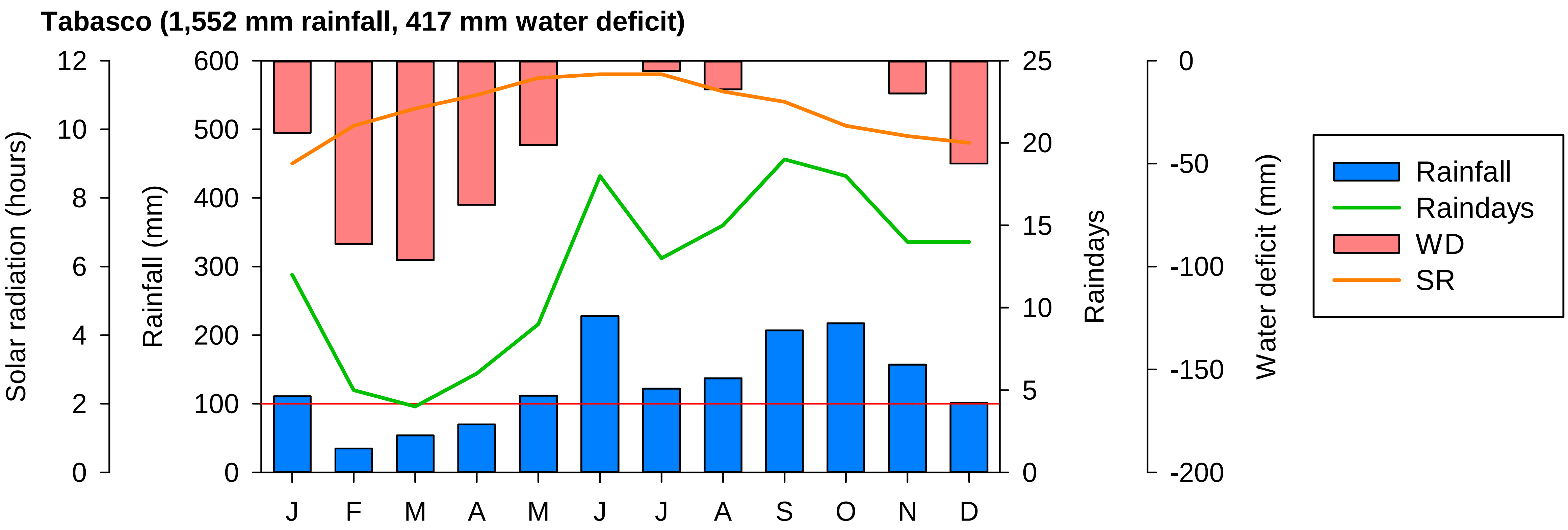
Campeche



- Three months with <100 mm rainfall, WD 124 mm/year

- Less solar radiation during wet season (cloud cover)

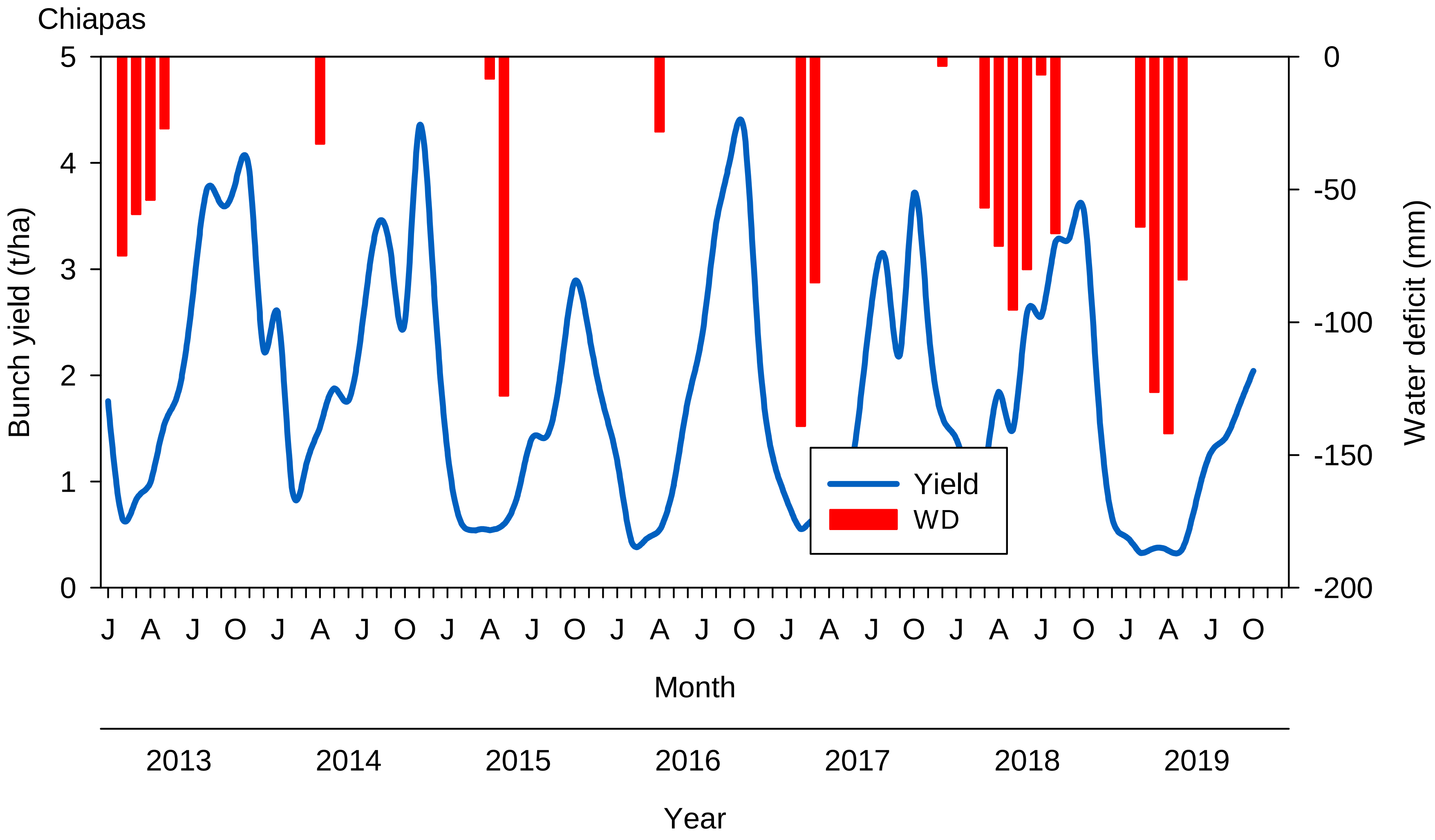
Tabasco



- Three months with <100 mm rainfall, WD 124 mm/year

- Less solar radiation during wet season (cloud cover)

Effect of seasonal drought on monthly yield in Chiapas

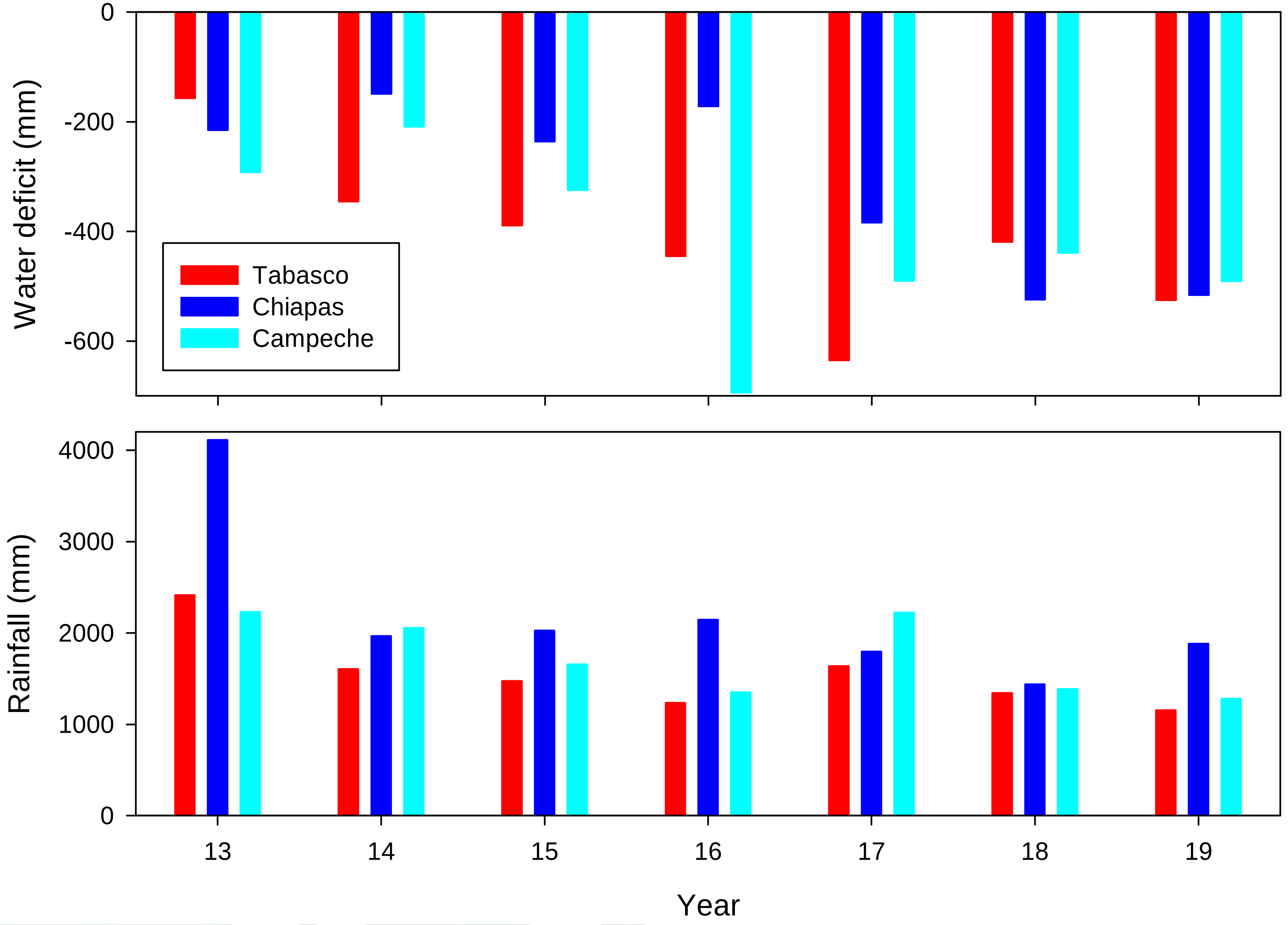


Annual water deficit triggers fluctuating monthly yield due to:

- Fluctuation is due to bunch number!
- Effect on sex determination (time lag 24 months).
- Effect on abortion (time lag 12 months).
- Effect on bunch failure (time lag <5 months).

- Data for plateau yield phase (PYP) blocks in Palenque.

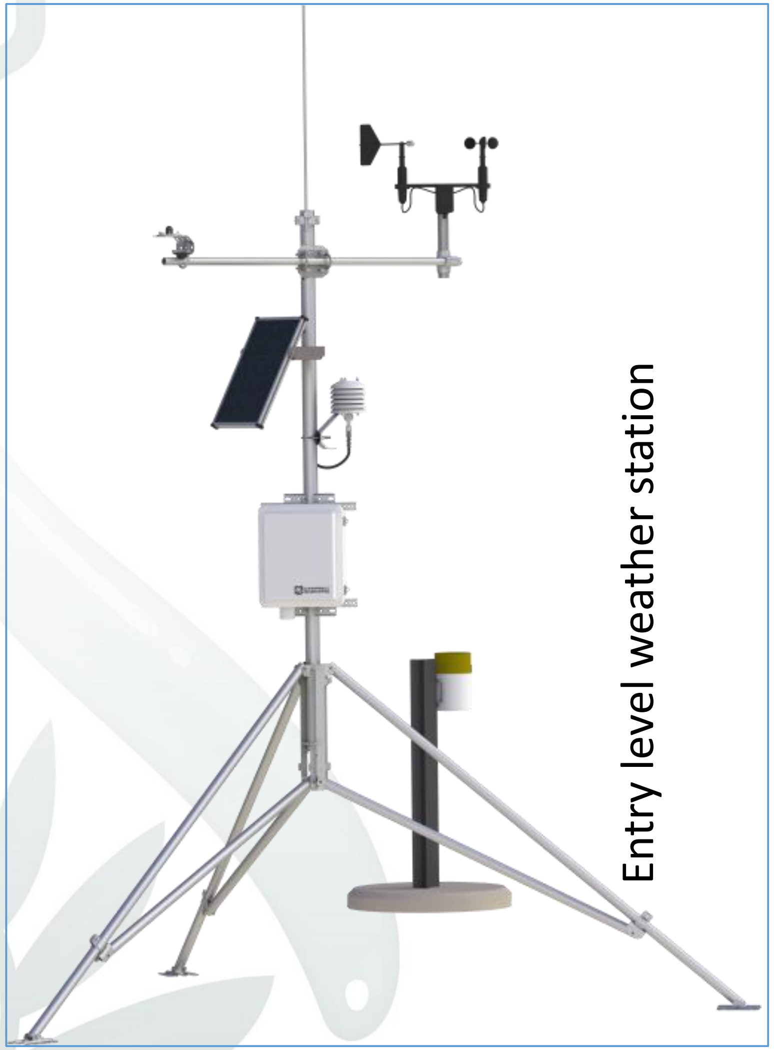
Long term trends in rainfall and water deficits



Long term trends

- Rainfall decreasing?
- Water deficits increasing?
- Requirement for forensic analysis of multiple data sets over the long term (50-year time span).

Equipment and measurements for meteorological data



Equipment

- Quality weather station
- Tensiometers (20 cm, 40 cm, one set per 1,000 ha)
- Piezometers (one per 1,000 ha)
- Phyllotaxis palm (one per 1,000 ha)

Measurements

- Daily weather data
- Daily tensiometer readings
- Daily piezometer readings
- Daily piezometer readings
- Weekly Unopened frond records
- Phyllotaxis palm measurements

Sources: https://en.eijkelkamp.com, https://www.campbellsci.com

Importance of collecting and storing meteorological data

Ver detalles de lotes

Distrito	Rancho	Block	Año
D1-S01	Desquite	1001	2019

Edad: 19 a
Mes sembrado: 07-2000
Área: 27.77 ha
Área mad.: 25.38 ha

Datos básicos | Producción | Siembra | Censo | Mantenimiento | Crecimiento veg. | Nutrientes foliar | Suelo | Fertilización | Clima

Clima

ID estación meteo.: Palenque

Eficiencia en el uso de lluvia: 6.61 t/(ha mm)

Mes	Lluvia	Riego	Días lluvia	ET	Déficit	IDH	THS	RFA	Sol	Temperatura [°C]			Velo. viento
	mm	mm	d	mm	mm	%	kPa	MJ/m²d	h/d	Pmd	max	min	m/s
Ene	92	0	16	120	0	-23			7.9	22.9	31.8	15.2	0
Feb	62	0	9	150	-64	-59			9.6	25.6	35.5	17.2	0
Mar	24	0	6	150	-126	-84			9.5	25.8	35.8	18.4	1
Abr	8	0	5	150	-142	-95			9.3	28.5	40.1	16.7	1
May	66	0	9	150	-84	-56			10.0	31.1	40.6	22.8	1
Jun	281	0	15	120	0	134			10.5	28.9	39.4	21.9	1
Jul	116	0	16	120	0	-3			10.5	28.2	36.2	21.3	1
Ago	56	0	9	150	0	-63			10.0	29.0	38.2	22.4	1
Sep	329	0	21	120	0	174			9.5	28.0	38.7	22.9	1
Oct	428	0	22	120	0	257			9.0	27.0	36.6	21.9	0
Nov	214	0	21	120	0	78			8.7	25.0	33.8	18.3	0
Dic	208	0	20	120	0	73			8.4	23.6	32.6	15.4	0
Año	1,883	0	169	1,590	-416	18			9.0	27.0	36.6	19.5	1

Mes secos: 6 ms

Filtro

Filtrado por: Año = 2019

OMP

- Comprehensive meteorological data stored for each weather station.
- All blocks linked to the nearest weather station.
- Irrigation recorded
- Water deficits calculated.

Site information

- Collect and store meteorological data at each site.

Response to irrigation and effect on yield

Yield response (YR, t/ha) = (Water deficit (mm) x 0.0288)

- Assume site yield potential without water deficit is 30 t/ha (averaged over the lifetime of a planting)

Site yield potential (SYP) = yield potential (t/ha) – yield response (t/ha)

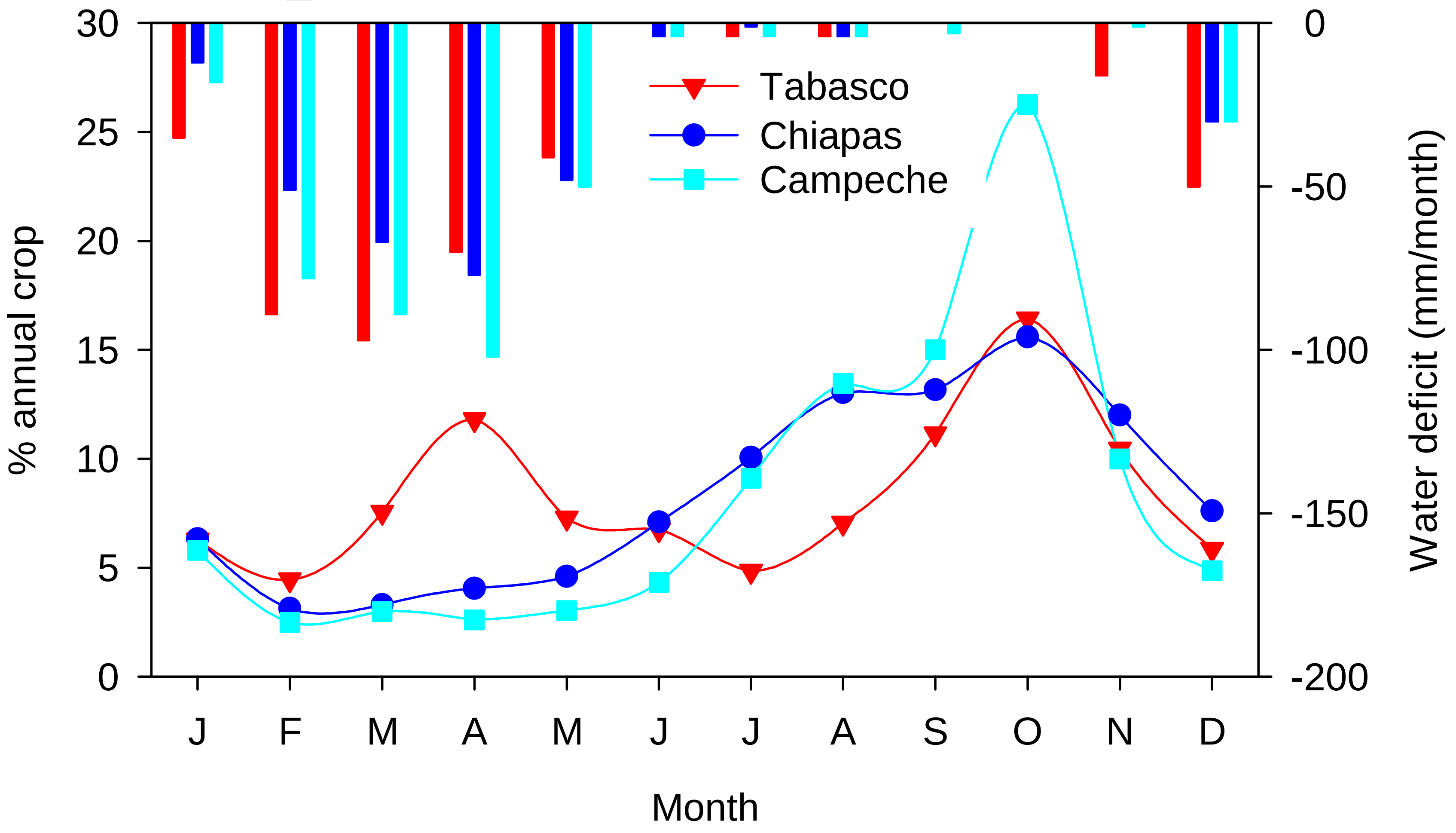
Chiapas
Yield potential = 30 t/ha – (314 mm/year x 0.0288) = 30 – 9 = 21 t/ha

Tabasco
Yield potential = 30 t/ha – (417 mm/year x 0.0288) = 30 – 12 = 18 t/ha

Campeche
Yield potential = 30 t/ha – (420 mm/year x 0.0288) = 30 – 12 = 18 t/ha

Source: Carr, 2011

Effect of water deficits on crop distribution



- Peak crop production varies between 15–26% of annual production in a single month.
- Impact on:
- Labour demand.
- Transport requirements.
- Milling requirements.

Effect of crop distribution on mill capacity requirements

$$\text{Mill capacity (pph)} = \frac{\text{Yield (t/ha) x Area (ha) x Peak (\%)}}{550}$$

Chiapas (higher yield potential, smaller peak)

$$\text{Mill capacity} = \frac{25.7 \times 10{,}000 \times \frac{16}{100}}{550} = 75 \text{ tonnes per hour}$$

Campeche (lower yield potential, larger peak)

$$\text{Mill capacity} = \frac{23.2 \times 10{,}000 \times \frac{26}{100}}{550} = 109 \text{ tonnes per hour}$$

Water conservation

Water conservation

- Block drains before the end of the wet season (e.g. in October?)
- Install **tricanters** to generate more decanter cake and use as mulch to improve soil moisture retention
- Use of empty bunches
- Irrigate with palm oil mill effluent

Utilization of crop residues for 10,000 ha yielding 25 t/ha and 250,000 t fruit bunches

Item	% fruit bunches	Amount	Application rate	Area covered	
Units	%	t	t/ha	ha	% area
Empty fruit bunches	20	50,000	30	1,667	17
POME	70	175,000	650	270	3
Decanter cake	10	25,000	30	833	8
Total	-	**250,000**	-	**2,770**	**28**

Water conservation

- Huge potential to improve water availability by use of mill residues, pruned fronds and proper drainage systems.
- Full use of mill residues reduces fertilizer requirements.

Possibilities for irrigation

Operating cost of irrigation	
Cost parameter	USD/ha
Irrigation capex USD 3,000 @ 10% depreciation	300
Three months irrigation @ USD 150/month	450
Total cost	750

Water requirement		
Parameter	Units	Value
Daily requirement	m^3/ha/day	60
Period (3 months)	days	90
Water requirement	m^3/ha/period	5,400

Power source for pumping water
- Diesel engines
- Electric power from mill
- Electric power from cogeneration (CH_4 capture over effluent ponds)

Irrigation method
- Sprinklers
- Micro sprinklers
- Drip irrigation
- Channel irrigation
- Flood irrigation

Sustainability of water supply
- Competition with local villages
- Tap into ground water with wells?
- Draw water from rivers?

Select suitable varieties, adapted to water stress

Estimates of yield potential in relation to water deficit				
Main characteristics with optimum crop management	Units	0 mm water deficit Sandy clay soils	200 mm Water deficit	400 mm Water deficit
Planting density	p/ha	143	143	143
Fruit bunch yield (>7 YAP)	t/ha	29–32	**24–27**	**17–20**
Bunch weight	kg	<18	<18	<18
CPO extraction rate	%	26–27	25–26	24–25
PKO extraction rate	%	2–3	2–3	2–3
CPO yield	t/ha	7.5–8.5	6.0–7.0	4.0–5.0
CPO + PKO yield	t/ha	8.0–9.5	6.5–8.0	4.5–5.5
Iodine value	Wijs	>55		
Vertical growth	cm/year	46–56	44–54	42–52
First harvest	MAP	24	30	36

Source: https://www.palmelit.com

Phyllotaxis palms to assess production dynamics

Installation

- One palm per 1,000 ha
- Label all fronds with frond number tags. Move the tags every two months => train staff to identify Frond #17 correctly.

Record keeping

- Petiole cross section
- Date of anthesis and date of harvest => days from anthesis to bunch harvest.
- Number of inflorescences reaching anthesis.
- Sex of flowers.
- Number of pollinated bunches reaching harvest.

Impact

- Measure effect of treatments (irrigation, water conservation)
- Measure sex ratio
- Measure bunch failure

Planting in Mexico

Plantation planning

- Gantt chart of events
- Choose adapted planting material.
- Planting density (143–160 p/ha). 160 p/ha can be thinned to 137 by removing 1 in 7 palms.
- Time nursery so that optimal aged seedlings 10–12 MASP) are ready to plant in the wet season (June-October).
- Investigate water availability for irrigation and carry out partial budget.
- Consider peak crop production when planning mill capacity (>15% in peak month).

Plantation establishment

- Install sufficient drainage that will also provide the means for water conservation (permanent water gates).
- Recapitalize soil phosphorus by incorporating 300 kg/ha P_2O_5 as reactive rock phosphate.
- Full establishment of legume cover plants (*Mucuna bracteata* (if labour supply allows) or *Pueraria phaseoloides*).
- **Set up irrigation before planting**
- **Complete planting by October.**
- Apply empty bunches (300 kg/palm) immediately after planting as mulch (water conservation).
- Implement fertilizer programme (4 Rs)
- Ablate palms (2 cycles/month) from the appearance of flowers (12 MAP) to 5 months before start of harvest at 30 MAP.

Conclusions

Oil palm in Mexico

- Opportunities to develop oil palm in Mexico on suitable soils.
- Low carbon footprint.
- Climatic conditions are marginal and attainable yields are lower than other countries in Central and South America.
- Special techniques are required to optimize water availability.

Plantation establishment

- Very careful site selection after considering soil and climate conditions.
- Selection of drought tolerant planting materials.
- Consider the requirement for soil P recapitalization.
- Full water conservation programme.
- Maximum use of mill residues.

Crop agronomy

- Plant in the wet season and complete planting by October.
- Requirement for a network of fertilizer experiments to determine optimal rates and critical leaf levels.
- Requirement for research into water management (water conservation).
- Learn from oil palm sector in other drought stressed environments (e.g. Thailand).
- Feasibility studies on sustainable irrigation techniques.

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Source: Rutgers, 1922

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Muchas gracias
por su atención

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