SESSION NINE

Session Nine
Fruit size and production

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Growing Avocados in Chile: A Focus on Orchard Systems, Fruit Set and Size

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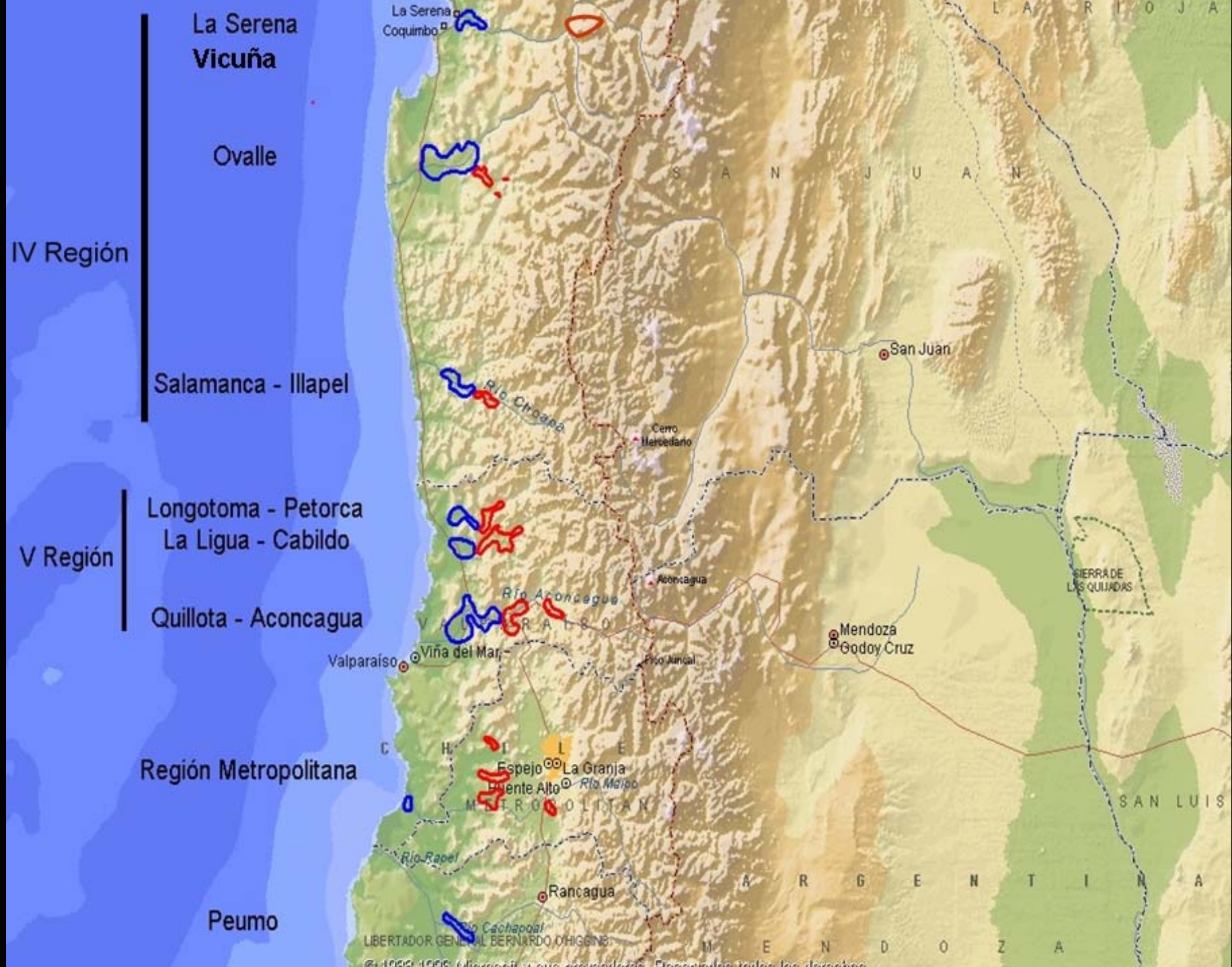
Introduction

- Climatic Conditions.
- Quality and Availability of Water.
- Low Incidence of Pests.
- Possibility to Grow Avocados on Steep Slopes.
- Growers vision.


La Serena
Vicuña
Ovalle
IV Región
Salamanca - Illapel
Longotoma - Petorca
La Ligua - Cabildo
V Región
Quillota - Aconcagua
Región Metropolitana
Peumo
La Serena
Coquimbo
Río Choapa
Cerro Mercedario
Río Aconcagua
Aconcagua
Valparaíso
Viña del Mar
Pico Juncal
Espejo
La Granja
Puente Alto
Río Maipo
Río Rapel
Rancagua
Río Cachapoal
San Juan
Mendoza
Godoy Cruz
SIERRA DE LOS QUIJADAS
SAN LUIS
LA RIOJA
SAN JUAN
ARGENTINA
MENDOZA
CHILE
METROPOLITAN
LIBERTADOR GENERAL BERNARDO O'HIGGINS

Chilean Avocado Production Areas

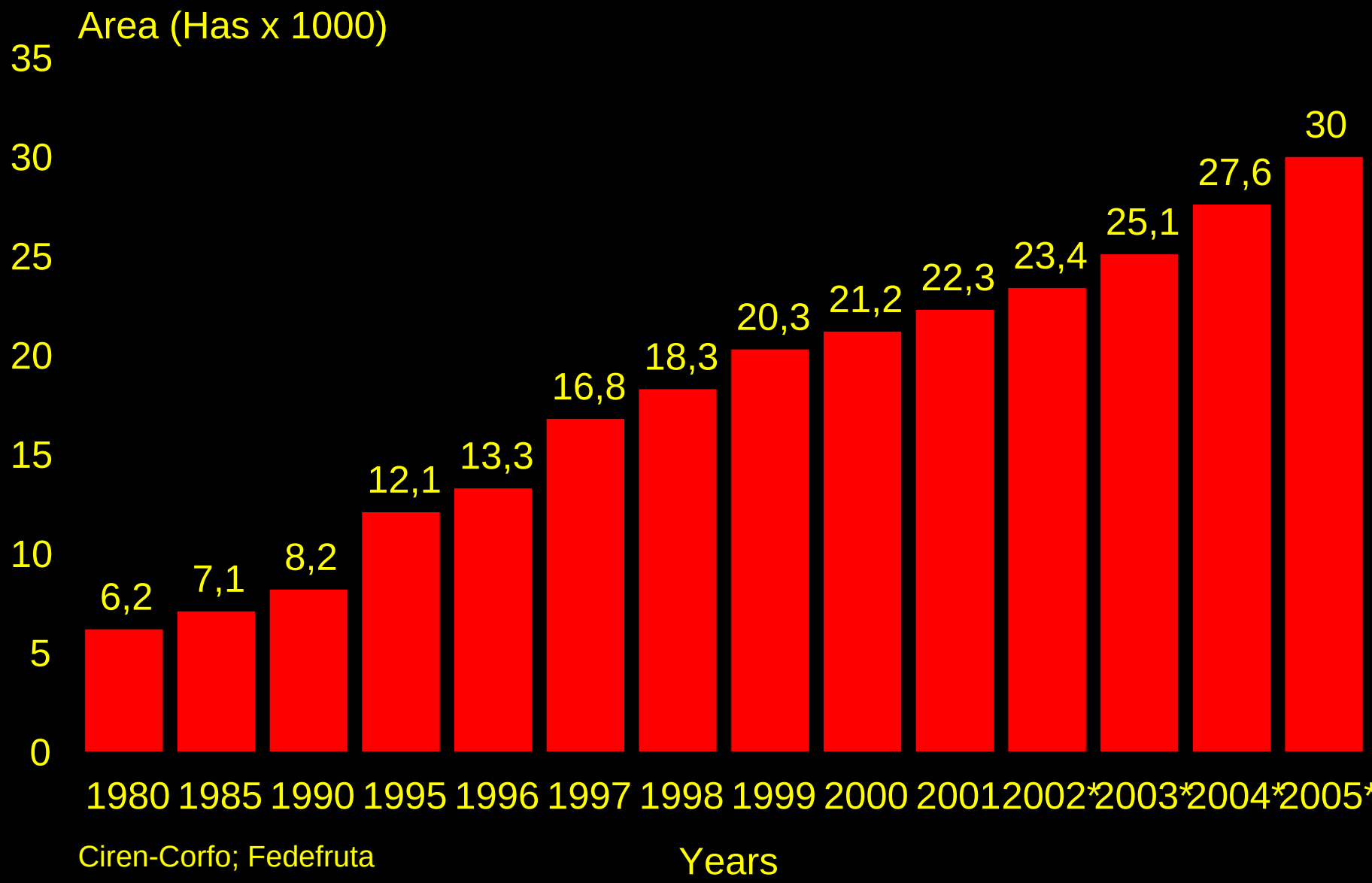
Coastal Areas

- Low heat accumulation. (±1.000 h > 13,5ºC).
- High Humidity (90 – 40%).
- Low risk of cold
- Cold winds during flowering.
- Low temperatures during flowering (fruit set)
- Extreme temperatures (means).
  - Summer : 10 – 26 ºC
  - Winter : 2 – 18 ºC
- ETo Dec. 7,1 mm/day.
- Rainfall: 400 mm.V Region
- Coastal wind during spring and Summer

Inland Areas

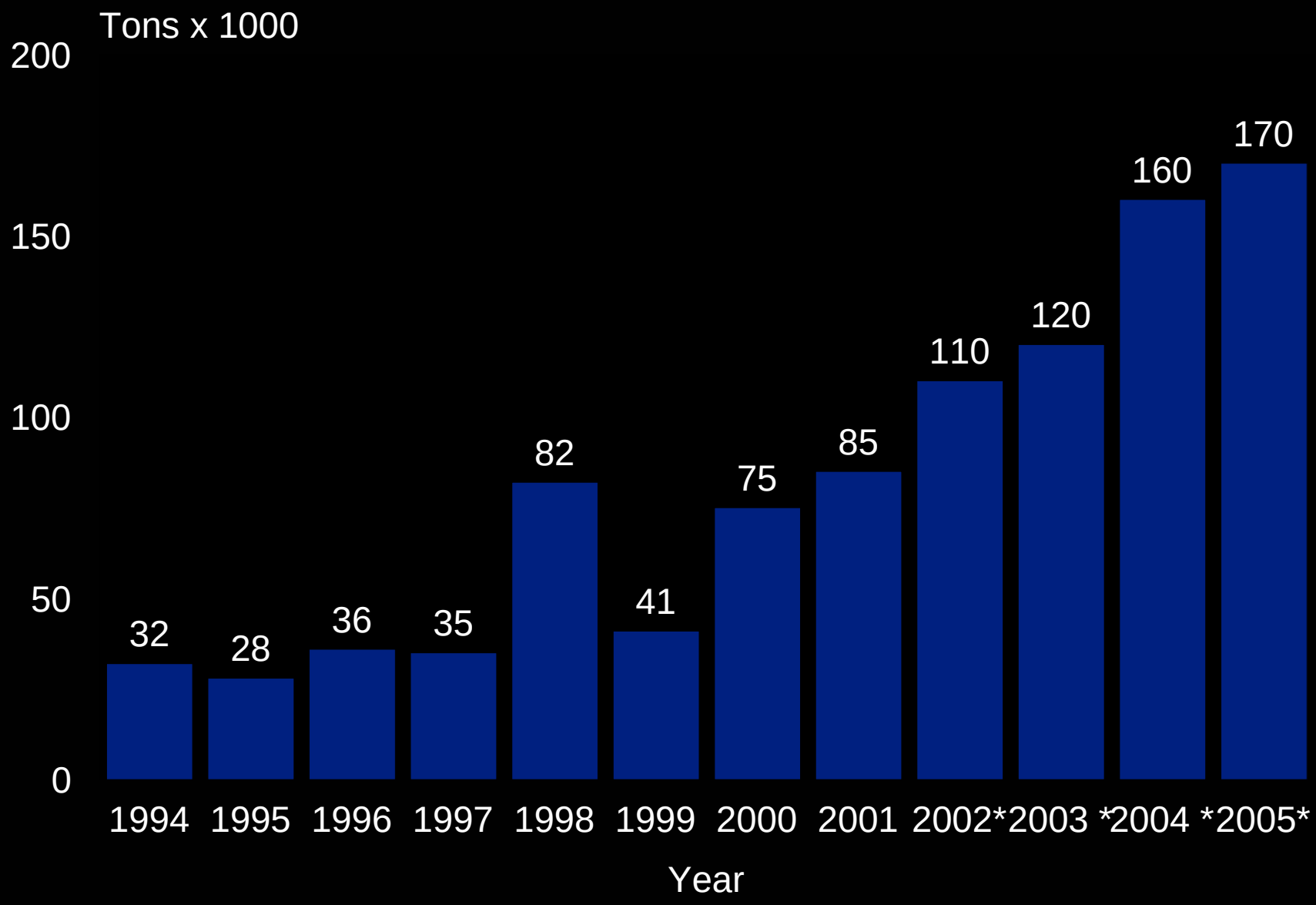
- High heat accumulation. (±1.400 h > 13,5ºC).
- High Humidity (80 – 25%).
- High risk of cold (Hills)
- Less wind problems.
- High temperatures during flowering (fruit set)
- Extreme temperatures (means).
  - Summer : 18 – 33 ºC
  - Winter : 0 – 22 ºC
- ETo Dec. 10,2 mm/day.
- Rainfall: 200 mm.V Region
- Mostly sunny during spring and Summer

The Growth in Numbers – Area Planted with Avocados

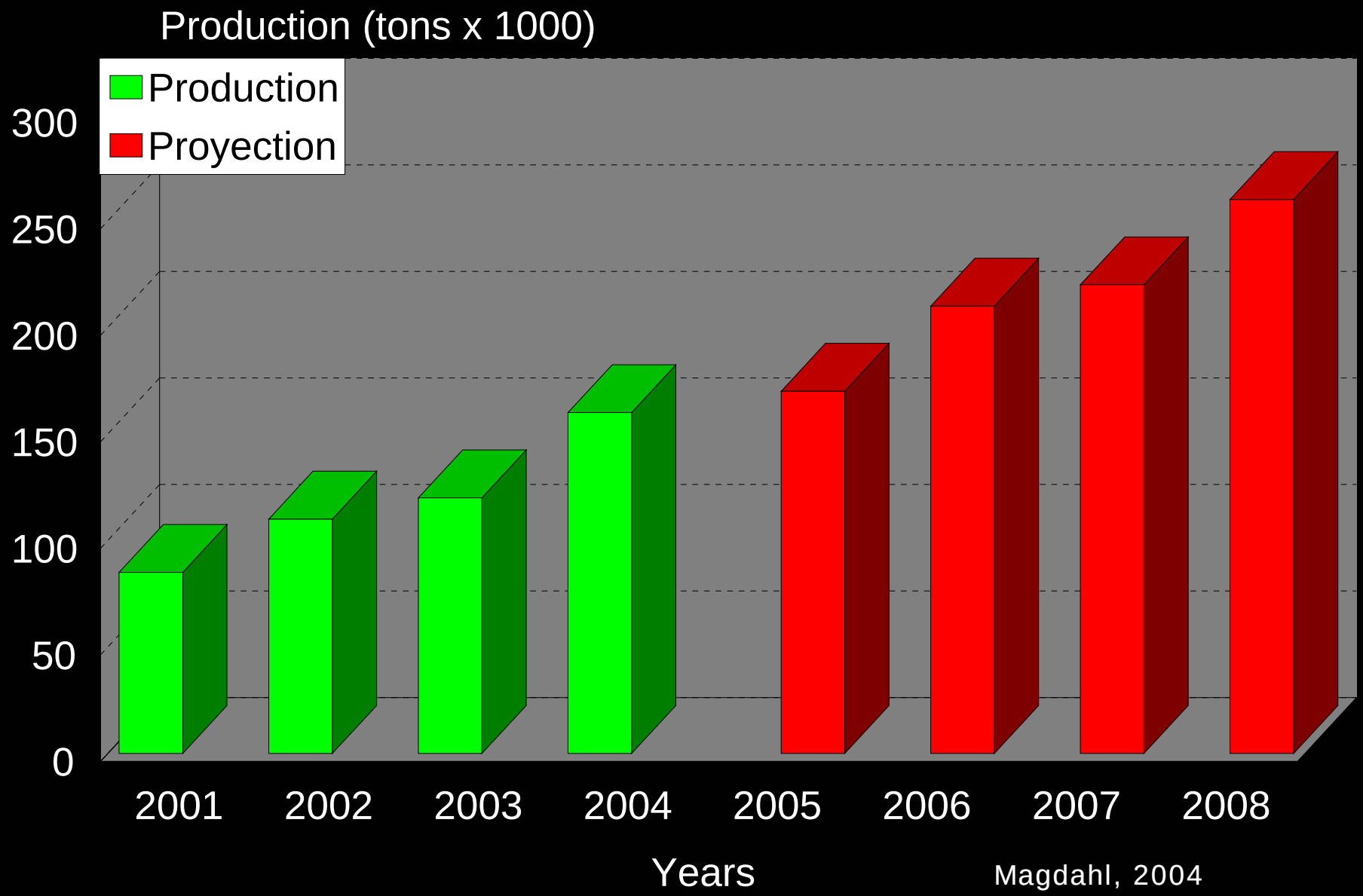


Ciren-Corfo; Fedefruta

The Growth in Numbers – Production

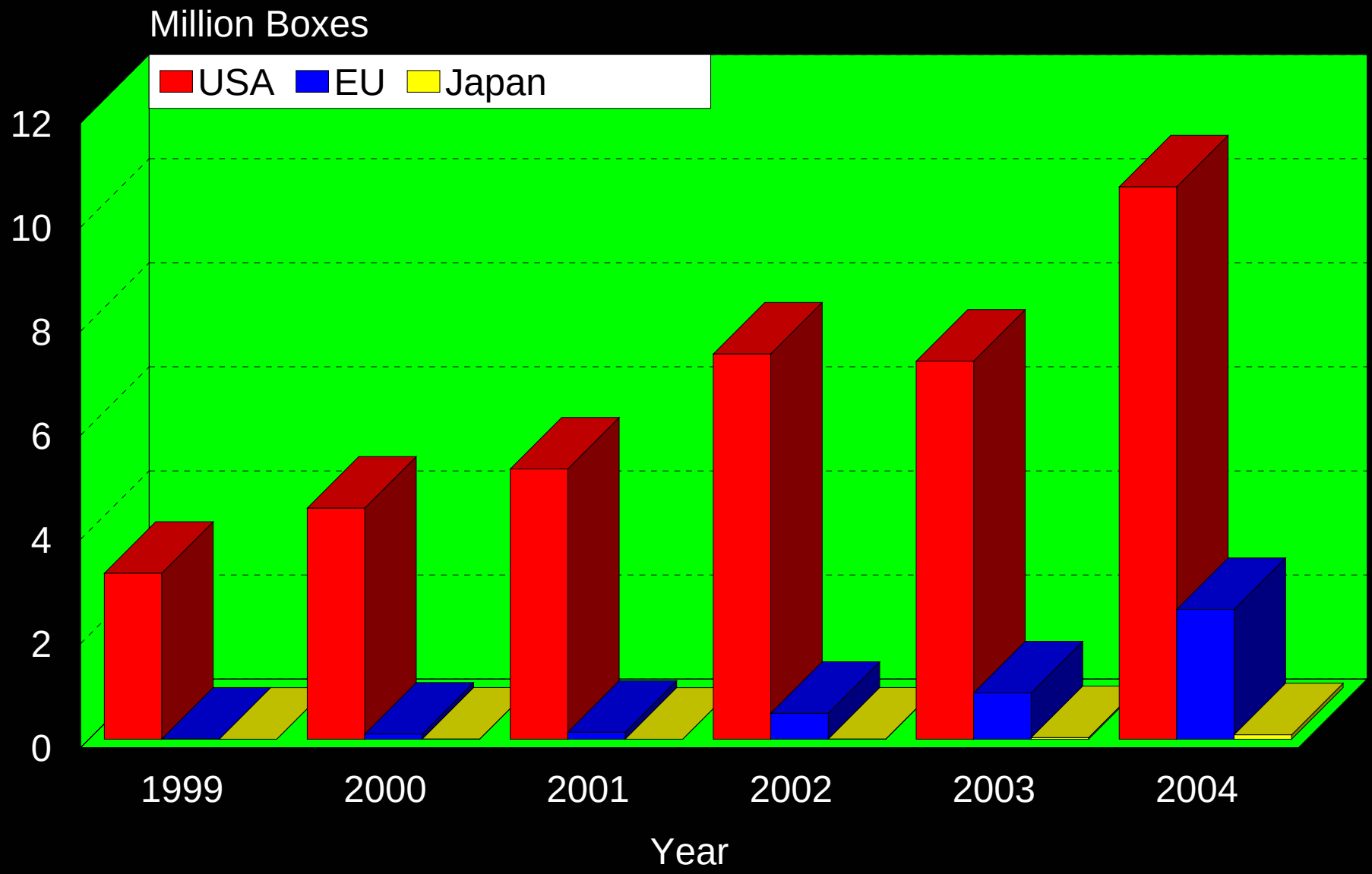


The Growth in Numbers – Proyections



Magdahl, 2004

The Growth in Numbers – Exports



The Challenge

- Maintain profitability with increasingly higher volumes and competition at destination markets

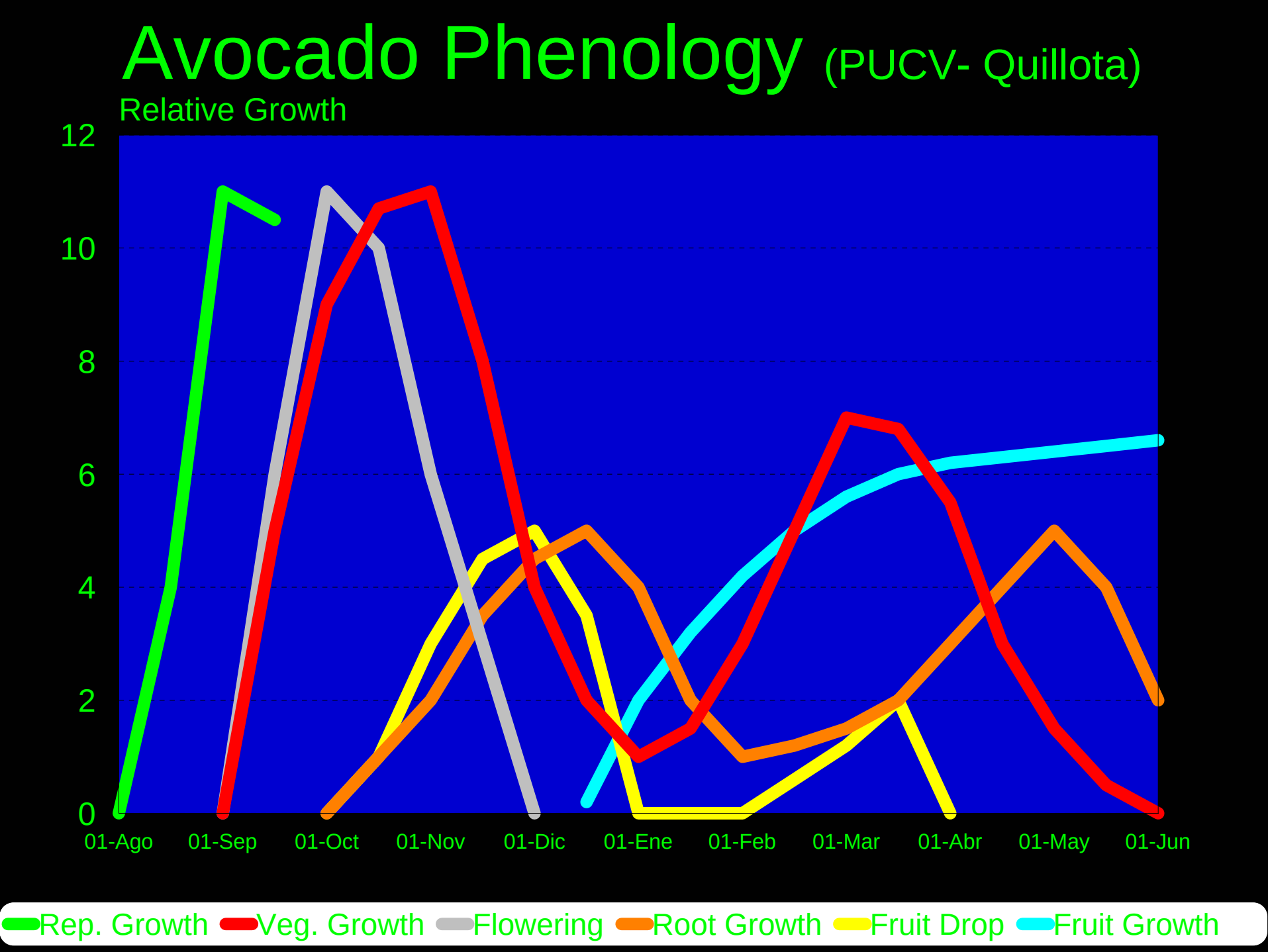
Facing the Challenge

- Yield is not the main factor anymore
- Production and Fruit Size.
- Production Costs (per kilo, not per hectare).
- **Production efficiency**

Strategies to Face The Challenge

- ☑ Understanding the Crop (Phenology)

Avocado Phenology (PUCV- Quillota)



Phenology

- The base for every cultural practice.
- Anticipate the response of the tree.
- Key to Orchard Management.

What’s new:

- Develop models for Inland areas.
- Redo the models for the Quillota and other areas under new management tools and rootstocks.

Strategies to Face The Challenge

- ☑ Understanding the Crop (Phenology)
- ☑ Irrigation

Irrigation

- Irrigation in Chile is a Must.
- 80% of the Orchards with pressurized irrigation systems.
- Micro sprinklers and Micro jets the most common.

Scheduling Irrigation

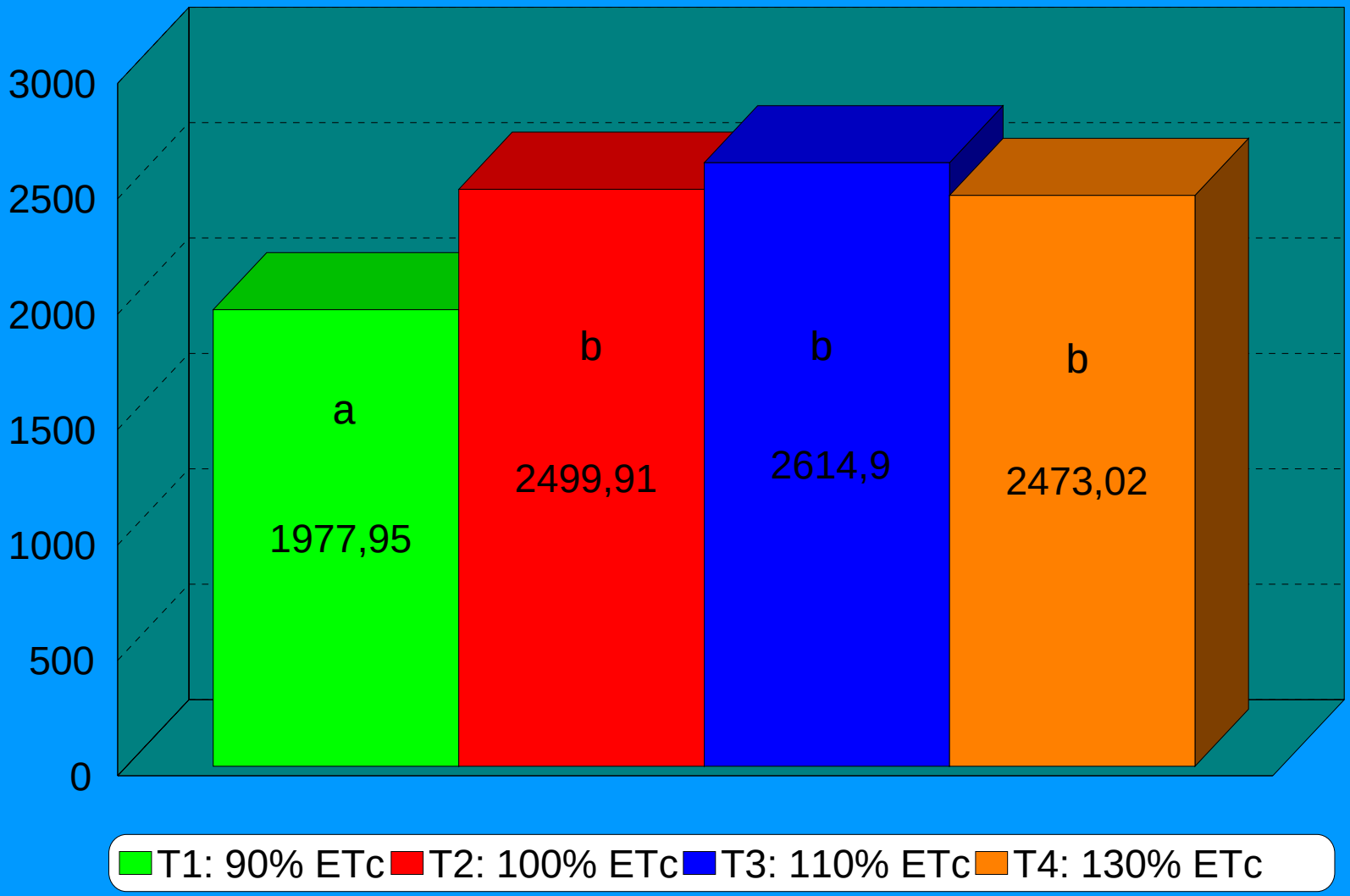
- Evaporation Pan and Crop Coefficient.

Irrigation in Avocados. Seasons 1998 - 1999 & 1999 - 2000

Treatments
T1: 90% ETc
T2: 100% ETc
T3: 110% ETc
T4: 130% ETc
T4: 130% ETc

GAMA

Average Harvest per Treatment, Years 1999 - 2000



Relation between fruit Size and Treatments

	CAL 36	CAL 40	CAL 50	CAL 60	CAL 70	CAL 84	PRECAL
T1: 90%	0,00 a	1,08 a	14,59 a	28,57 a	26,26 b	12,97 b	16,52 b
T2: 100%	0,03 a	3,82 a	28,17 b	31,67 a	21,74 ab	7,40 a	7,17 a
T3: 110%	0,06 a	4,40 a	26,83 b	31,30 a	17,22 a	4,87 a	5,33 a
T4. 130%	0,17 a	4,04 a	28,38 b	30,99 a	21,19 ab	7,83 ab	7,40 a

GAMA 2001

Economic Analysis of the Results (1)

Calibre	T1: 90%	T2: 100% [1]	T3: 110%	T4: 130%
36	0	4,20	8,79	23,54
40	119,60	534,80	644,33	559,52
50	1.615,75	3.950,38	5.393,37	3.930,46
60	3.163,96	4.433,80	4.583,56	4.291,93
70	2.908,14	3.043,60	2.521,69	2.934,69
84	1.436,35	1.036,00	713,16	1.084,41
Precal (M Nac)	1.829,49	1003,80	780,52	1.024,86

[1] 100%: 14.000 K/há.

GAMA 2001

Economic Analysis of the Results (2)

CAL	US$/K	Calibre	T1: 90%	T2: 100% [1]	T3: 110%	T4: 130%
		36	0	5,04	10,54	28,25
36	1,20	40	125,58	561,54	676,55	587,49
40	1,05	50	1.615,75	3.950,38	5.393,37	3.930,46
50	1,00	60	2.214,77	3.103,66	3.208,49	3.004,35
60	0,70	70	1.454,07	1.521,80	1.260,85	1.467,35
70	0,50	84	430,90	310,80	213,95	325,32
84	0,30	Precal (M Nac)	457,37	250,95	195,13	256,21
M.N.	0,25	TOTAL	6.298,45	9.704,17	10.958,89	9.599,44

GAMA 2001

Avocados, Pan (Kb) and Crop Coefficient (Kc)

MES	Proposed Kb	Proposed Kc
JANUARY	0,75	0,72 - 0,75
FEBRUARY	0,80	0,72 - 0,75
MARCH	0,85	0,72 - 0,75
APRIL	0,95	0,72 - 0,75
MAY	0,95	0,72
JUNE	1,10	0,72
JULY	1,20	0,72
AUGUST	1,10	0,72
SEPTEMBER	1,00	0,72
OCTOBER	0,80	0,72
NOVEMBER	0,80	0,72 - 0,75
DECEMBER	0,75	0,72 - 0,75

Gardiazabal et al., 2003

Methods to measure water Status in Soil and Tree

- **Tensiometers**
  - -25 to -35 Kpa before irrigating.
- **Manually inspecting the Soil.**
- **Neutron Probes.**
  - Difficult calibration due to high soil variability.
- **LVDT dendrometers.**
  - Until now measures are difficult to use as irrigation scheduling tool, as they do not integrate water content in the soil.
- **Pressure Chamber**
  - Still under research.

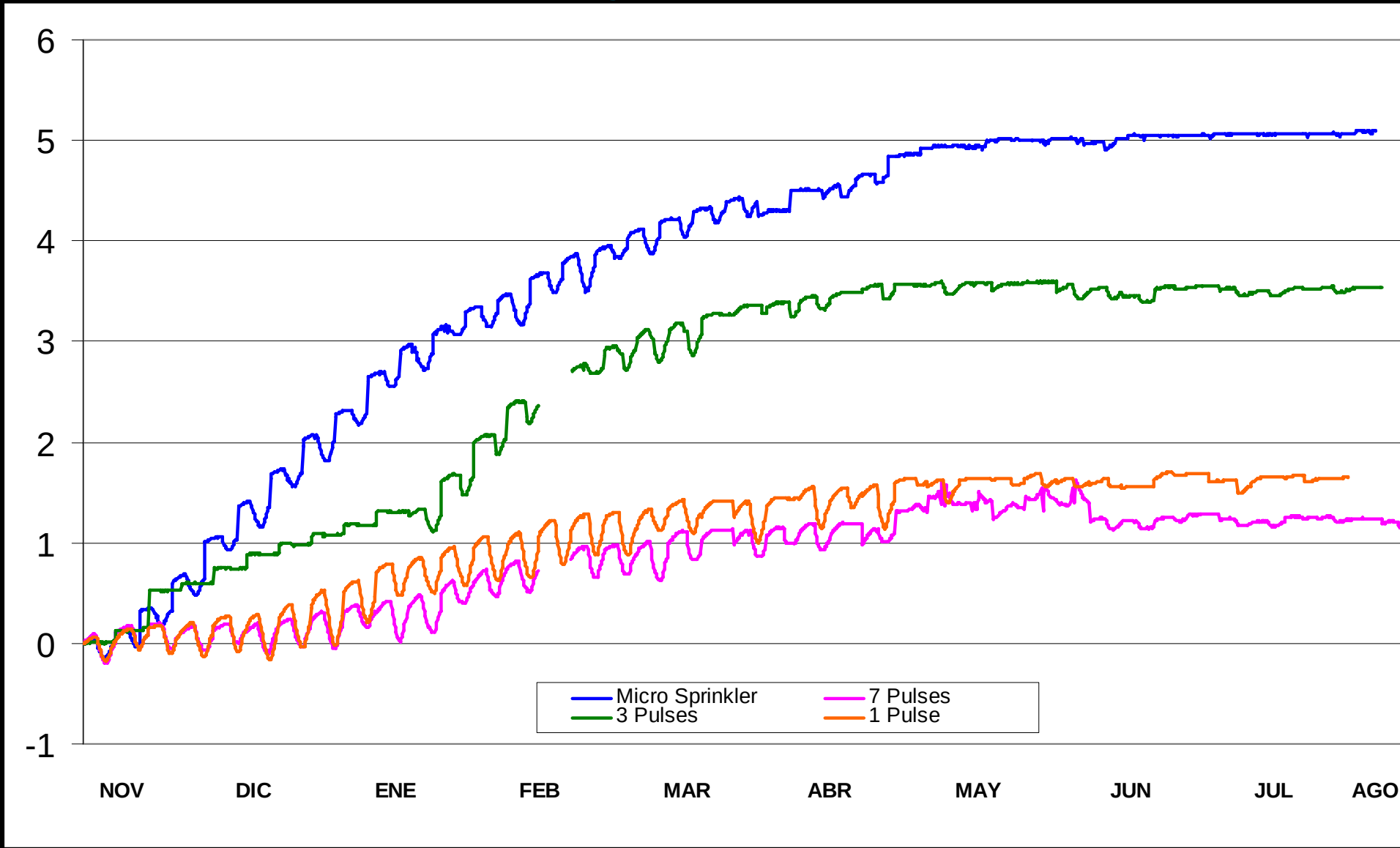
Irrigation Frequency

- Two main trends in Chile today.
  - Pulse irrigation (+20 pulses per day).
  - Low frequency irrigation (2 or 3 times/week in summer).

EVALUATION OF PULSE IRRIGATION AND THE USE OF DENDROMETERS TO INCREASE PRODUCTIVITY IN AVOCADOS

- **TREATMENTS:**
  - **7 pulses per day (drippers)**
  - **3 pulses per day (drippers)**
  - **1 pulses per day (drippers)**
  - **Control Micro sprinklers (1/3 of available water consumed)**
- **INSTRUMENTS:**
  - **Tensiometers**
  - **Dendrometers**
  - **Weather Station**
  - **Pressure Chamber**
- **MESUREMENTS:**
  - **Vegetative growth**
  - **Root growth**
  - **Contraction and expansion of trunk**
  - **Fruit growth**
  - **Water potential in leaves**
  - **Yield**
  - **Fruit Size**

Trunk Growth per treatment during November 2003-August 2004.



Results of Pulse irrigation after 2 years

Treatment	Kg/tree 2003	Fruits/tree 2003	Fruit weight 2003	Kg/tree 2004	Fruits/tree 2004	Fruit weight 2004
Micro Sprinkler	69,6 a	385 a	186,7	79,7 a	470 a	174,3 a
3 pulses/day	70,3 a	398 a	181,8	81,3 a	524 a	162,2 b
7 pulses/day	61,3 ab	352 ab	184,8	59,8 b	368 b	168,5 a
1 pulse/day	43,9 b	246 b	180,3	71,7 ab	518 a	139,8 c

GAMA – CORFO, 2004

Size distribution in Kilos and % per Treatment October 2004.

Treatment	Kilos & (%)				
	40	50	60	70	Precalibre
Micro Sprinkler	11 (0,4)	750 (23,9)	1019 (32,5)	974 (31,1)	381 (12,1)
3 pulses/day	11 (0,4)	370 (13,4)	728 (23,6)	1131 (40,9)	526 (19,0)
7 pulses/day	56 (2,5)	515 (22,5)	638 (27,9)	750 (32,8)	325 (14,2)
1 pulse/day	0 (0)	123 (4,8)	493 (19,3)	1176 (46,1)	762 (29,8)

Strategies to Face The Challenge

- ☑ Understanding the Crop (Phenology)
- ☑ Irrigation
- ☑ Nutrition

Nitrogen

- After Lovatt, 2001 results: 3 main application times.
- 150 – 250 Kilos of N per hectare

Timing:

- April – May: 40%
  - End of 2nd vegetative flush and flower initiation.
- October: 30 - 40%
  - Full flowering
- January: 20- 30%
  - Rapid fruit growth

Other nutrients

- Potassium & Phosphorous:
  - Mostly no effect.
- Zinc & Boron :
  - A very common problem, applied every year.

Strategies to Face The Challenge

- ☑ Understanding the Crop (Phenology)
- ☑ Irrigation
- ☑ Nutrition
- ☑ Pruning

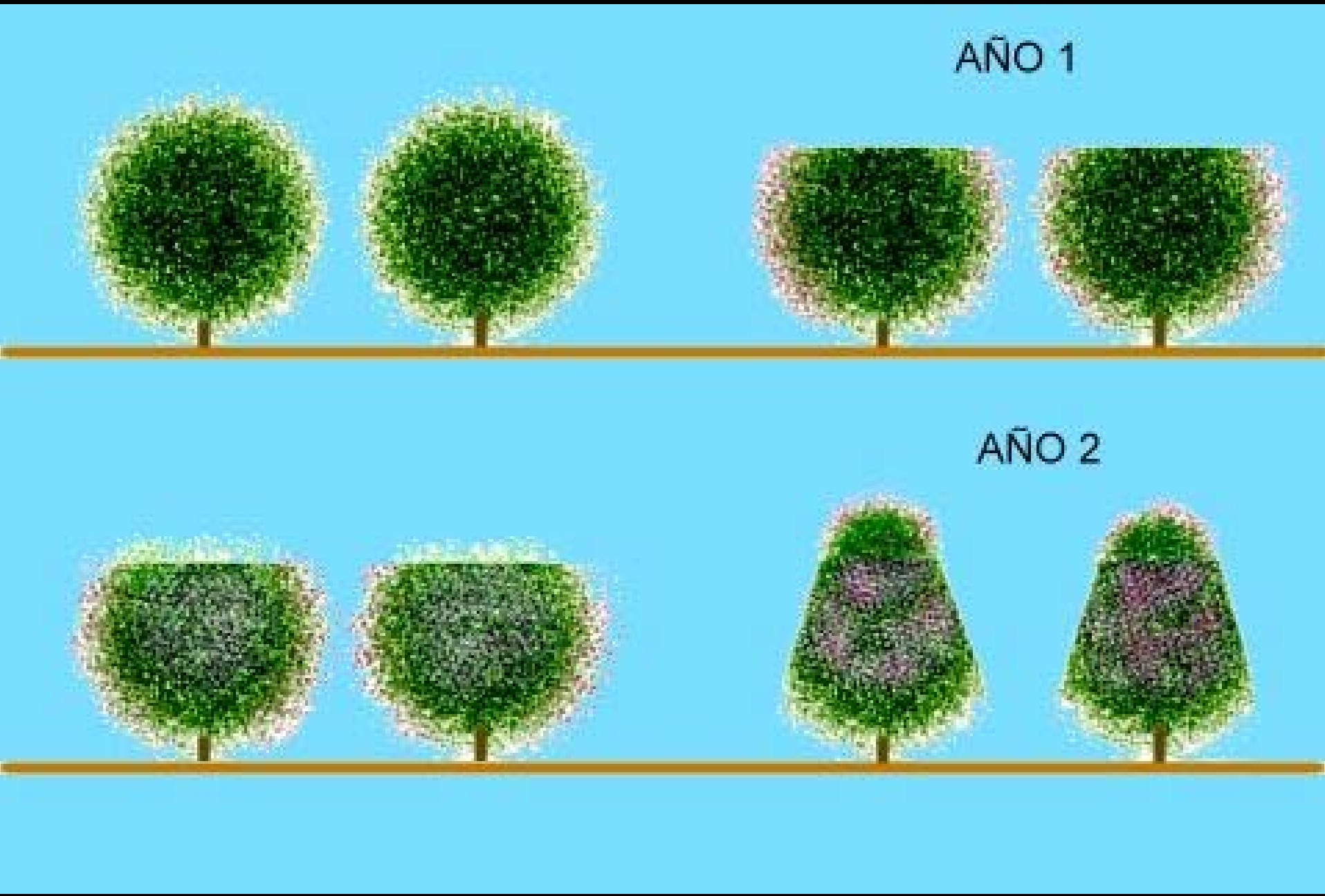
Pruning

- Today pruning is a common practice among growers.
- The questions today are:
  - How to prune based on the orchard situation.
  - When to prune.
  - What to do with the regrowth.
- Two main Situations:
  - Old overcrowded orchards.
  - New orchards designed for pruning.

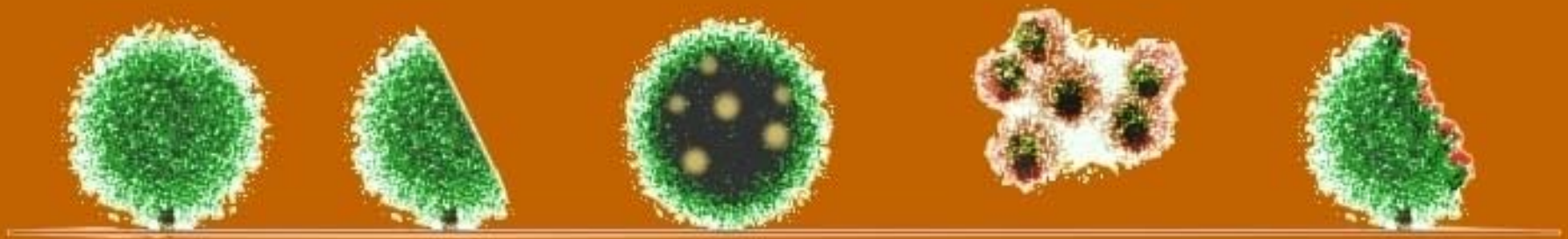
Old Orchards and Overcrowded Orchards

Overcrowded Orchards

- Smaller fruit.
- Lower Yields.
- Higher susceptibility to root rot
- Higher salinity damage.
- Higher picking costs and risks.


AÑO 1
AÑO 2

Sept - Dec.



End of Summer

Spring

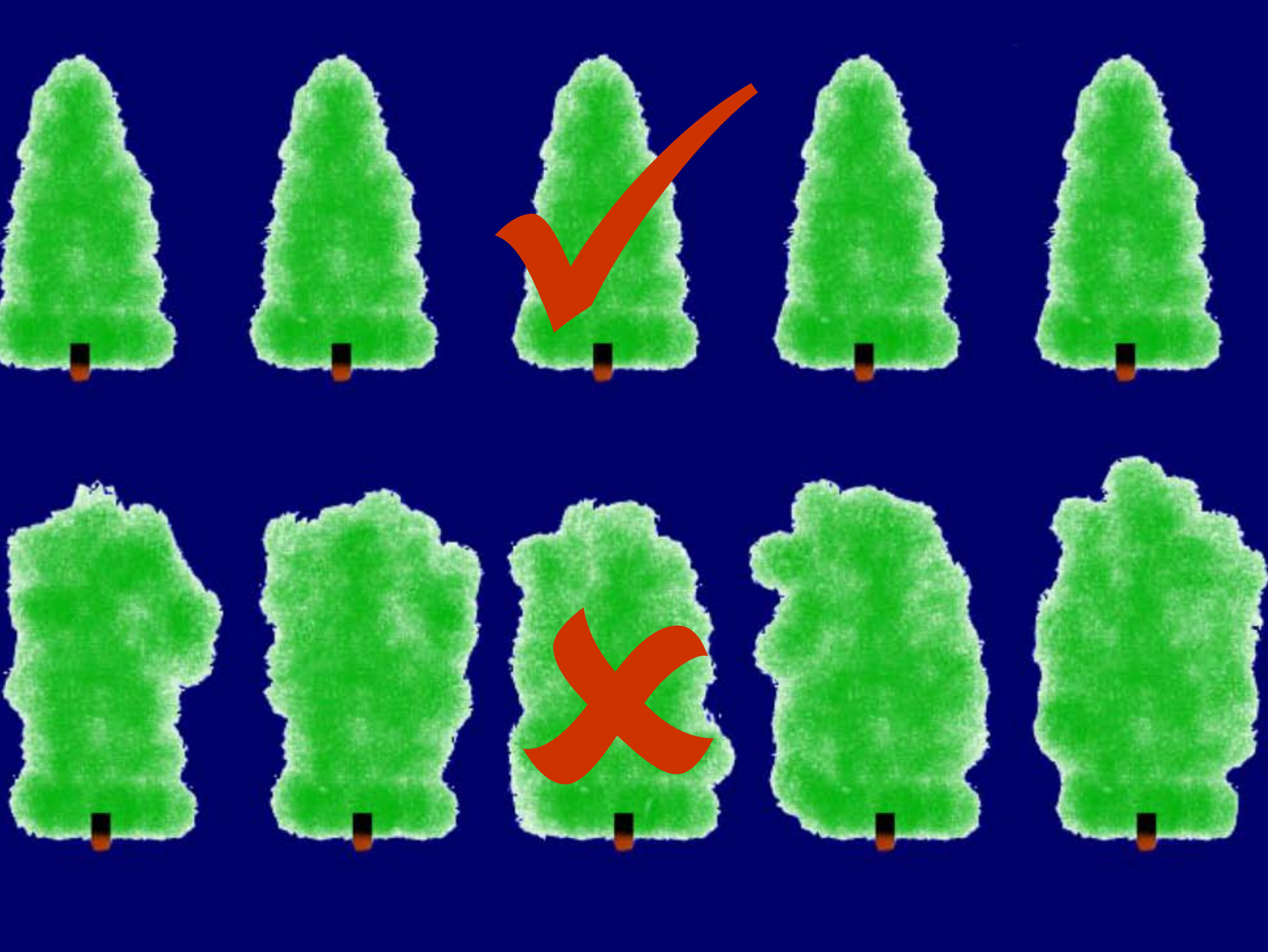
Winter

Spring 05 Autumn 06 Spring 06 Autumn 07

High Density Orchards

Pruning High Density Orchards

- New Orchards planted on rectangular pattern.
- Pruning starts before shading becomes a problem.
- Trees are formed in a pine shape.
- If pruning is light is commonly done at the end of summer to let autumn lower temperatures control the response of the new re-growth.



Strategies to Face The Challenge

- ☑ Understanding the Crop (Phenology)
- ☑ Irrigation
- ☑ Nutrition
- ☑ Pruning
- ☑ Pollination

Pollination

- Pollinators:
  - ☑ The use of bees is very common.
  - ☑ 8 – 10 hives/hectare
  - ☑ Increasingly higher concern on Quality of the hives.
  - ☑ Weeds as pollen source for the hive.

- Pollenizers
  - ☑ Edranol the most common.
  - ☑ 5 to 11% of pollenizers.
  - ☑ Ettinger and different combinations are under research.

Cross pollination in Hass

% of Parental pollen

Treatment	Hass	Zutano	Rincon	Edranol	Bacon
Hass Control	21,6	16,8	2,6	32,1	26,9
Hass/Hass	35,5	11,6	2,3	18,5	32,1
Hass/Rincon	15,3	30,8	10,1	19,9	23,9
Hass/Edranol	7,7	2,2	0,4	76,9	12,8
Hass/Zutano	2,6	74,1	3,1	1,9	18,4
Hass/Bacon	16,3	12,1	3,9	15,3	52,5

Gardiazabal & Gandolfo, 1995

Strategies to Face The Challenge

- ☑ Understanding the Crop (Phenology)
- ☑ Irrigation
- ☑ Nutrition
- ☑ Pruning
- ☑ Pollination
- ☑ Orchard Planning & High Densities

Orchard Planning

- Highest percentage of new plantations are on hillsides (+70% of new developments).
- Many times soils are shallow or not very uniform and trees are planted on ridges.
- Under these conditions roads play a fundamental role in operational effectiveness and prevention of erosion.

High Densities (1)

Main Objectives:

- Higher production the first years.
- Lower operation costs.
- Quick return of investment.
- Easier “Mechanization” (Depending on slope).

High Densities (2)

- Today the most common densities range from 555 to 832 trees/ha (6 x 3 – 6 x 2 m)
- Root competition is used to maintain tree size.
- Pyramidal Hedgerows.
- Orchards designed for pruning.

Ultra High Densities

- System developed in California by Reuben Hofshi.
- Pruning is required since the first year
- Trees trained in Cylindrical shape.
- In the past 2 years, probably more than 1.000 hectares have been planted at 3 x 3 m (1.111 trees/ha).

Conclusions

- Important growth.
- Under today’s scenario yield is not the main factor anymore.
- Fruit size and operational costs play a fundamental role in final results.
- Understanding the phenology is essential in Orchard management and technical decisions.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