JatroMed Project
(EuropeAid/128320/C/ACT/Multi - Reference Number: DCI/ENV/2009/13/12)
Evaluation of the energy crop Jatropha curcas as a mean to promote renewable and sustainable energy for the Mediterranean region (JatroMed)

2° JatroMed International Workshop

Algeria, May 8th 2014

Mechanical harvest: a key success factor for the efficient cultivation of Cynara cardunculs L. for energy production

Dr. Luigi Pari, PhD

C.R.A. Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Unità di Ricerca per l'Ingegneria Agraria

Via delle Pascolare, 16 - 00016 Monterotondo (Roma) - Tel. +39 06 90675 249 – email: luigi.pari@entecra.it

CRA-ING

Plant description

Cynara cardunculus L.

- Asteraceae (Compositae)
- Mediterranean origin
- Perennial herb
- Annual growth cycle
- Very deep root system
- Floral stem 2-3 m high
- Gross heads (capitula)
- Lilac-violet florets
- Oil fruits (achenes, ~ sunflower)

CRA-ING

JatroMed

Crop cycle

Development cycle

PLANTLETS (autumn)

SPROUTING (September)

ROSETTE (winter)

ELONGATION (spring)

BLOSSOM (June)

DRYING (August)

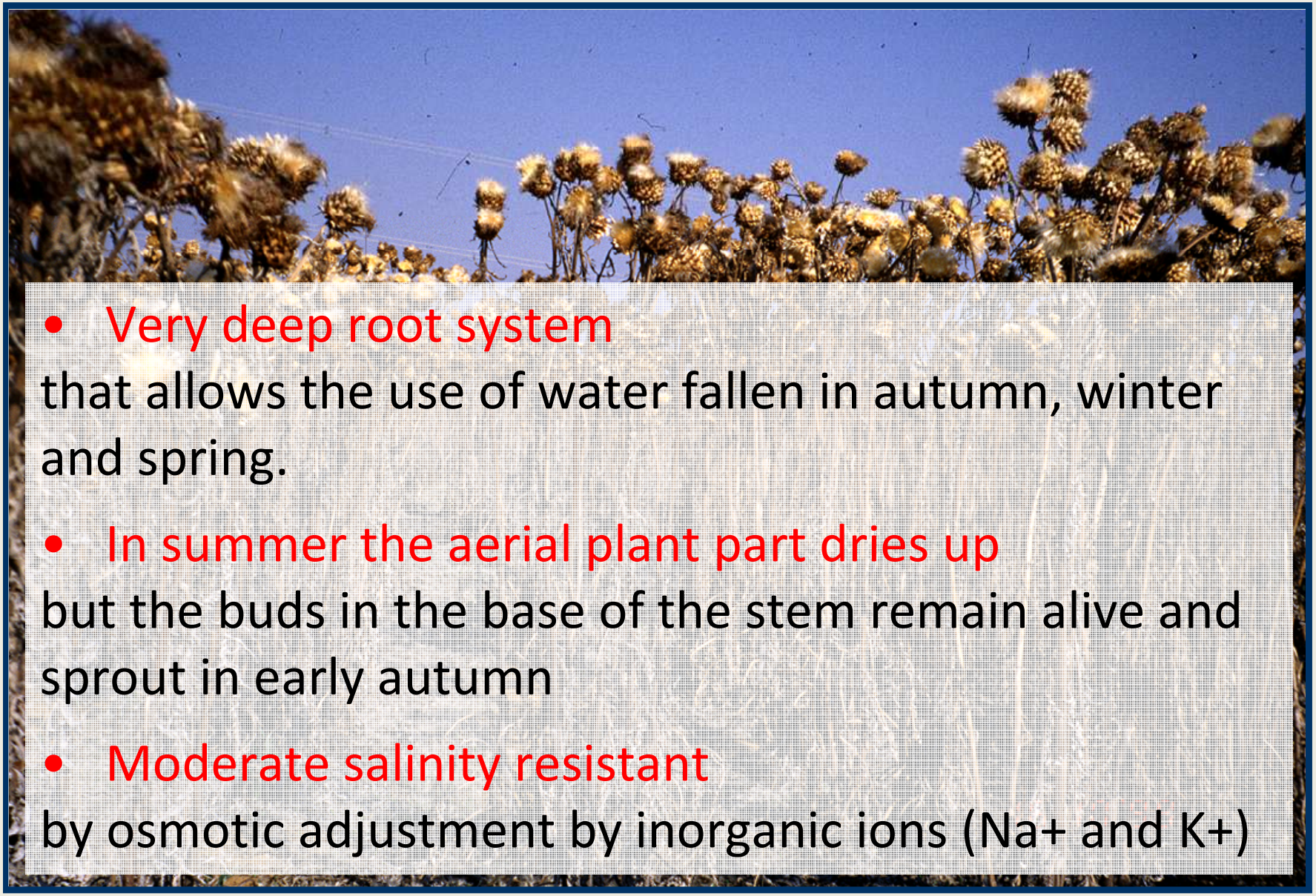
FRUITS ('seeds')

J. Fernández U.P.M.

JatroMed

CRA-ING

Adaptative mechanisms to Mediterranean conditions



- Very deep root system

that allows the use of water fallen in autumn, winter and spring.

- In summer the aerial plant part dries up

but the buds in the base of the stem remain alive and sprout in early autumn

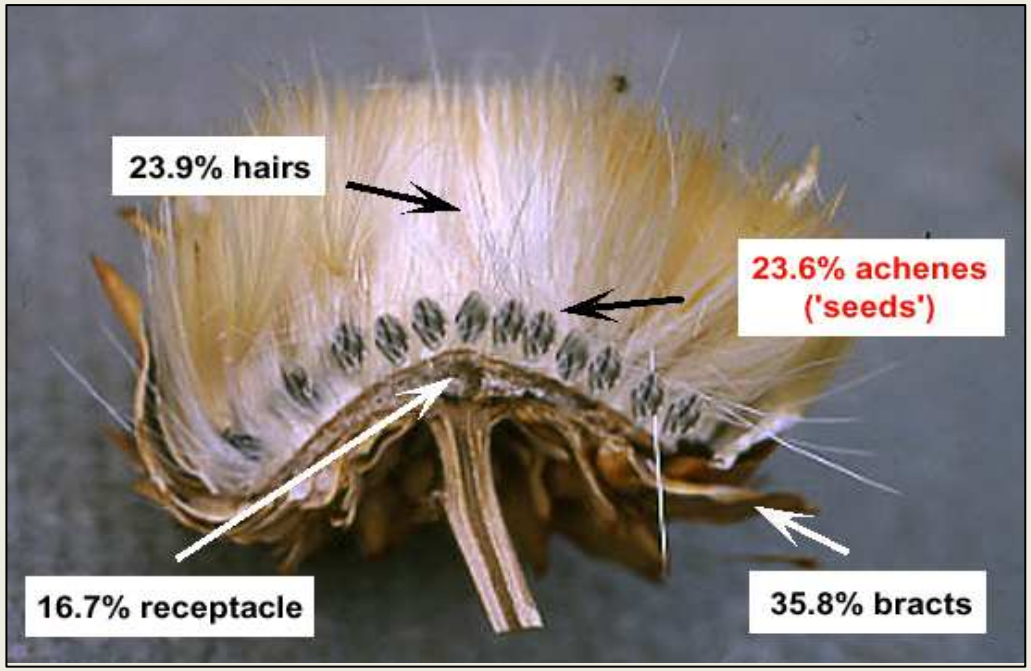
- Moderate salinity resistant

by osmotic adjustment by inorganic ions (Na+ and K+)

CRA-ING

Biomass partitioning (dry weight basis)

Heads ~ 33%



J. Fernández U.P.M.

Stalk + branches ~33 %

Cauline leaves ~14%

Basal leaves ~20%

CRA-ING

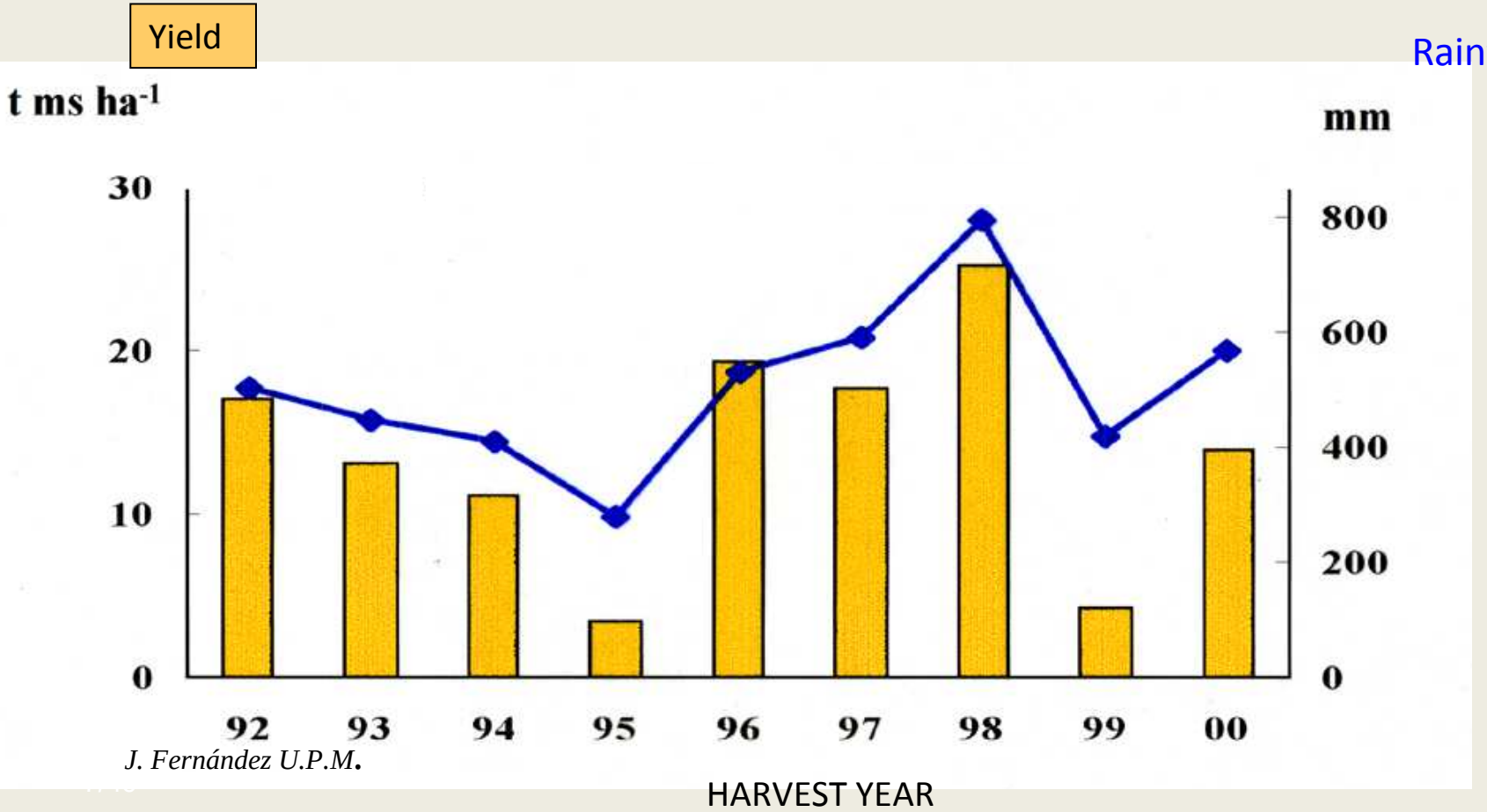
Recommendations on crop management

- **FIRST YEAR (Establishment)**
  - **Basal dressing as a function of soil fertility** (e.g.500 kg 9:18:27)
  - **Subsoiling, ploughing and harrowing**
  - **Sowing** (4-5 kg seeds/ha) (in rows 0.75-0.80 m apart)
  - **Herbicide treatment** (e.g.1.5 kg linuron+0.4 kg alachlor per ha)
  - **Pest control** (e.g. 40-60 g i.a/100L,dimethoate)
- **SECOND AND FOLLOWING YEARS (production)**
  - **Restoration fertilization** (e.g.~ 12.6 N ,3.5 P_2O_5, 20.8 K_2O kg/ton dm)
  - **Pest control** (dimethoate)
  - **Harvesting**

BIOCARD (EU PROJECT)

EXAMPLE OF A PERENNIAL CROP OF CYNARA
Madrid (Spain)

Mean: 14 t d.m./ha.year (~ 470 mm/year)



J. Fernández U.P.M.

BIOCARD (EU PROJECT)

MEAN AERIAL BIOMASS PRODUCTION OF CYNARA IN A MULTILOCAL EXPERIMENT DURING TWO CONSECUTIVE CYCLES

Rainfall from August to July next year

Site	1994-95		1995-96	
	Rainfall (mm)	Production (t d.m. / ha)	Rainfall (mm)	Production (t d.m. / ha)
Madrid (Spain)	280	6.5	529	23.1
Tebas (Greece)	490	28.6	324	33.4
Forly (Italy)	752	17.5	837	24.6
Policoro (Italy)	316	7.5	722	15.6
Sicily (Italy)	387	15.9	654	--
MEAN	**445**	**15.2**	**646**	**24.2**

J. Fernández U.P.M.

CRA-ING

JatroMed

Pathways for optimizing the uses of cynara

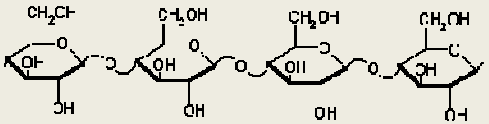
Whole biomass

Lignocellulosic biomass

Oil seeds (achenes)

Hairs and pappi

(7% of the total plant)



Chopped whole biomass (including pappi)

Bale

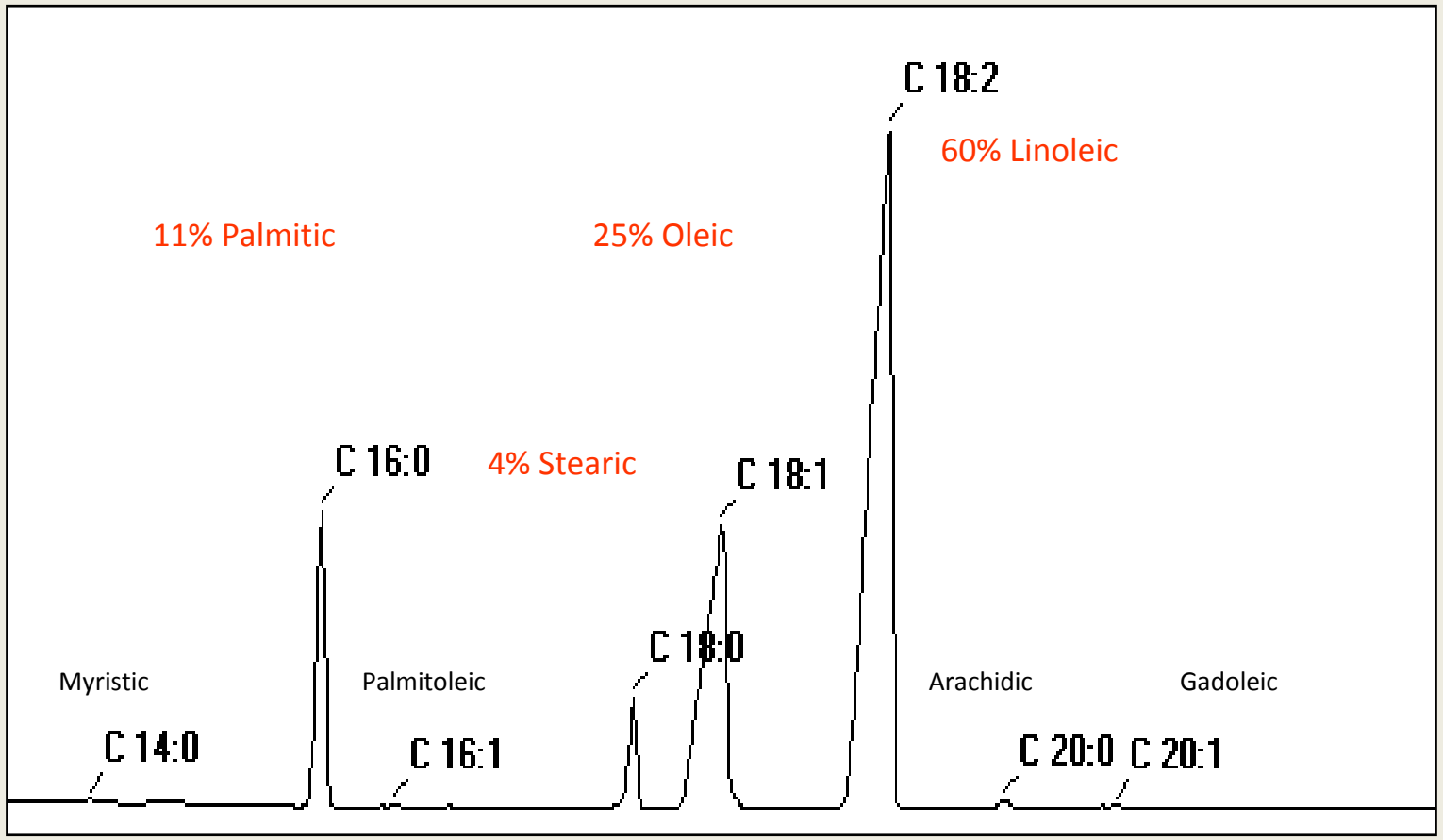
Chips

Pellets

Seed oil content ~ 25%.

BIOCARD (EU PROJECT)

FATTY ACID PROFILE OF CYNARA OIL (similar to sunflower)



J. Fernández U.P.M.

CRA-ING

Cynara cardunculus harvesting workyards

- Tractor mowers
- Combine harvesters
- Forage harvesters
- Balers

undifferentiated harvesting

Tractor mowers

Mounted rotary drum mower

Rotobaler with roller system

undifferentiated harvesting

Combine harvester

Prototype of cutting-baler

undifferentiated harvesting

Self-propelled forage harvester

Combine harvester

Combine harvester fitted for sunflower

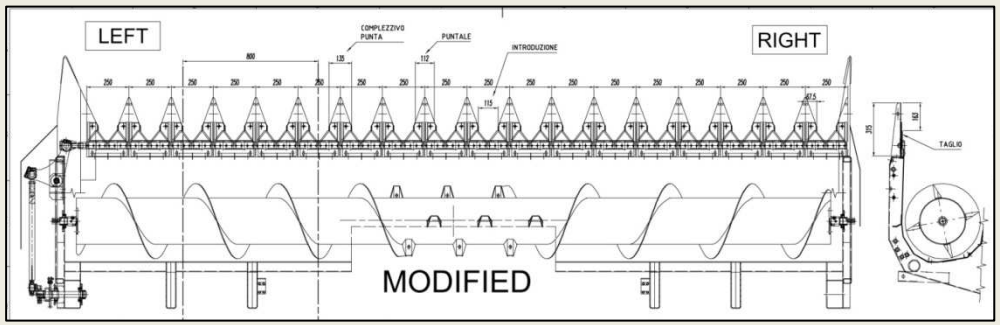
Combine harvester

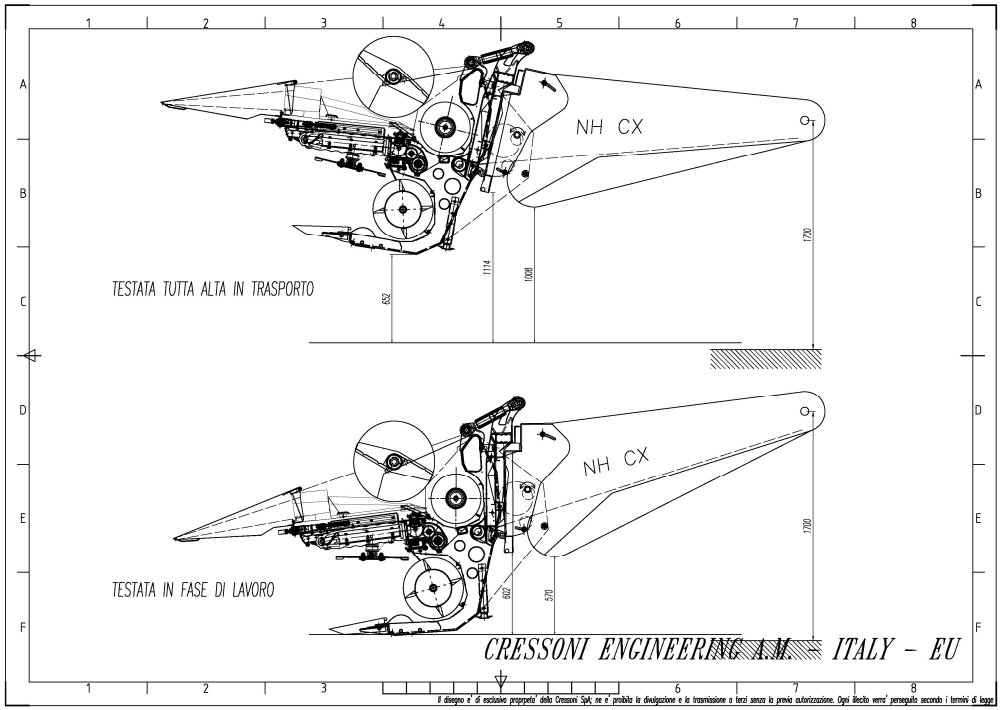
Combine harvester with maize picker attachment

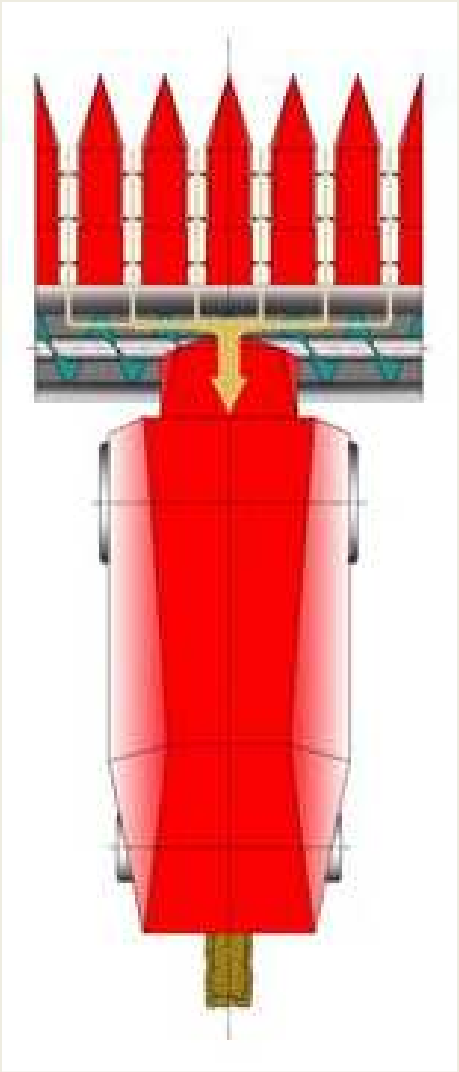
CRA-ING

Selective harvesting of cardoon products and co-products

Combine harvester with CRA-ING cardoon header







JatroMed

CRA-ING

Selective harvesting of cardoon products and co-products

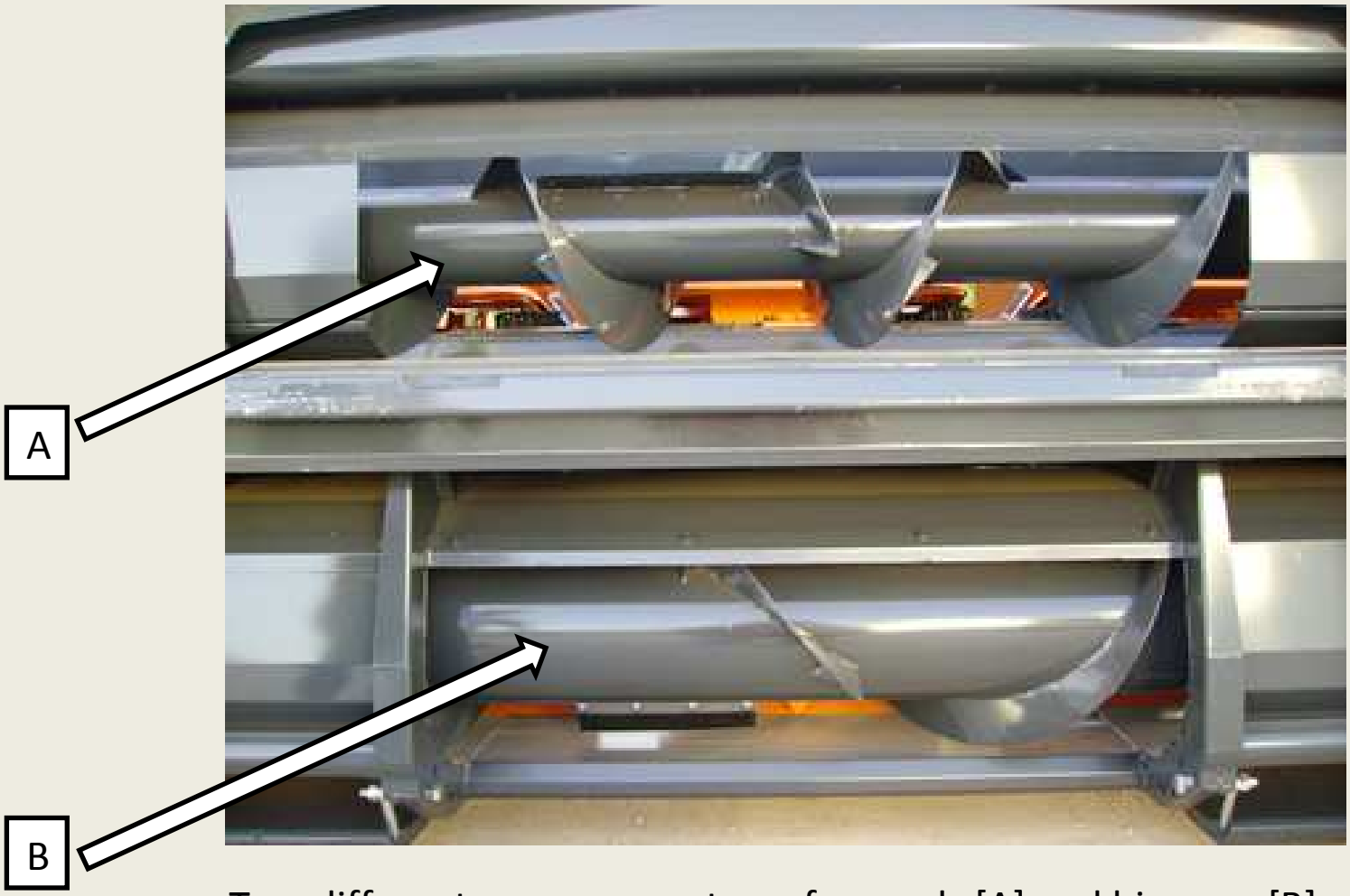
Combine harvester with CRA-ING cardoon header

Two cutting apparatus for a separated treatment of seeds [A] and residual biomass (stalks, branches, leaves) [B]

CRA-ING

Selective harvesting of cardoon products and co-products

Combine harvester with CRA-ING cardoon header

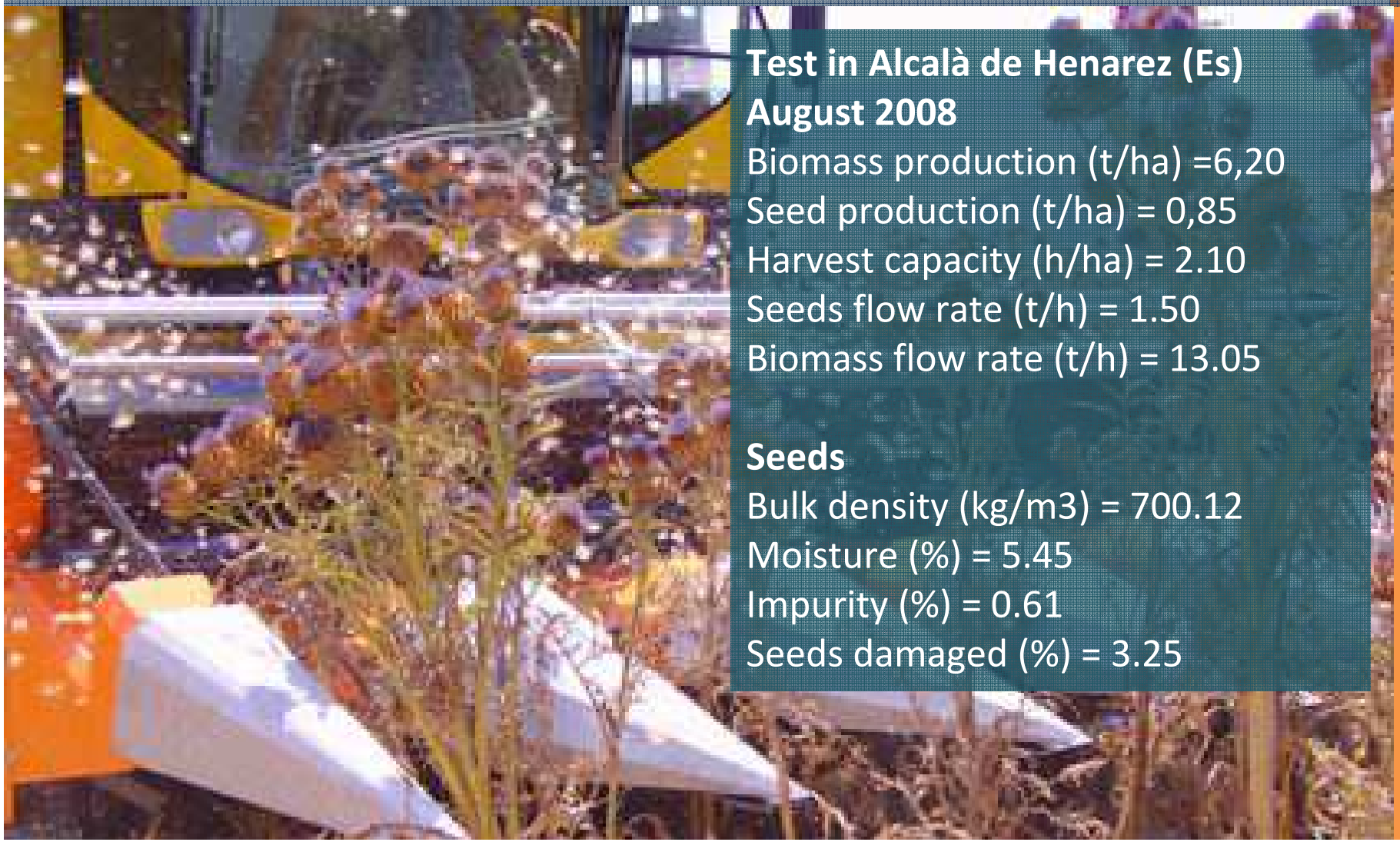


Two different conveyor systems for seeds [A] and biomass [B]

CRA-ING

Selective harvesting of cardoon products and co-products

Combine harvester with CRA-ING cardoon header



Test in Alcalà de Henarez (Es)
August 2008
Biomass production (t/ha) =6,20
Seed production (t/ha) = 0,85
Harvest capacity (h/ha) = 2.10
Seeds flow rate (t/h) = 1.50
Biomass flow rate (t/h) = 13.05

Seeds
Bulk density (kg/m3) = 700.12
Moisture (%) = 5.45
Impurity (%) = 0.61
Seeds damaged (%) = 3.25

CRA-ING

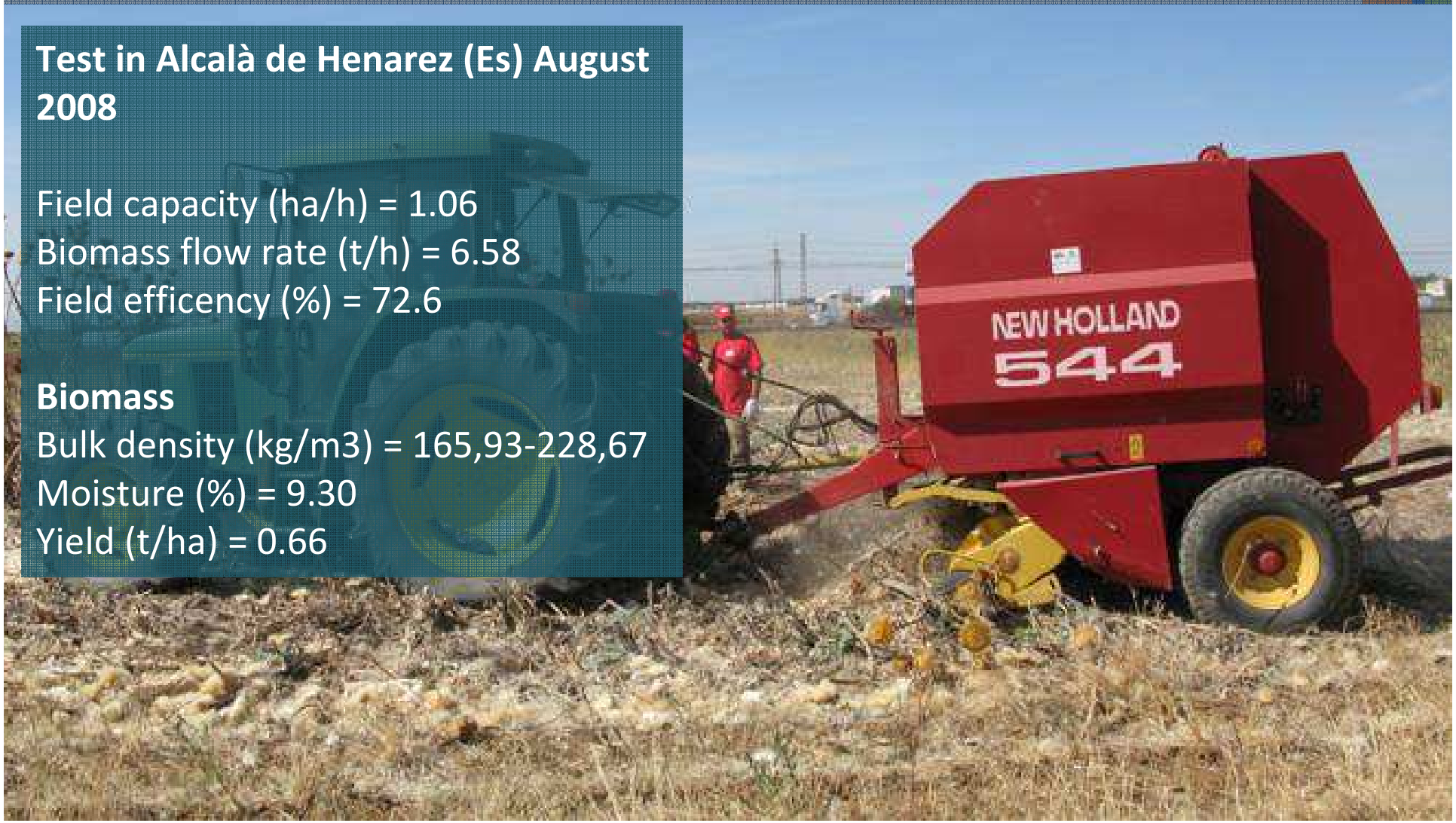
Selective harvesting of cardoon products and co-products

Rotobaler New Holland 544

Test in Alcalà de Henarez (Es) August 2008

Field capacity (ha/h) = 1.06
Biomass flow rate (t/h) = 6.58
Field efficency (%) = 72.6

Biomass
Bulk density (kg/m3) = 165,93-228,67
Moisture (%) = 9.30
Yield (t/ha) = 0.66



CRA-ING

Selective harvesting of cardoon products and co-products

Combine harvester with CRA-ING cardoon header

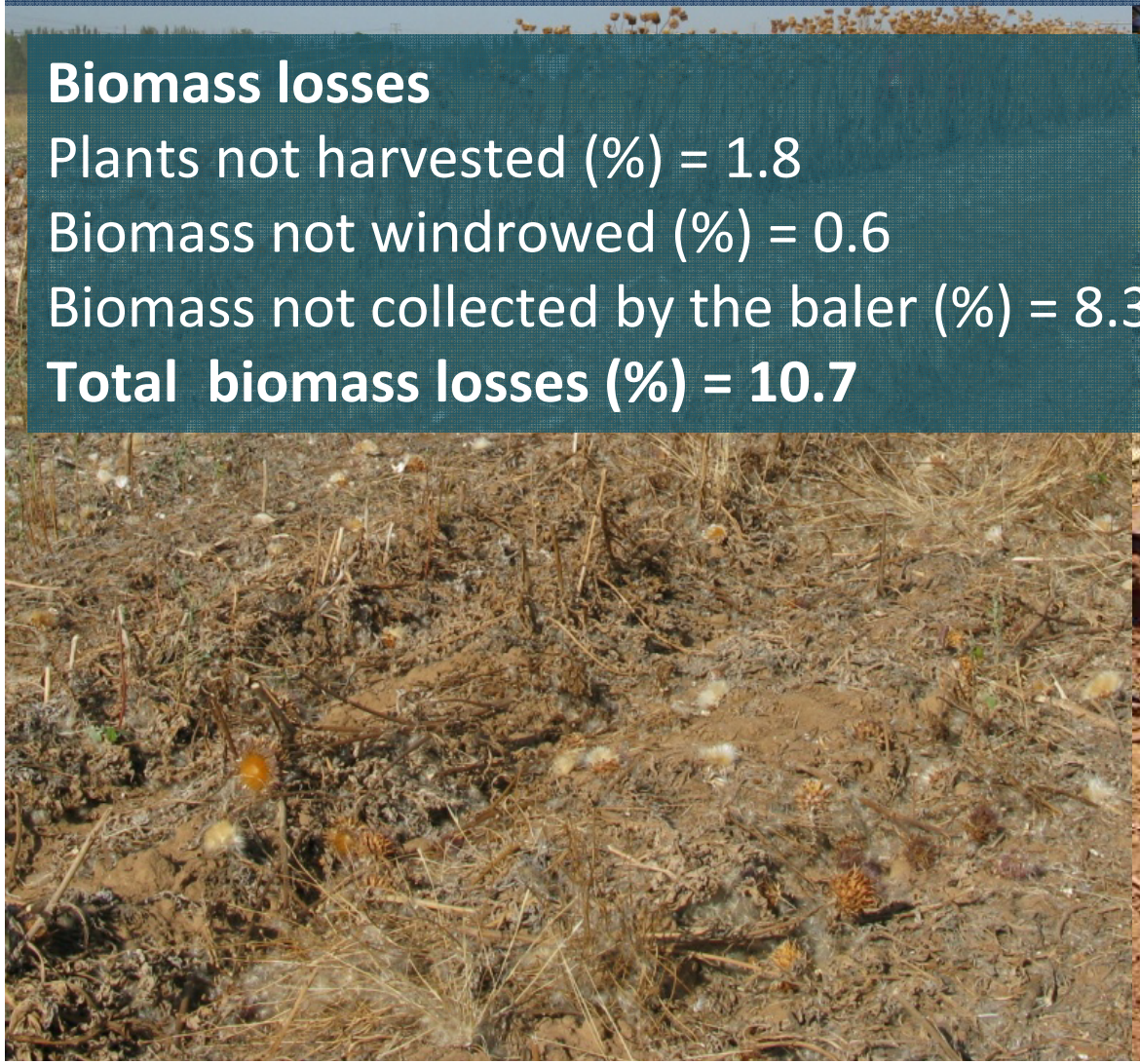
Biomass losses

Plants not harvested (%) = 1.8

Biomass not windrowed (%) = 0.6

Biomass not collected by the baler (%) = 8.3

Total biomass losses (%) = 10.7



CRA-ING

Selective harvesting of cardoon products and co-products

Pappi and hairs collecting system: Research in progress

Dr. Luigi Pari

Unità di Ricerca per l'Ingegneria Agraria

Via delle Pascolare, 16

00016 Monterotondo (Roma)

Tel.: +39 06 90675 250

Email: luigi.pari@entecra.it