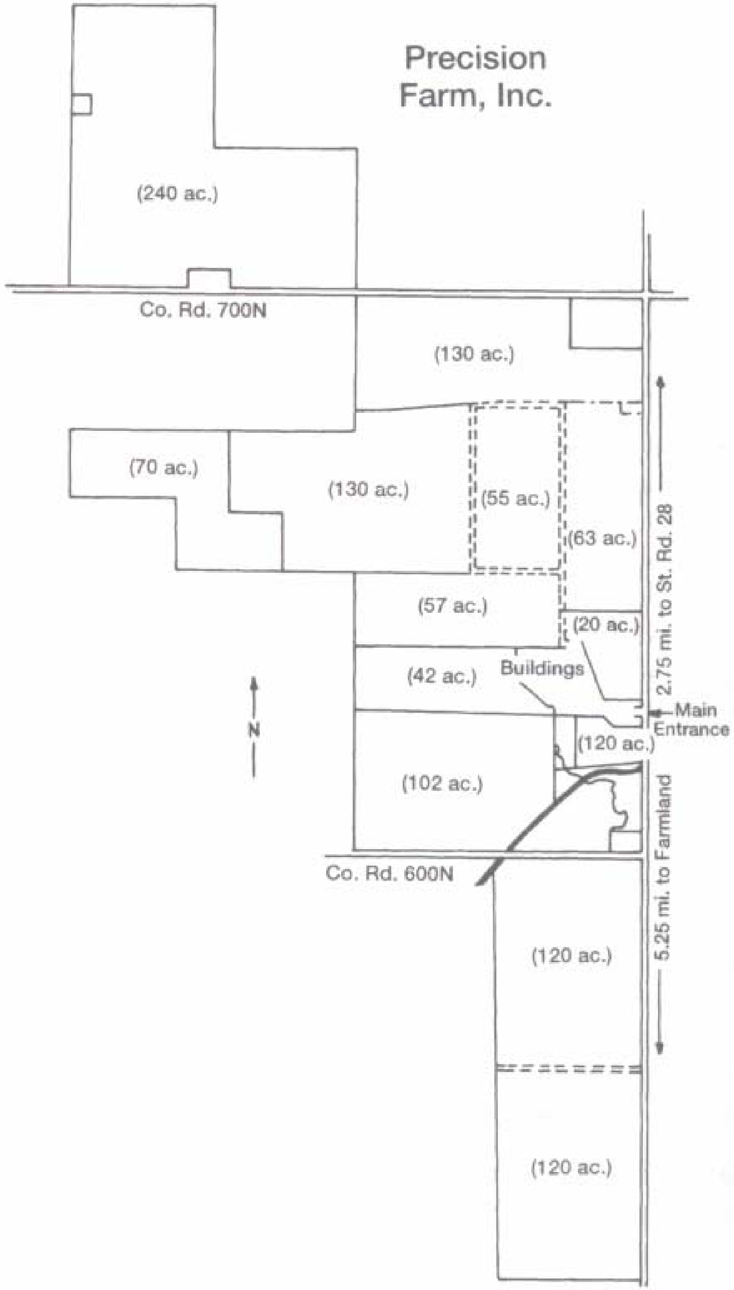
Precision Agriculture 04

Site Specific Management

Yield mapping

- Crop flow sensors
- Crop water content sensors
- Machine speed sensors
- GPS
- Working width
- GPS
- CPU

BEGINNING OF YEAR ONE: PRELIMINARY PURCHASES, START UP, AND TRAINING




YIELD
MONITOR
2000

Sensors for seed flow

- Combine harvester and its function

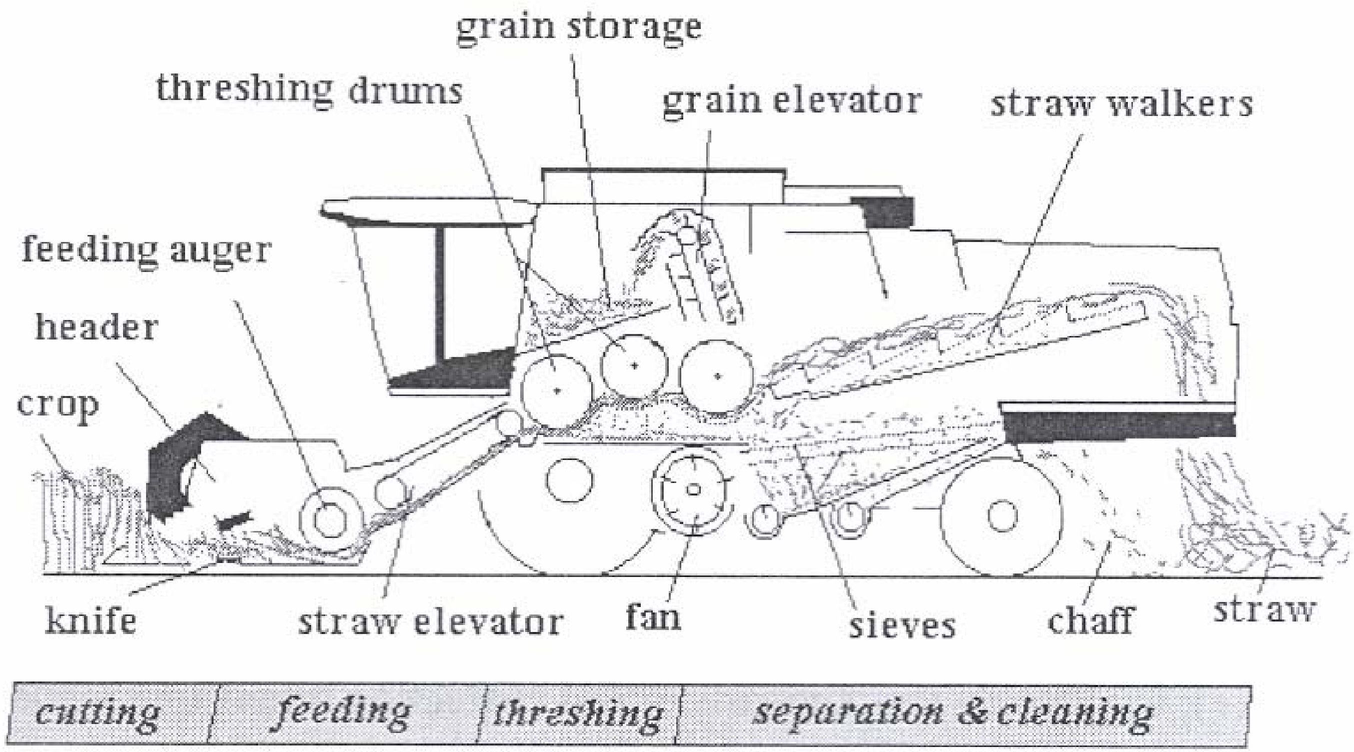
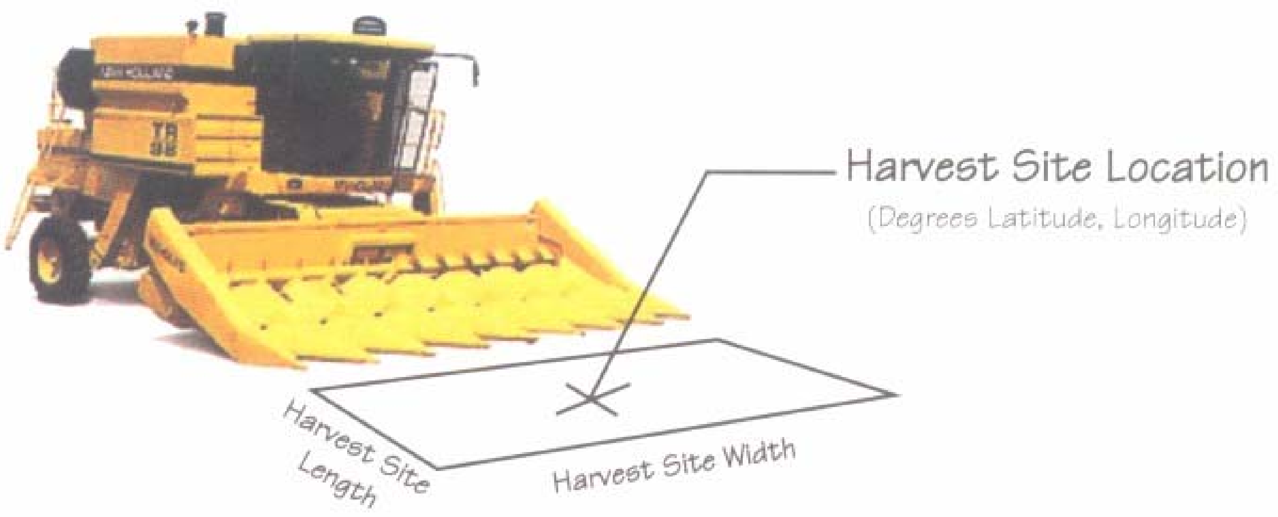


Figure 1. Different functional processes in a conventional combine (Missotten, 1998).

What we need to measure

- Seed flow rate
- Seed moisture content
- Working width of the machine
- Machine speed
- Machine position
- Head position sensor
- Data recording



Harvest speed	Travel distance (site length*)
3 mph	4.4 feet/sec
4 mph	5.9 feet/sec
5 mph	7.3 feet/sec
6 mph	8.8 feet/sec

*For 1-sec logging interval.

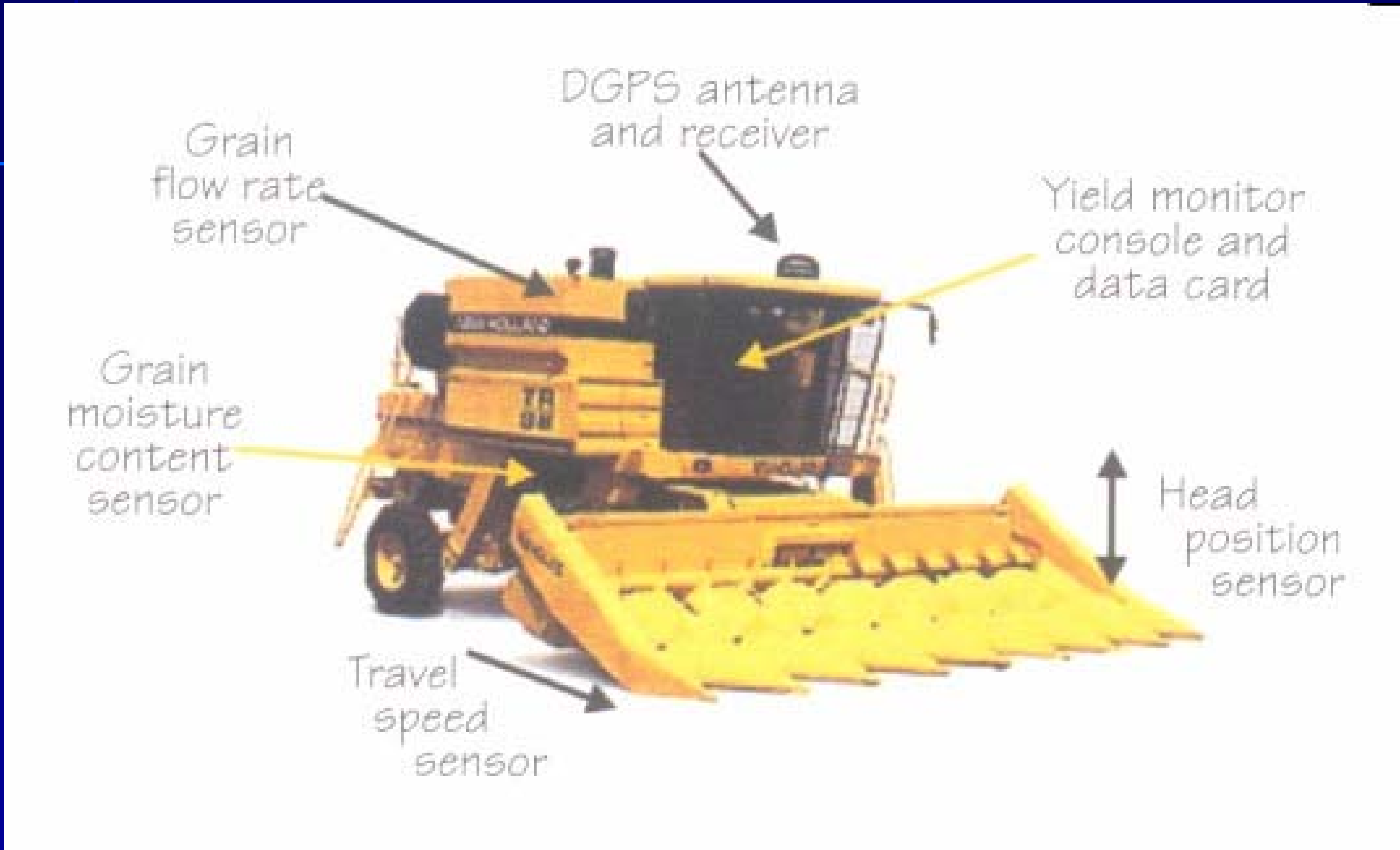
Harvest Site Specifications

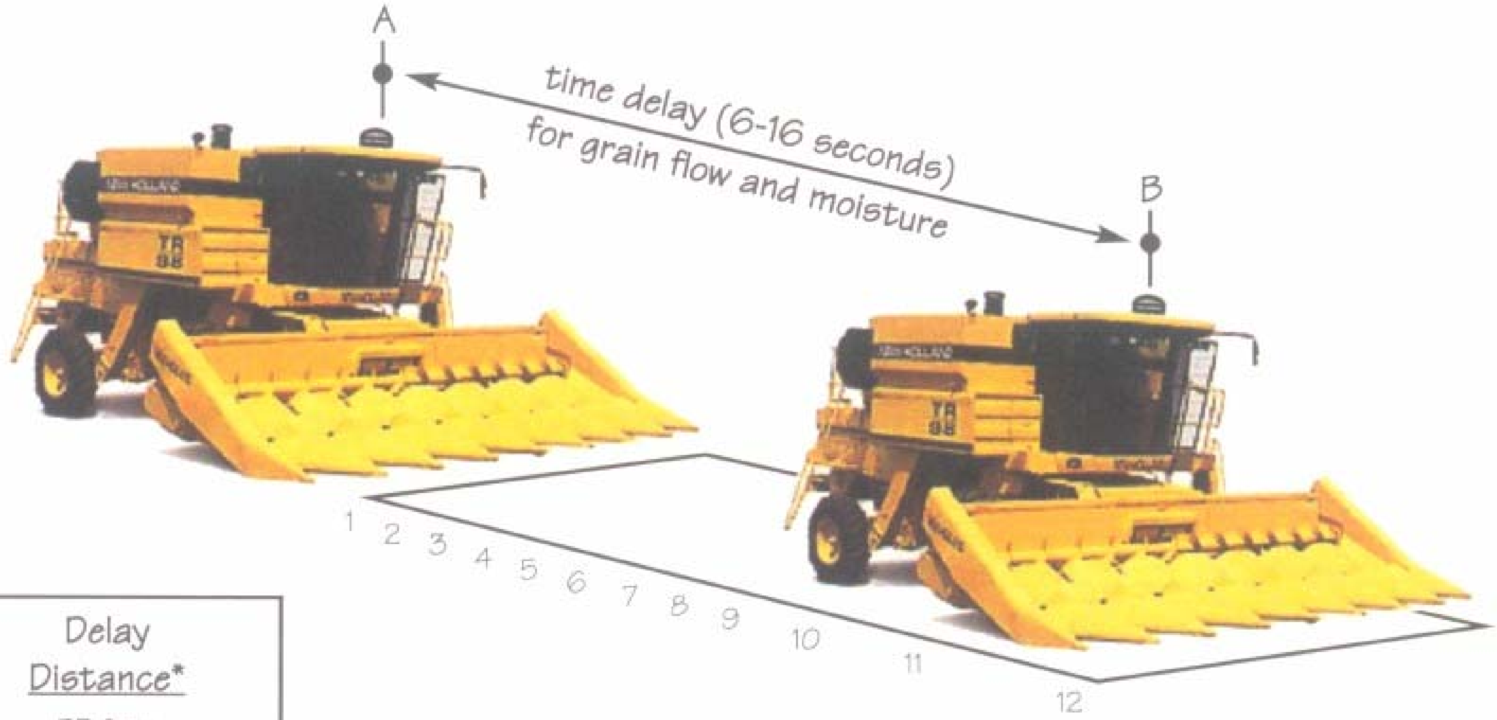
Location - Computed by DGPS unit.
Width - Set by combine operator.
Length - Computed as travel distance.
Grain Volume - Computed from grain flow and moisture sensor data, and "standard" bushel information.

Area and Yield Calculations

$$\text{Harvest Site Area (acres)} = \frac{\text{Length (ft)} \times \text{Width (ft)}}{43{,}560\ (\text{ft}^2/\text{acre})}$$

$$\text{Harvest Site Yield (bu/acre)} = \frac{\text{Grain Volume (bu)}}{\text{Harvest Site Area (acre)}}$$


DGPS antenna
and receiver
Grain
flow rate
sensor
Yield monitor
console and
data card
Grain
moisture
content
sensor
Head
position
sensor
Travel
speed
sensor



Harvest speed	Delay Distance*
3 mph	53 feet
4 mph	70 feet
5 mph	88 feet
6 mph	106 feet

*For 12-sec time delay.

Flow rate and moisture content
of grain harvested at point "A" will reach the
sensors and be measured, recorded and displayed at point "B".

Seed flow sensors

- Principle of function:
- A) By weighing
- B) Volume measurements
- C) Impact measurement
- D) Indirect methods

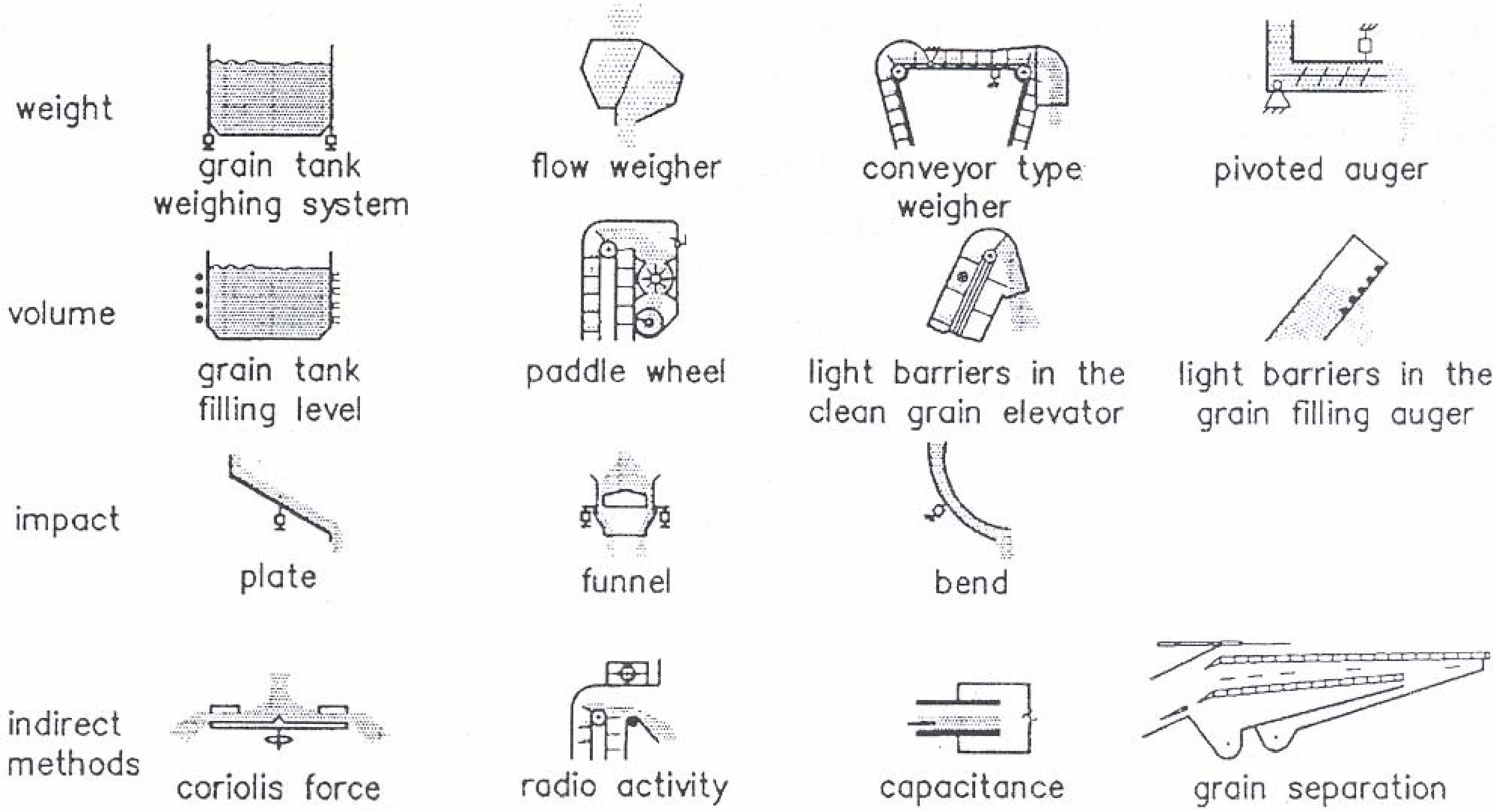


Figure 2. Different methods for the measurement of grain yield (Kützbach and Schneider, 1997).

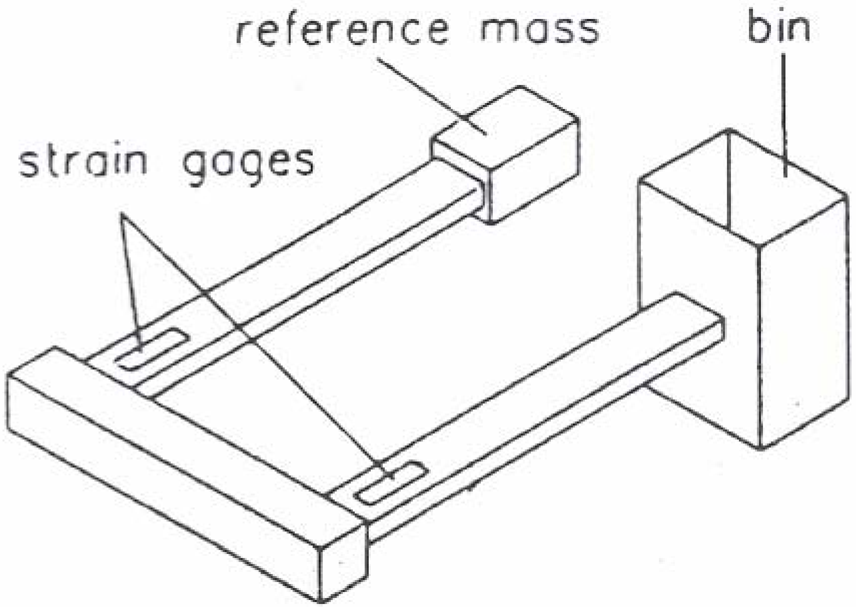
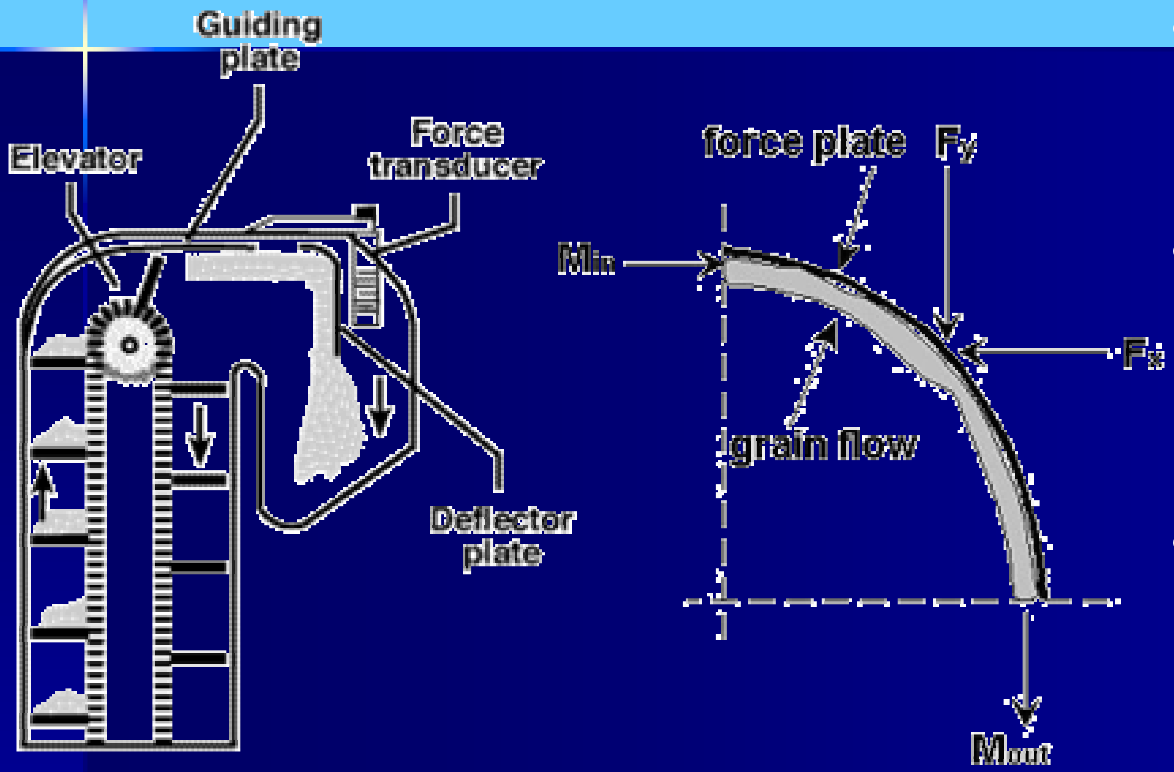


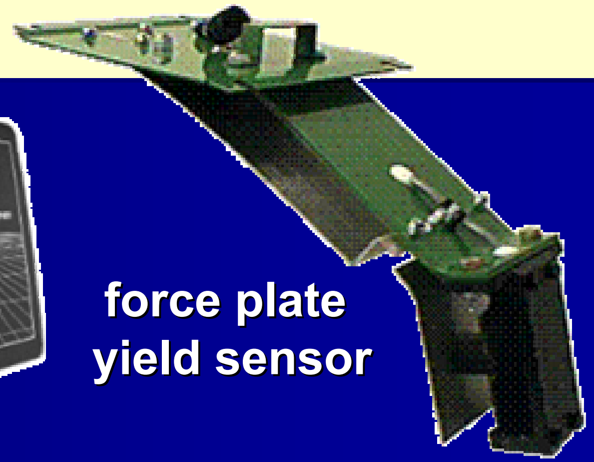
Figure 4. "Continuous" mass density measuring device (Böttinger, 1990).

Force Plate Sensors

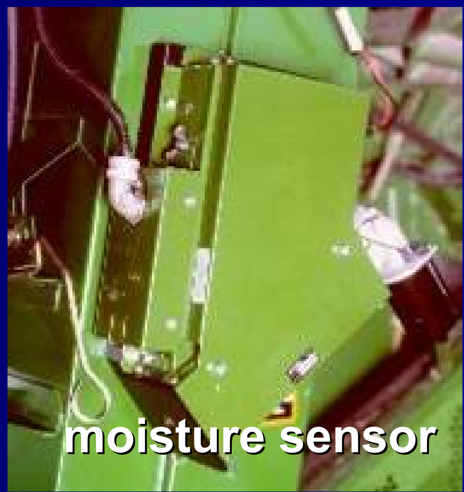


- Most commonly used grain yield sensor
- Use transducer to quantify force of grain thrown by the clean grain elevator
- Measured force calibrated to weight

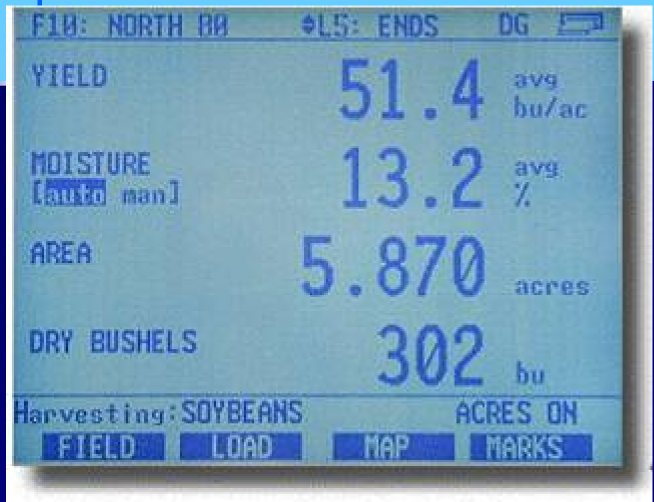
- Customized for more than 70 combines
- Reliable, user friendly, excellent support
- Display has multiple uses

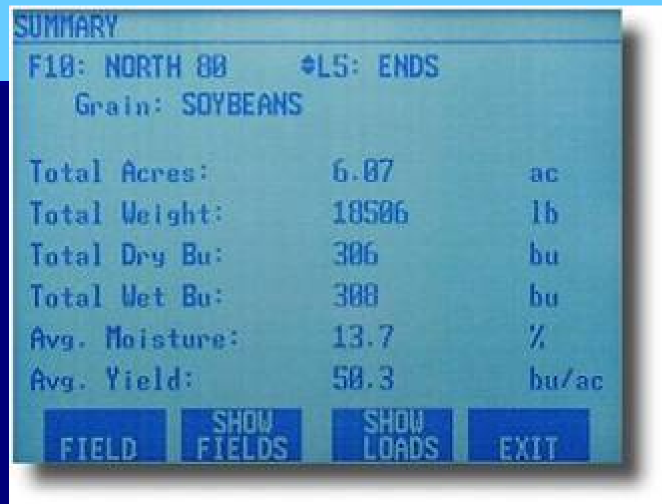


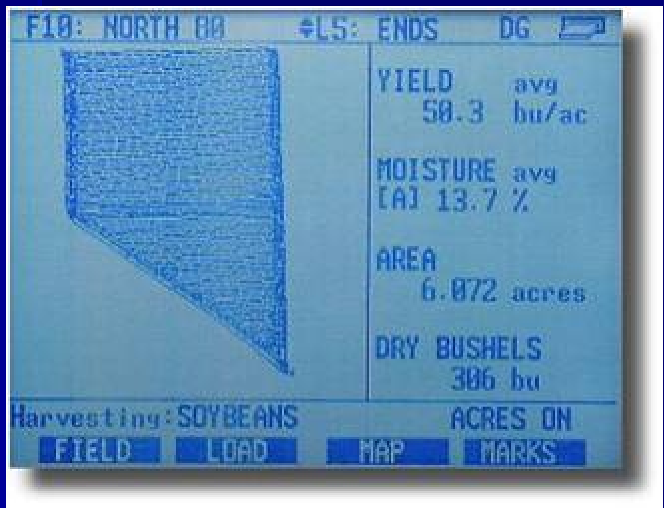
force plate yield sensor



PF3000 Display







CASE IH Advanced Farming Systems

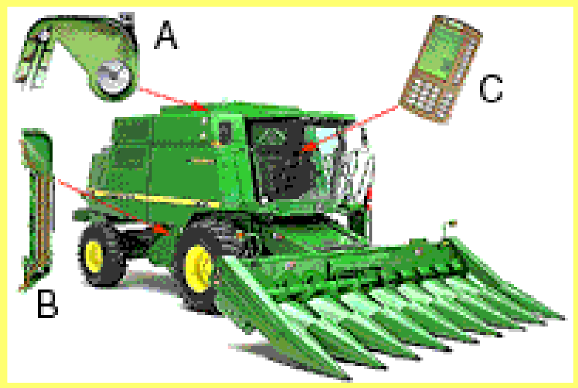
- Ag Leader force plate yield sensor
- Universal display
  - can mark problem areas or landmarks in fields
  - touchscreen interface

force plate yield sensor

AFS display

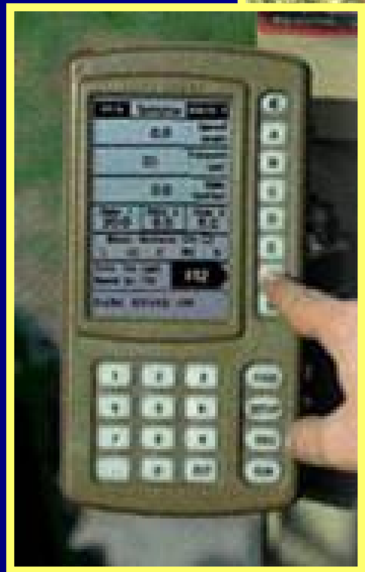
moisture sensor

John Deere



B – moisture sensor

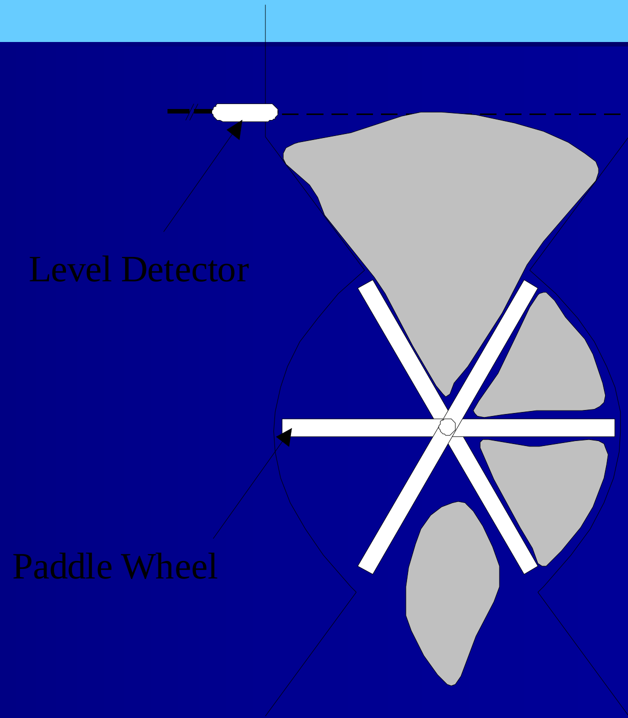
A – force plate yield sensor



C - display

Quantimeter

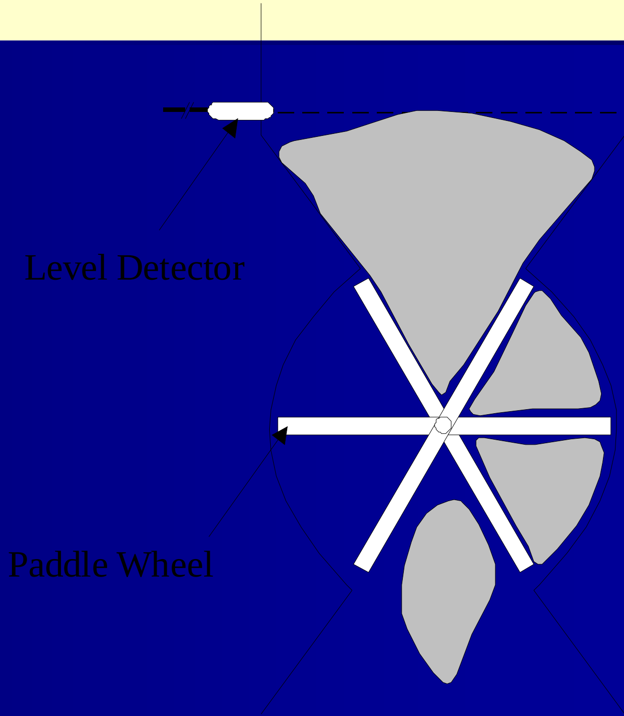
Quantimeter Display



Claydon Yield-O-Meter volumetric grain yield monitor

Quantimeter

Quantimeter Display



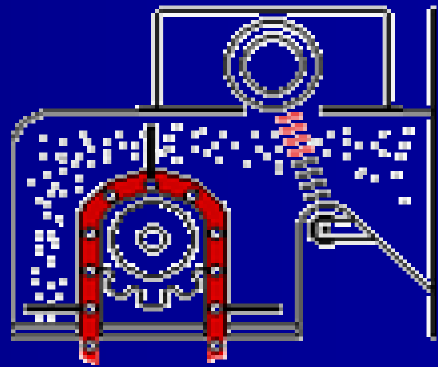
Claydon Yield-O-Meter volumetric grain yield monitor

FIELDSTAR®
The science of agriculture

AGCO

AGCO

radiometric sensor



Working width

- At the early stages the diver estimated the working width and added it to the recording unit.
- Sensors were developed using Ultra sonic signals.

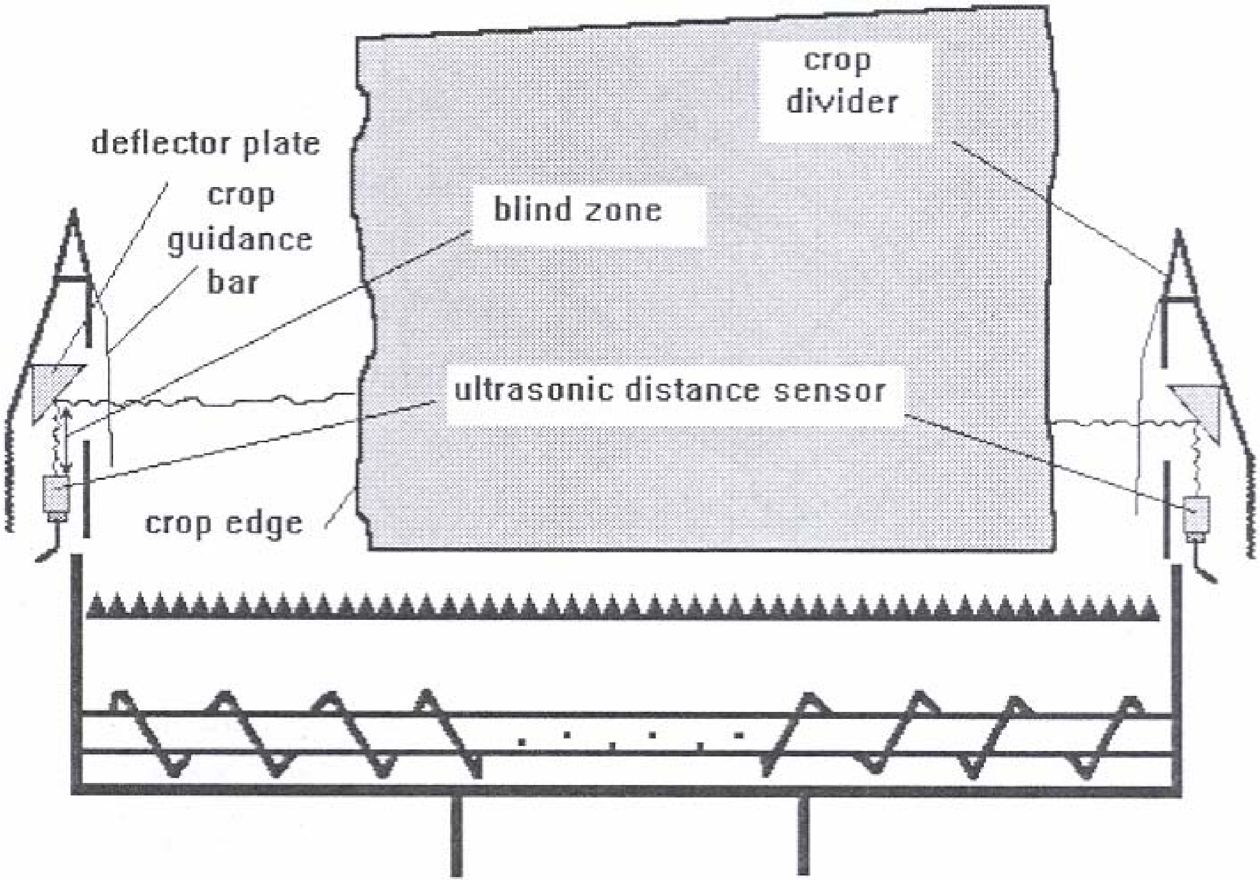


Figure 3. Measurement of cutting width by aid of ultrasonic sensors (Missotten, 1998).

Moisture Content of the seed measurement

- Use of the capacitance change from the change of the moisture content.

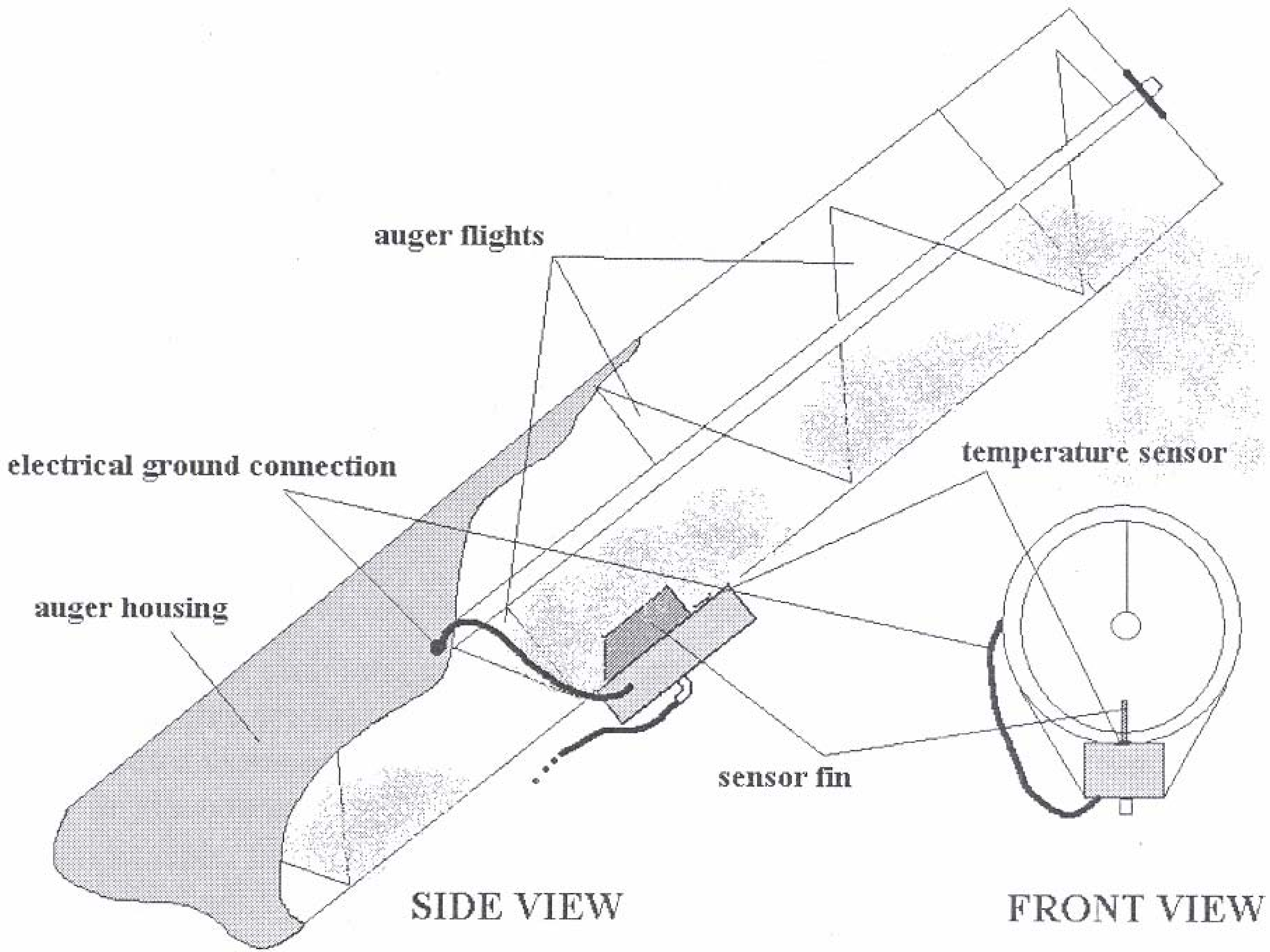
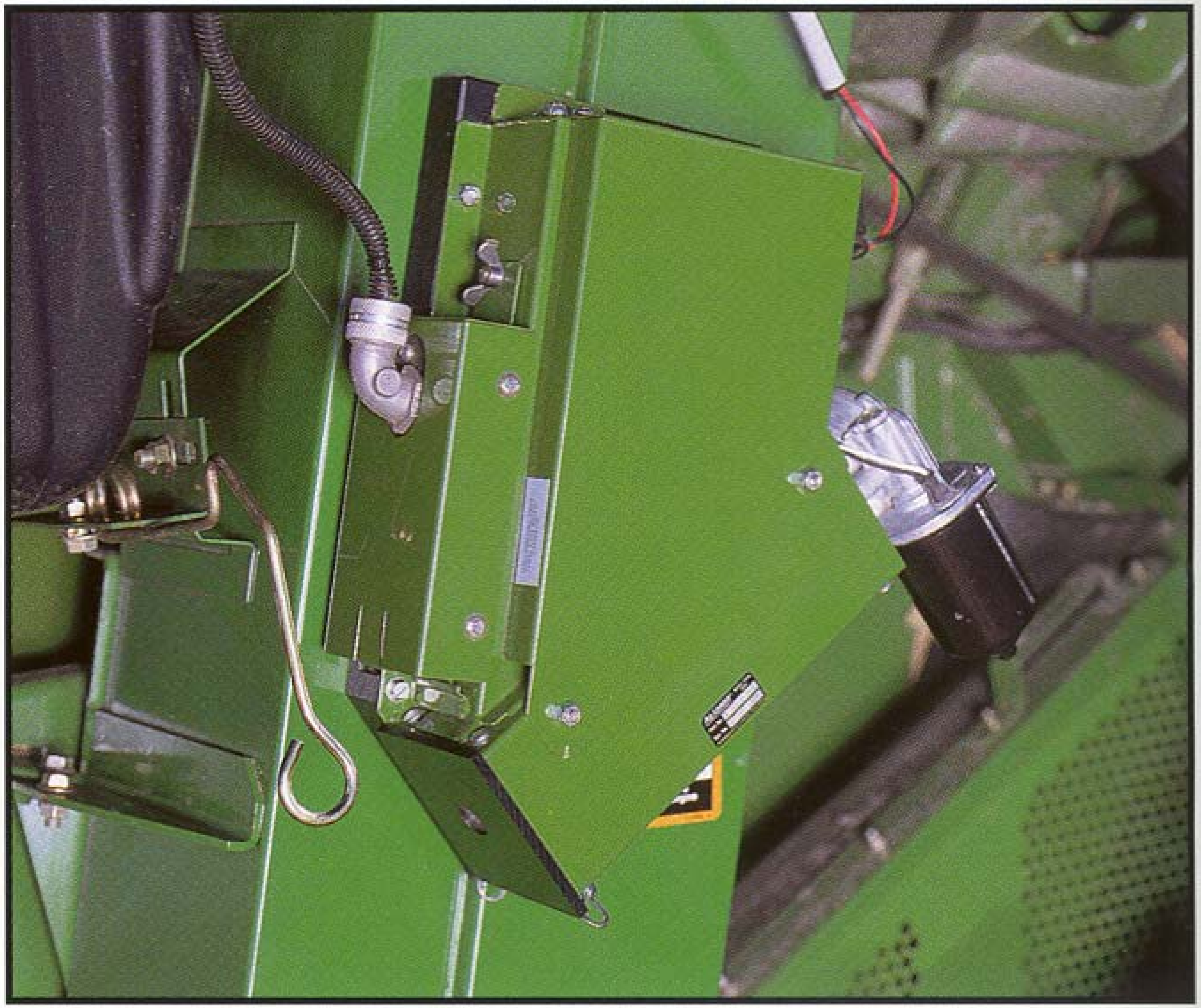


Figure 5. Capacitive moisture sensor.



Elevator Mount
Moisture Sensor

Αισθητήρες για βαμβάκι

Αισθητήρες για τεύτλα, πατάτες, βιομηχανική τομάτα

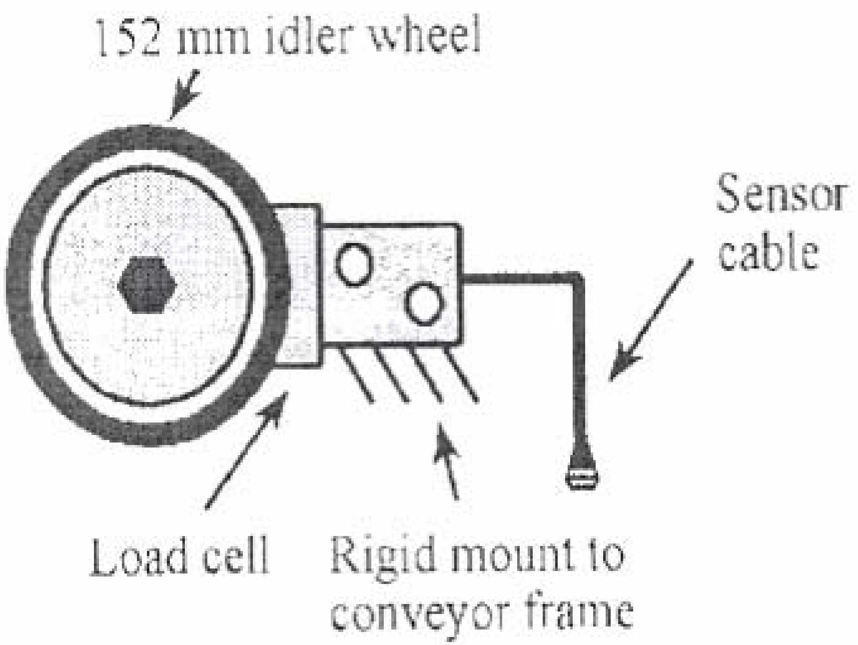


Figure 2. Idler wheel weight-sensing assembly.

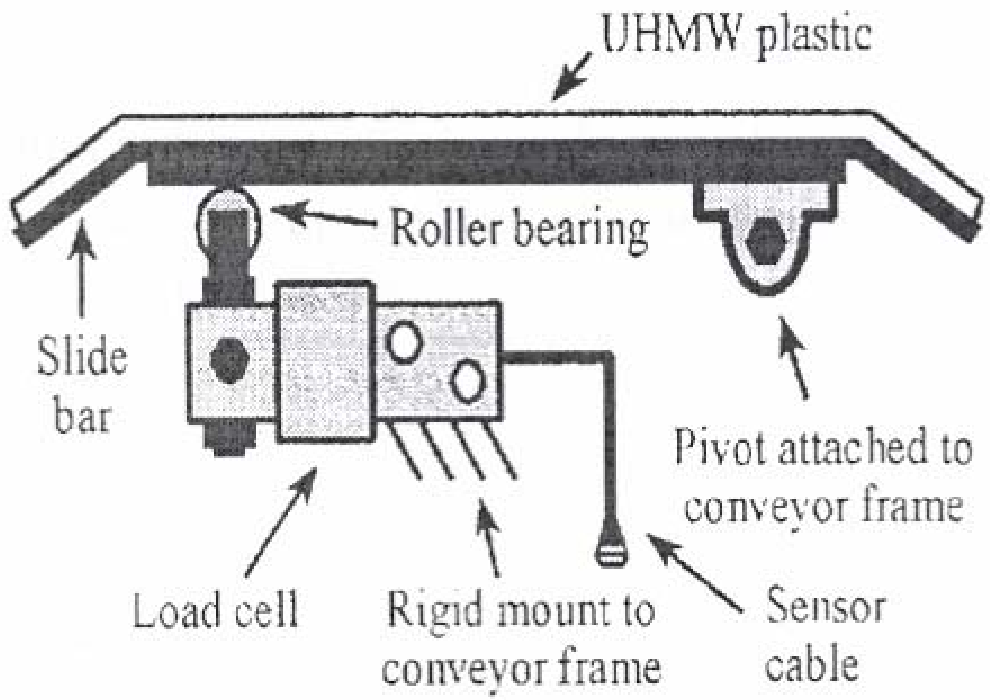


Figure 3. Slide bar weight-sensing assembly.

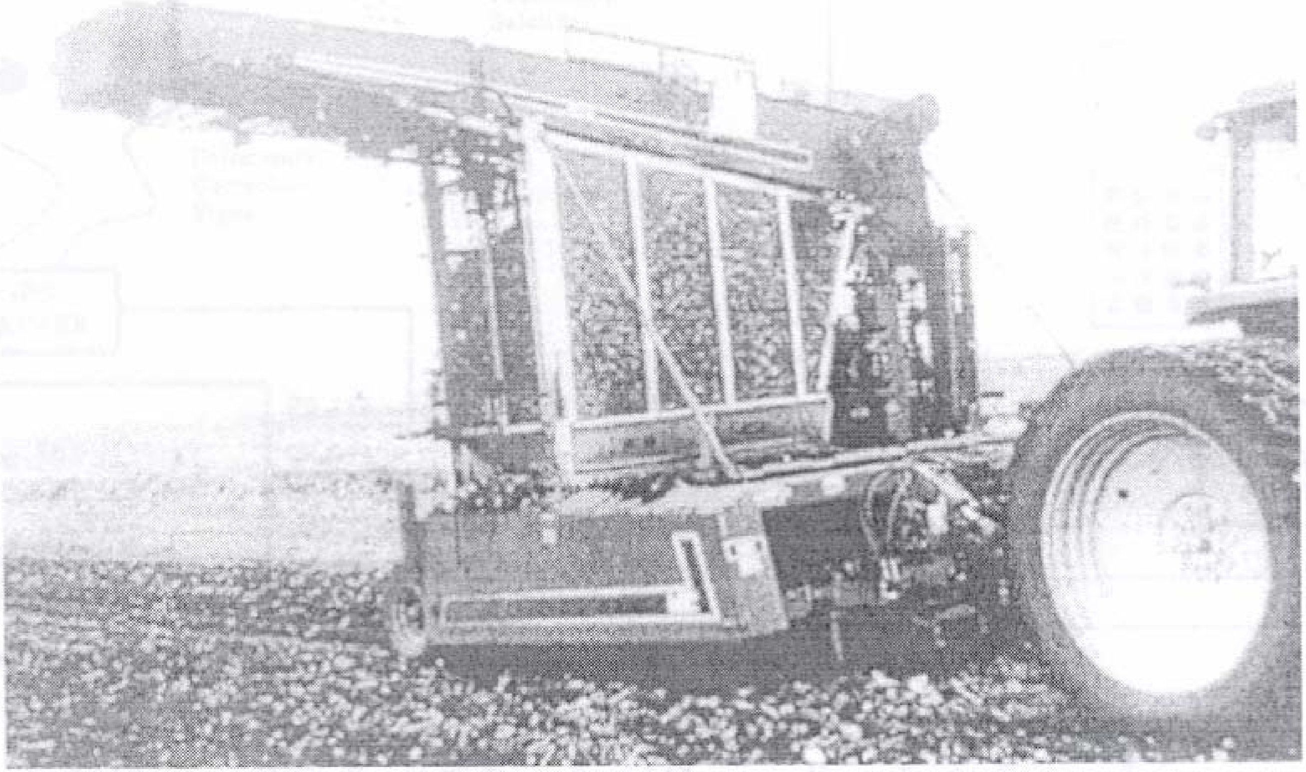


Figure 1. WIC sugarbeet lifter.

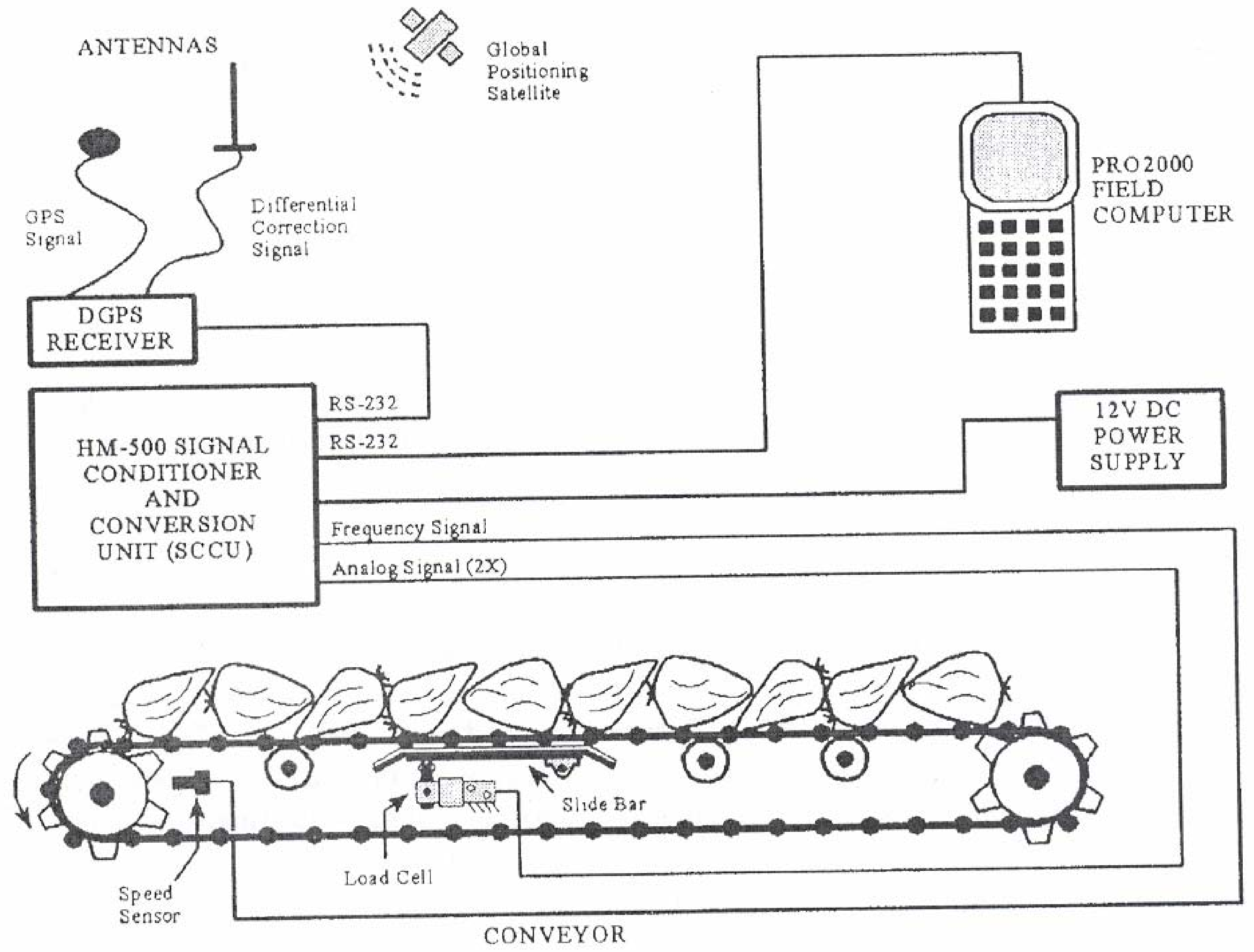


Figure 4. Sugarbeet yield-monitoring equipment setup and connection diagram.

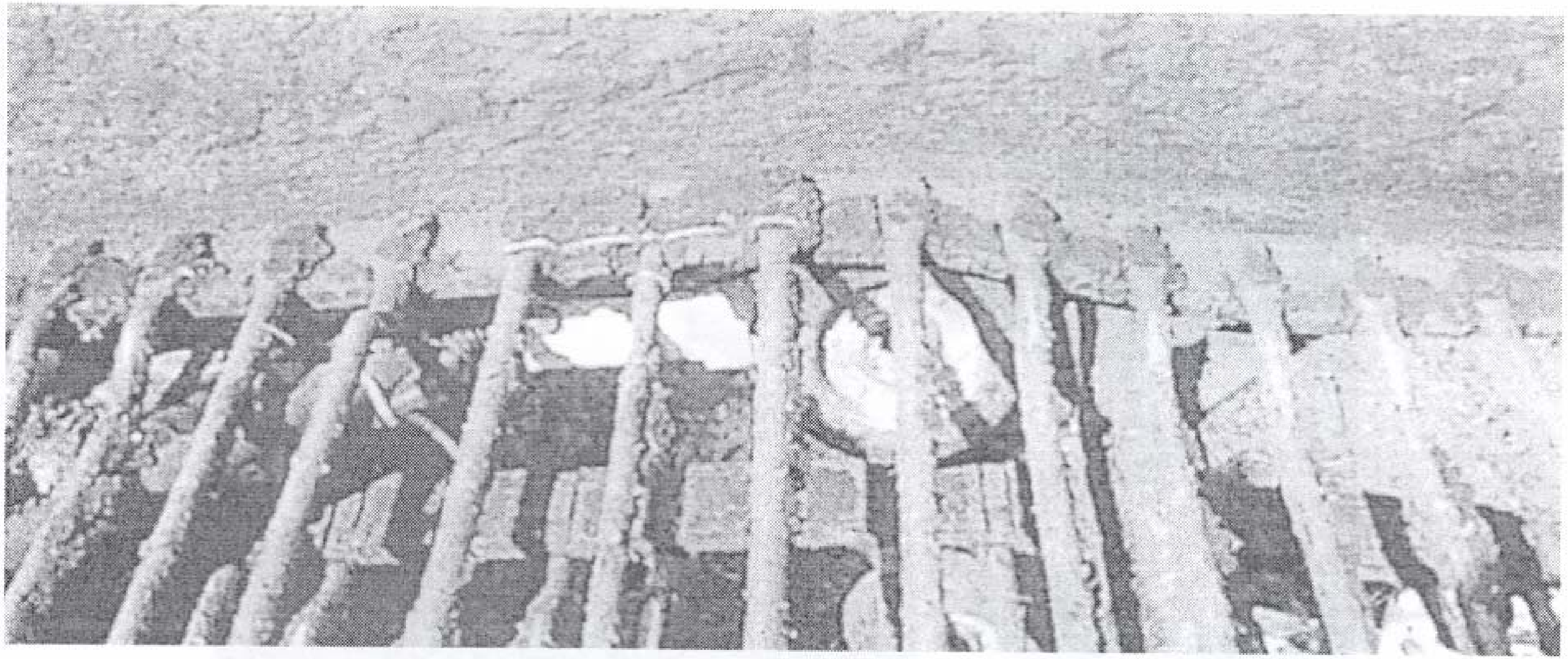


Figure 1. Load cell based product flow sensor.

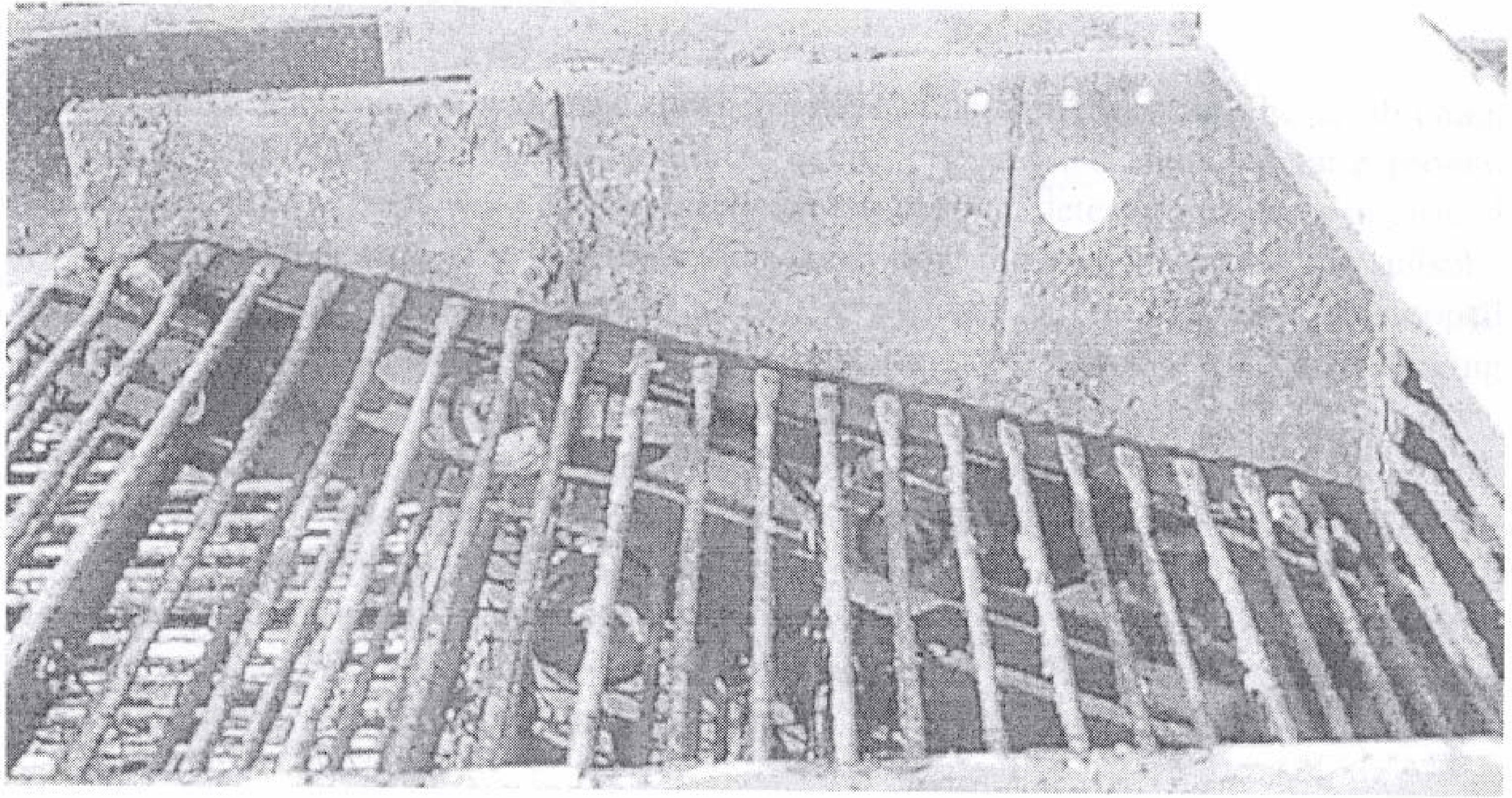


Figure 2. Scrub chain weight sensing system.

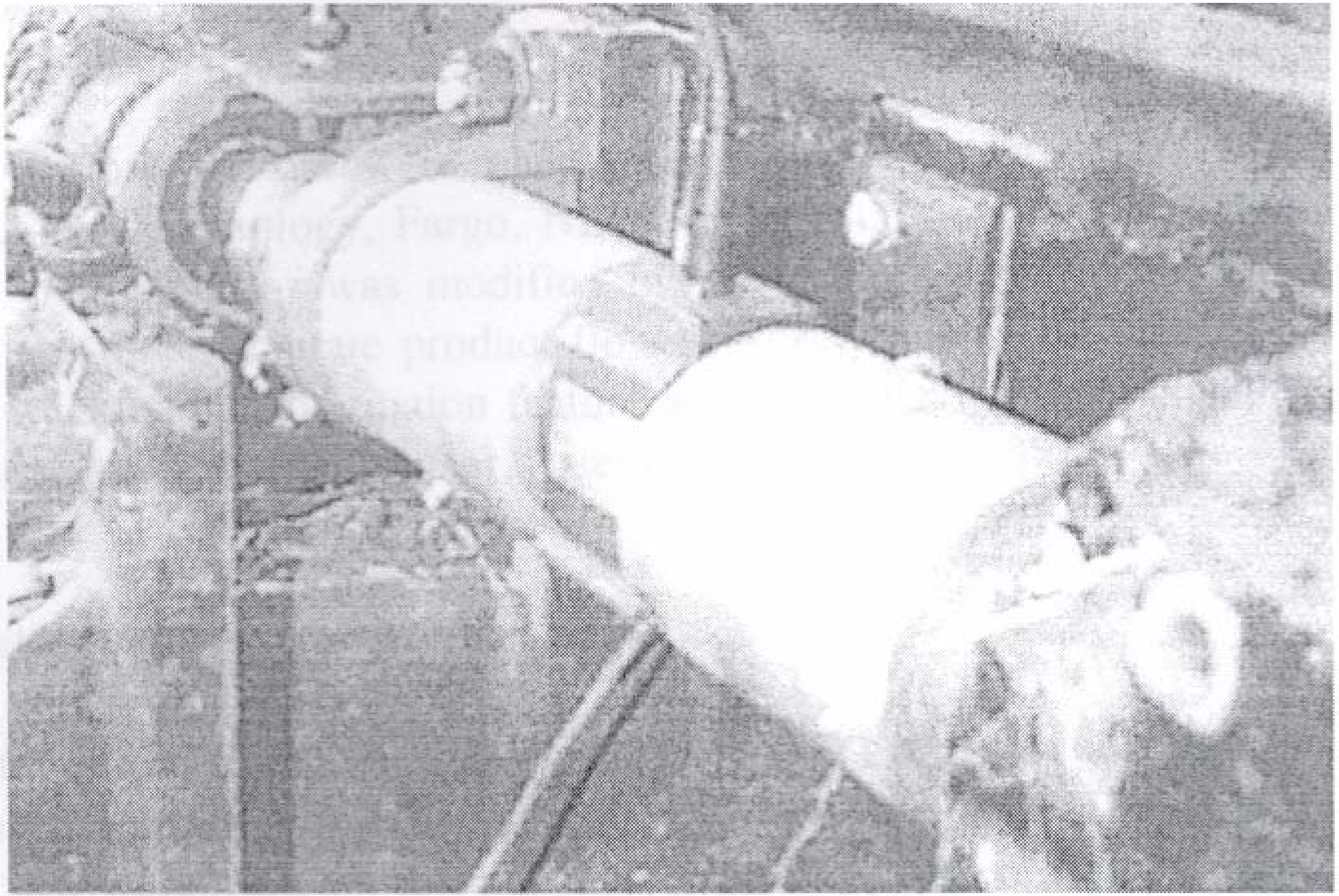


Figure 3. Torque sensor weight sensing system.

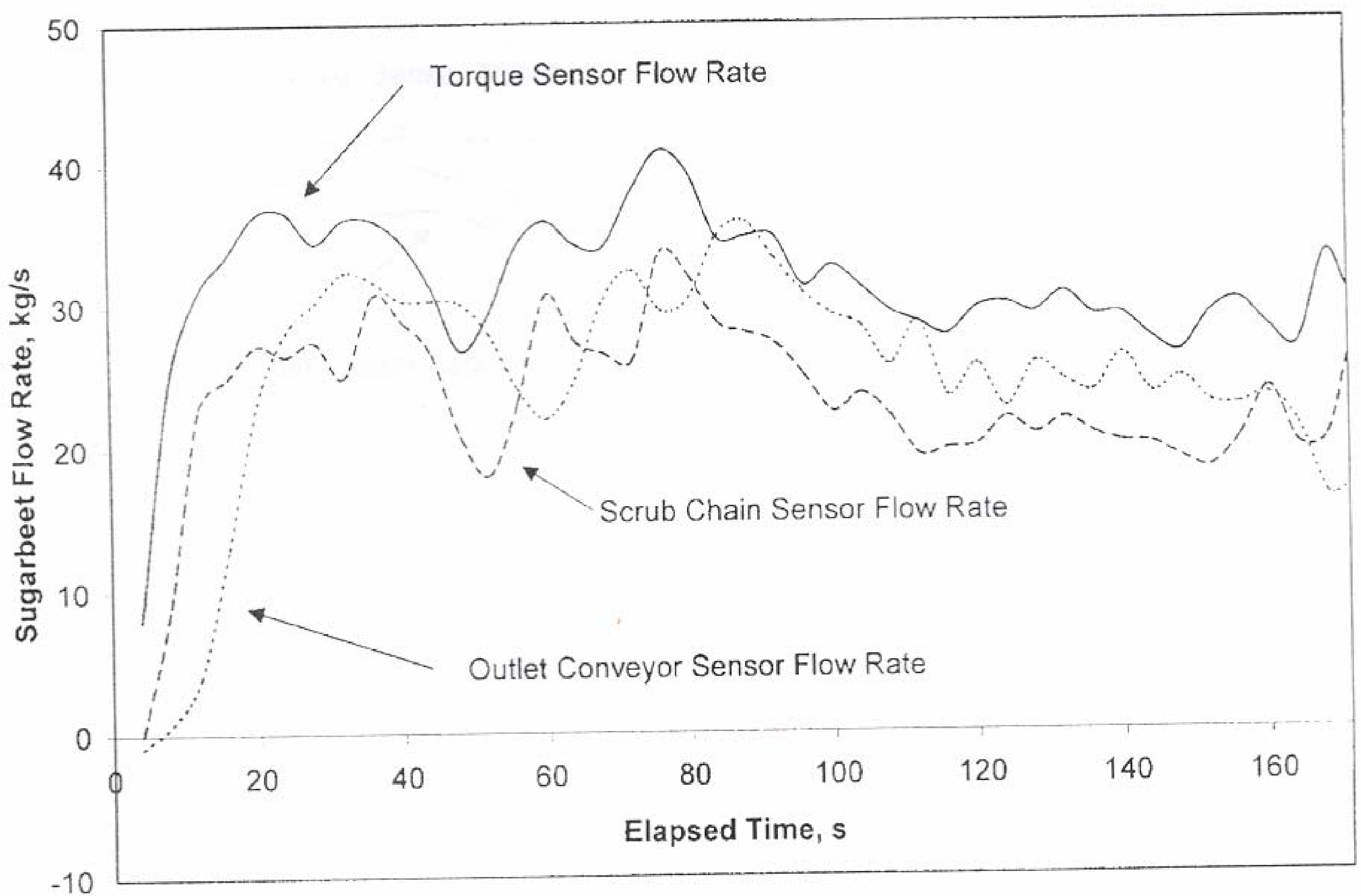


Figure 4. Calculated flow rate changes with elapsed time.

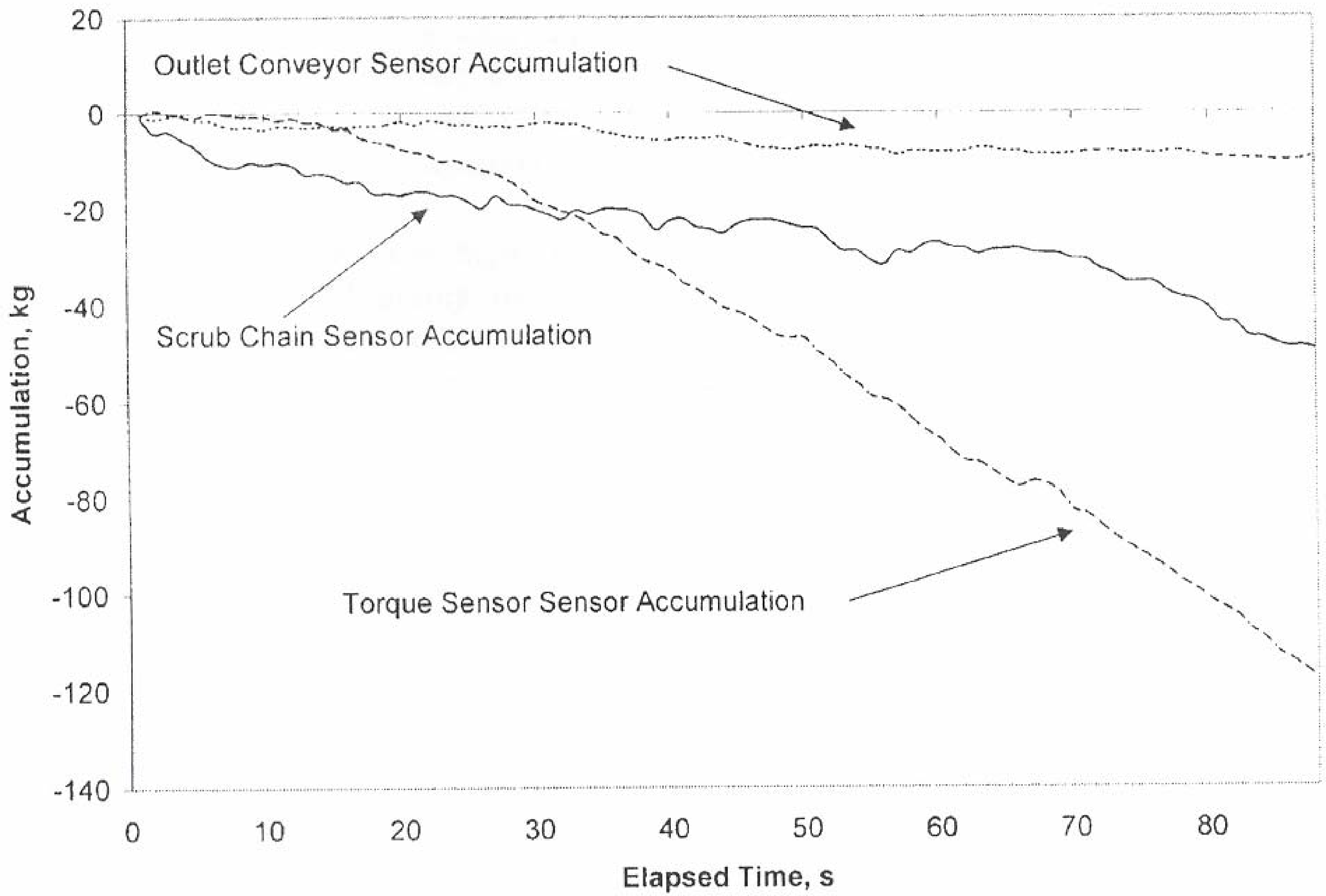


Figure 5. Stationary harvester weight accumulations.

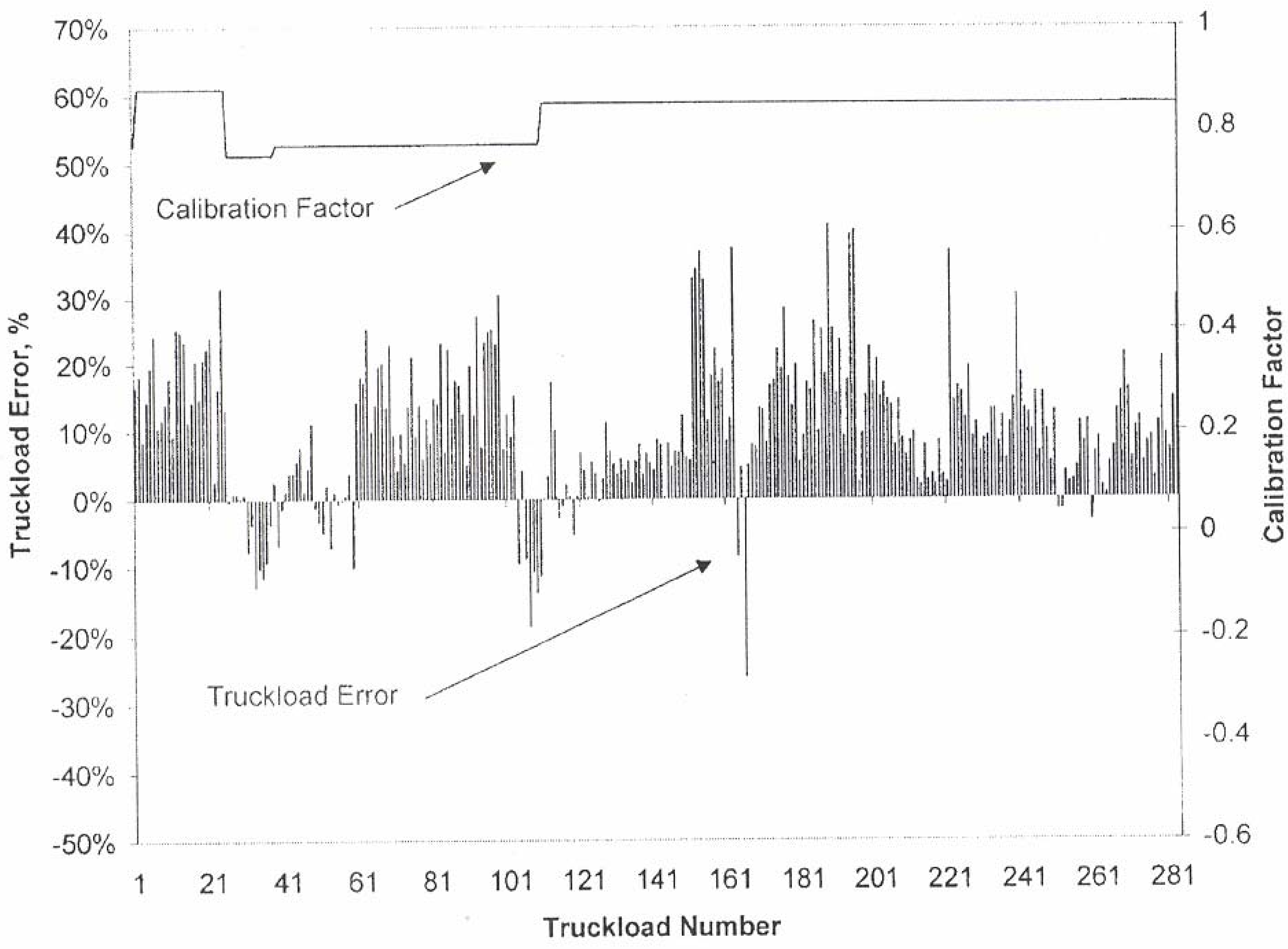


Figure 6. Outlet conveyor product flow sensor-truckload error graph.

Αισθητήρες για χορτοδοτικές καλλιέργειες

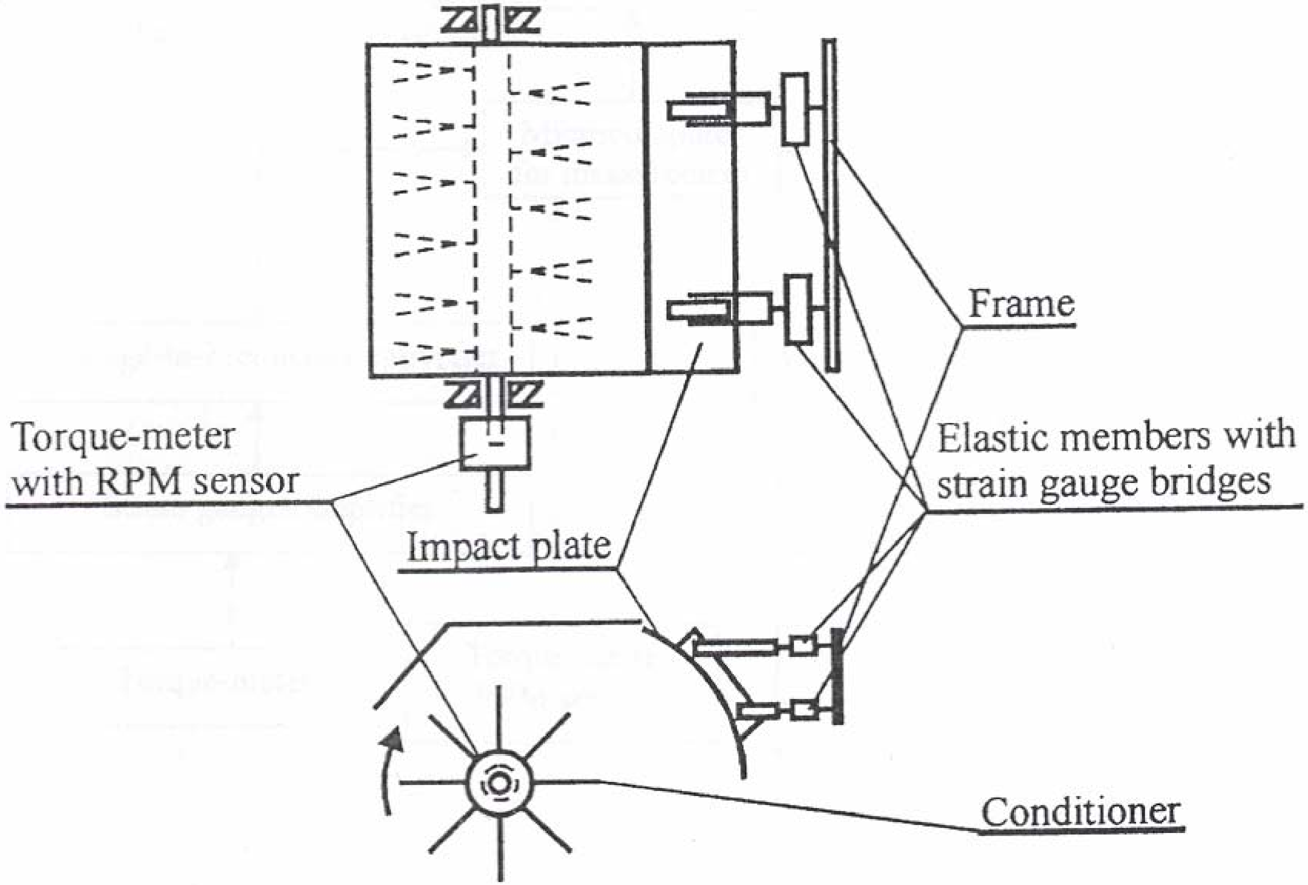


Figure 1. Equipment for material feed rate measurement.

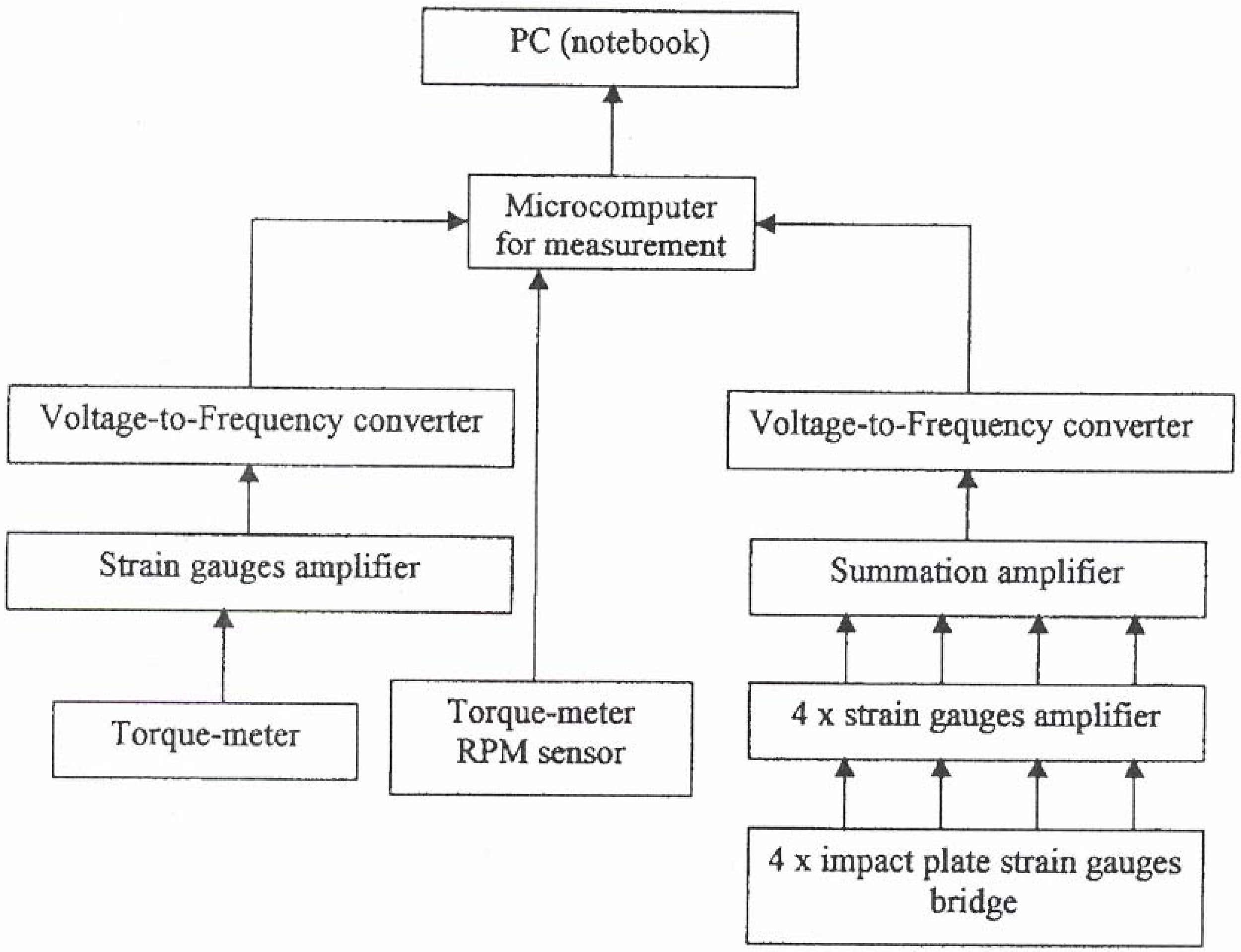
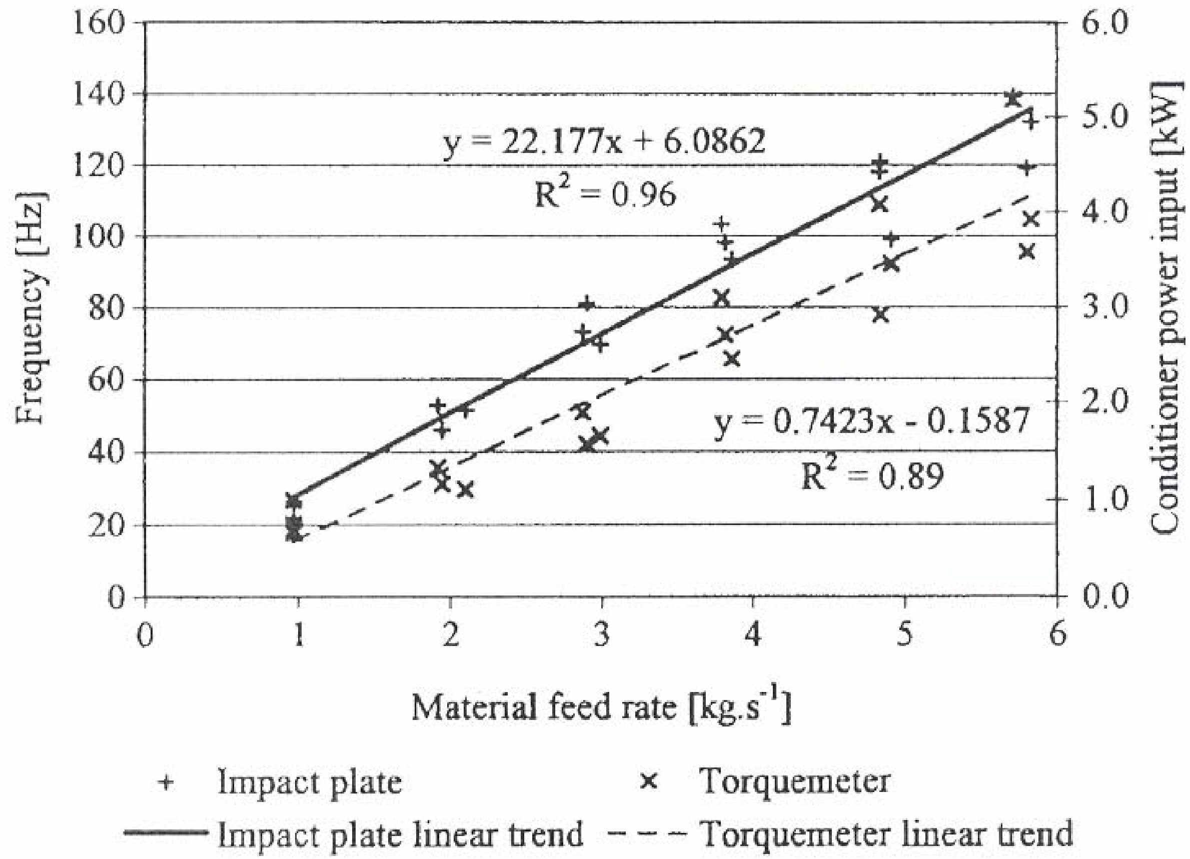


Figure 2. Block diagram of electronic apparatus arrangement for material feed rate measurement.



y = 22.177x + 6.0862
R^2 = 0.96
y = 0.7423x - 0.1587
R^2 = 0.89
Frequency [Hz]
Conditioner power input [kW]
Material feed rate [kg.s-1]
0 20 40 60 80 100 120 140 160
0.0 1.0 2.0 3.0 4.0 5.0 6.0
0 1 2 3 4 5 6
Impact plate
Torquemeter
Impact plate linear trend
Torquemeter linear trend

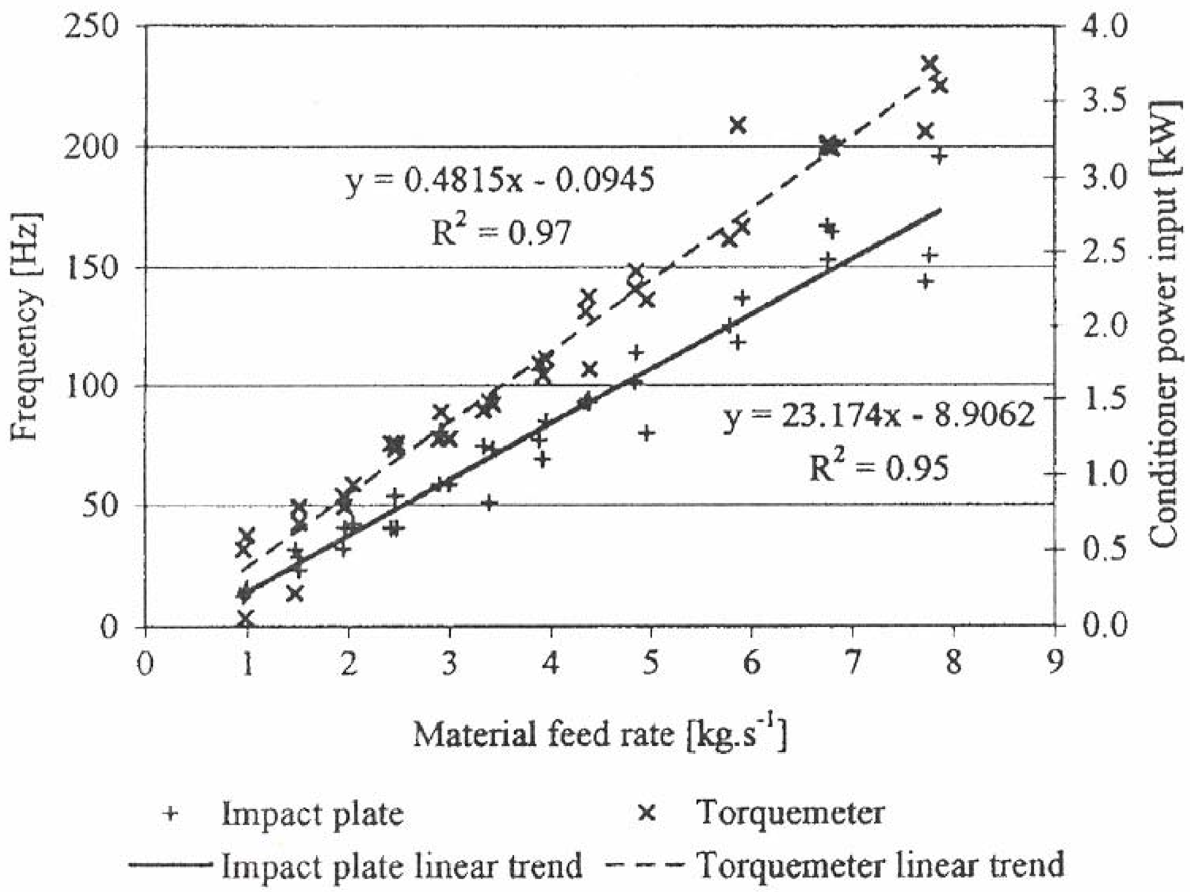


Figure 4. Dependence of the conditioner power input and output frequency of the apparatus measuring impact force by means of impact plate arrangement on material feed rate (second day measurements).

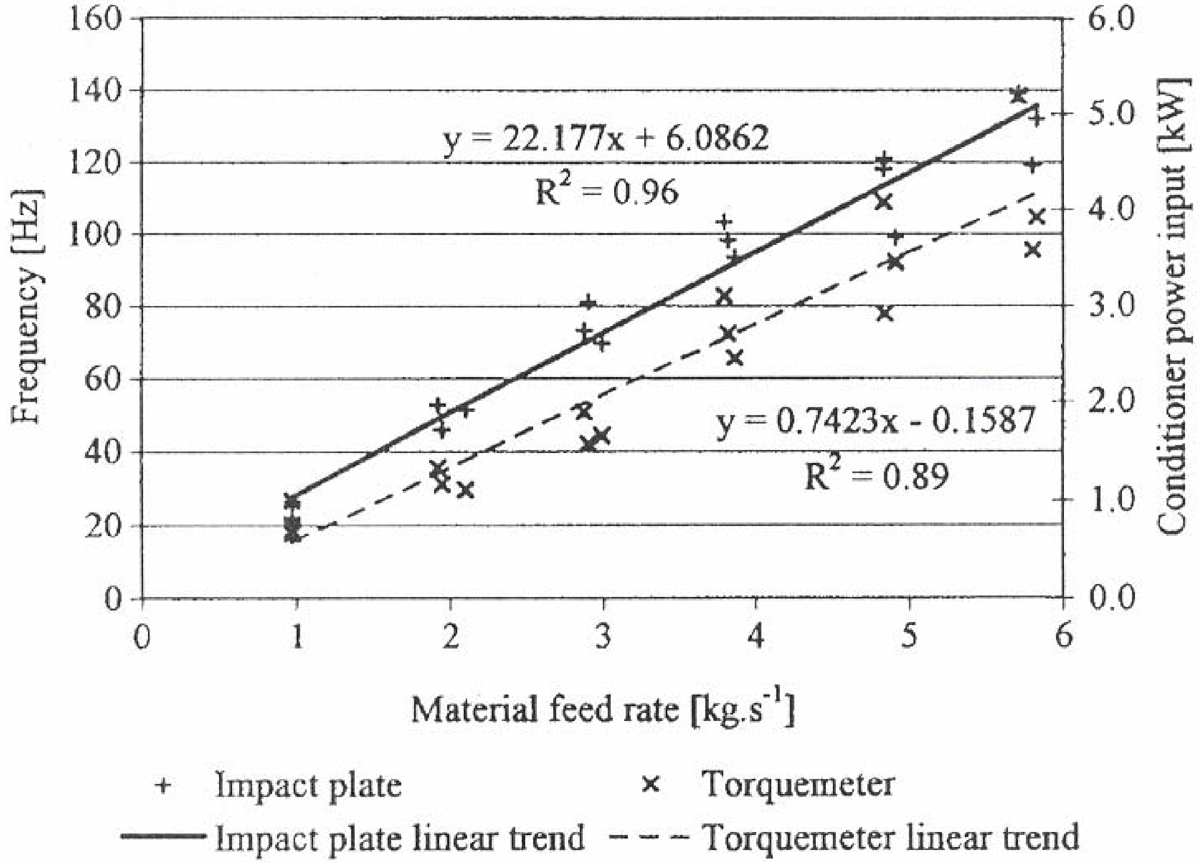


Figure 3. Dependence of the conditioner power input and output frequency of the apparatus measuring the impact force by means of impact plate arrangement on material feed rate (first day measurements).

Αισθητήρες για σταφύλια

Αισθητήρες για δενδρώδεις καλλιέργειες που συγκομίζονται με τα χέρια

- Χαρτογράφηση παραγωγής πορτοκαλιών
- Χαρτογράφηση παραγωγής ξηρών καρπών

Materials and Methods

Location : Ptolemaida area, Northern Greece

21º 50´15´´ E, 40º 39´13´´ N, 790m elevation

VENUS
0
10
20
30
40
50


COPA FOODS

Orchard

- Area: 0.8 ha apple orchard
- Age: six years old trees
- Cultivars: Red Chief and Fuji
- Between-row spacing 4m
- Intra-row 2.5m.
- Trees were trained as free palmette.

Orchard

Measurements

- Yield : 2004, 2005
- Quality: 2004, 2005
- Flowers: 2005

Yield measurement: Yield measured per five trees and recorded the geographical position in the centre of the five trees using a hand-held computer with GPS

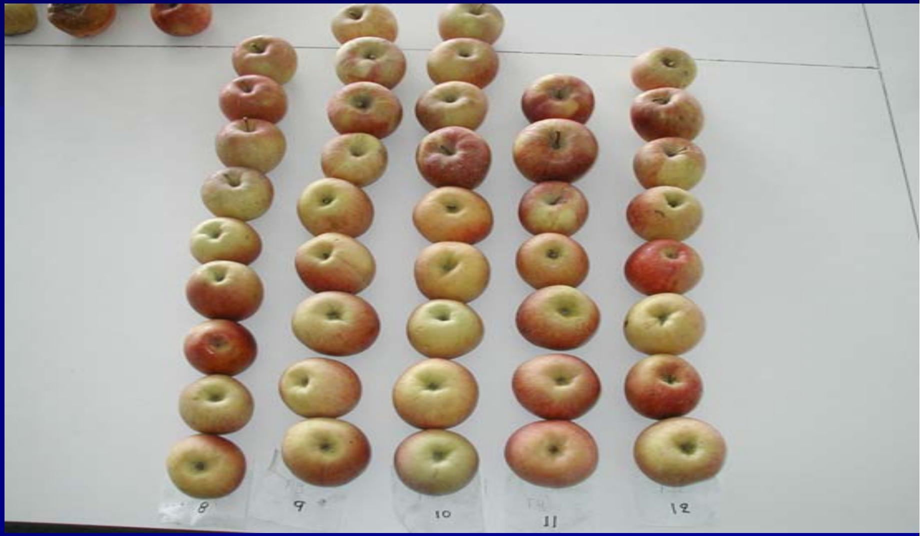
Flower measurement : Flowers measured every fifth tree and the data were projected to flowers / m^2

Quality Measurements

Samples were taken in 30 positions for cv. Red Chief and in 20 positions for cv. Fuji. Every sample contained 6 fruits. The following parameters were measured:

- Fruit mass
- Skin color
- Flesh firmness
- Soluble solids content
- Juice pH
- Juice acidity

Quality Measurements



- Fruit mass by weighing all 6 fruit together and calculating mean value per fruit.

- Skin color with Hunter chromamerter colour (L*, a*, b* coordinates). The calculation of parameters C* and hue angle followed

Quality Measurements

- Flesh firmness with Effegi penetrometer and 11mm diameter plunger

- Soluble solids content with refractometer Carl Zeiss Zena.

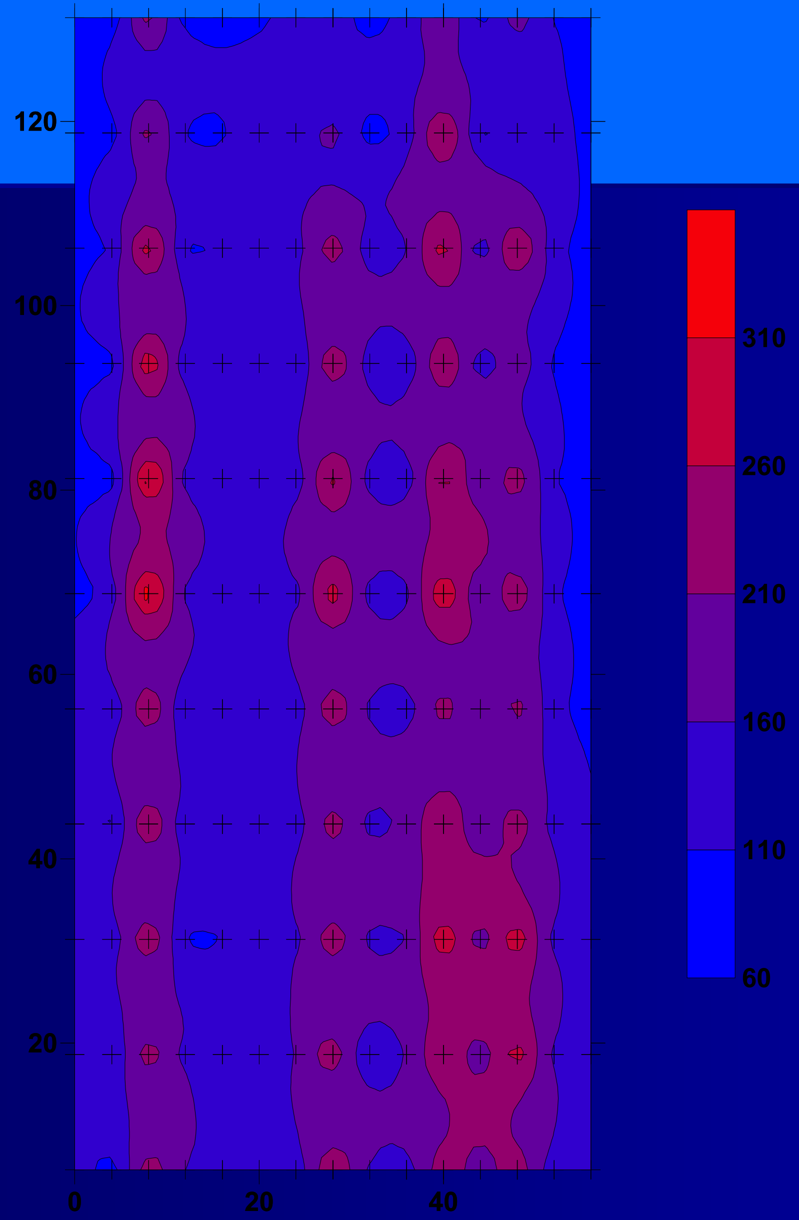
Quality Measurements

- Juice pH

- Juice acidity by titration with 0.1 N NaOH

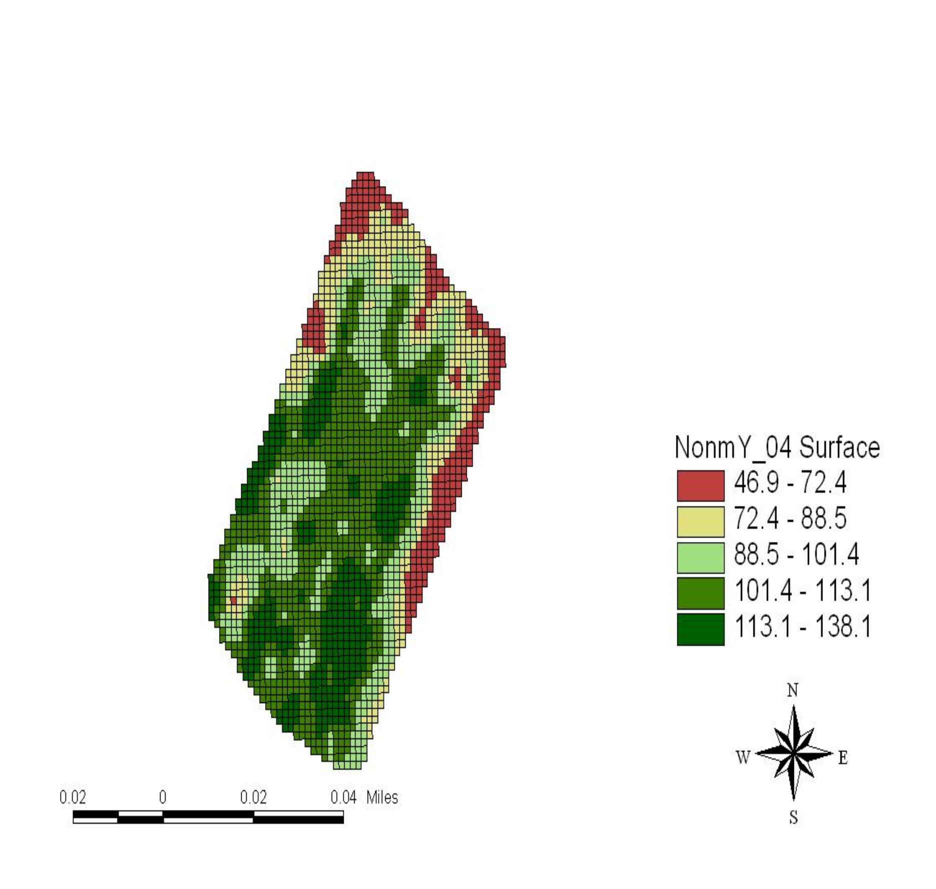
  to an endpoint of pH=8.2 and calculations to express acidity as g malic acid per 100 g of juice

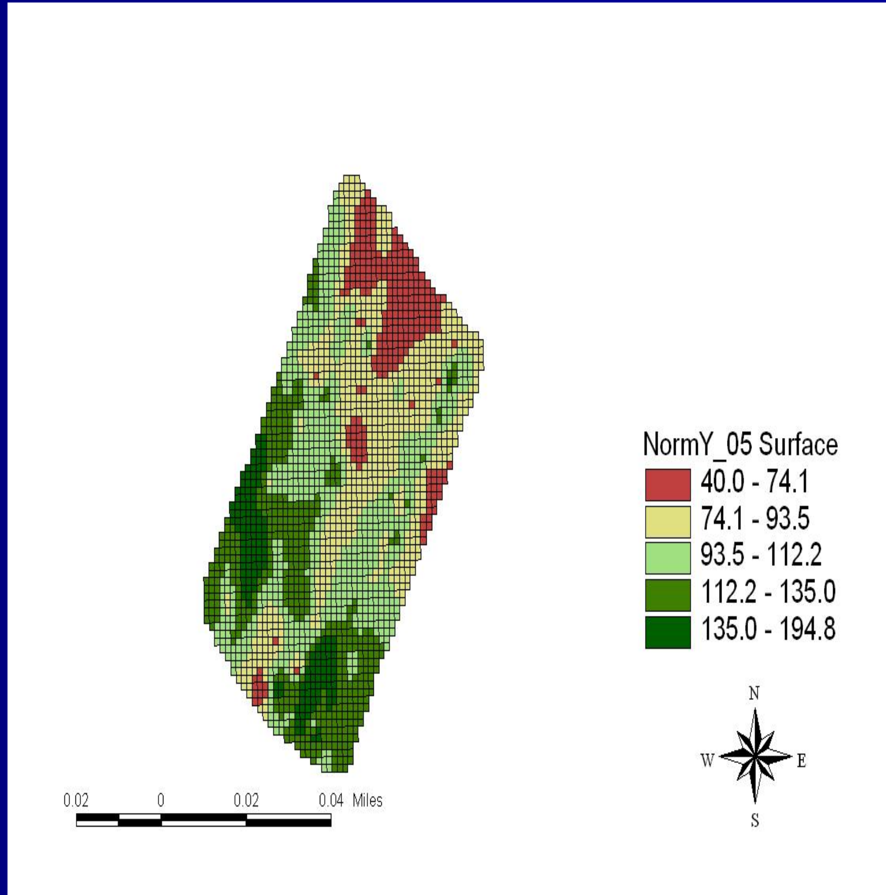
Apple yield map. Octomber 2004, Prolemaida. Two virieties. Fugi and delicius



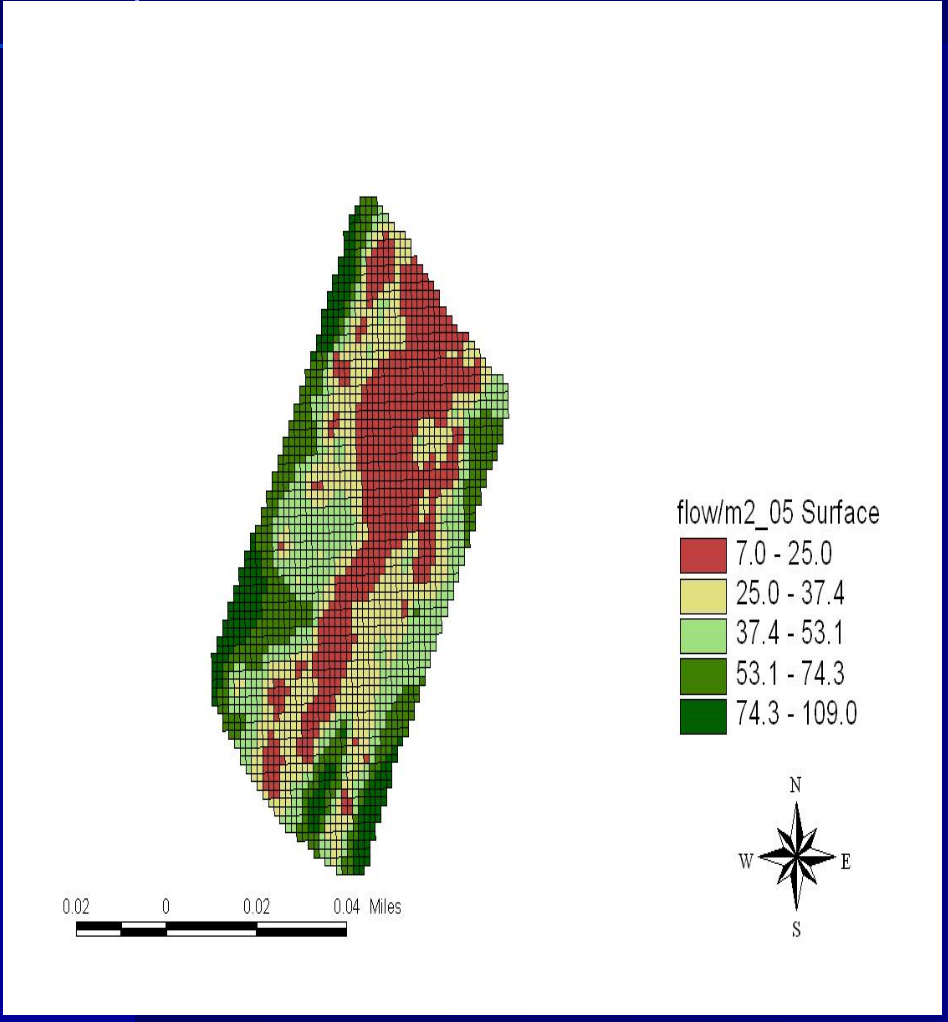
Results

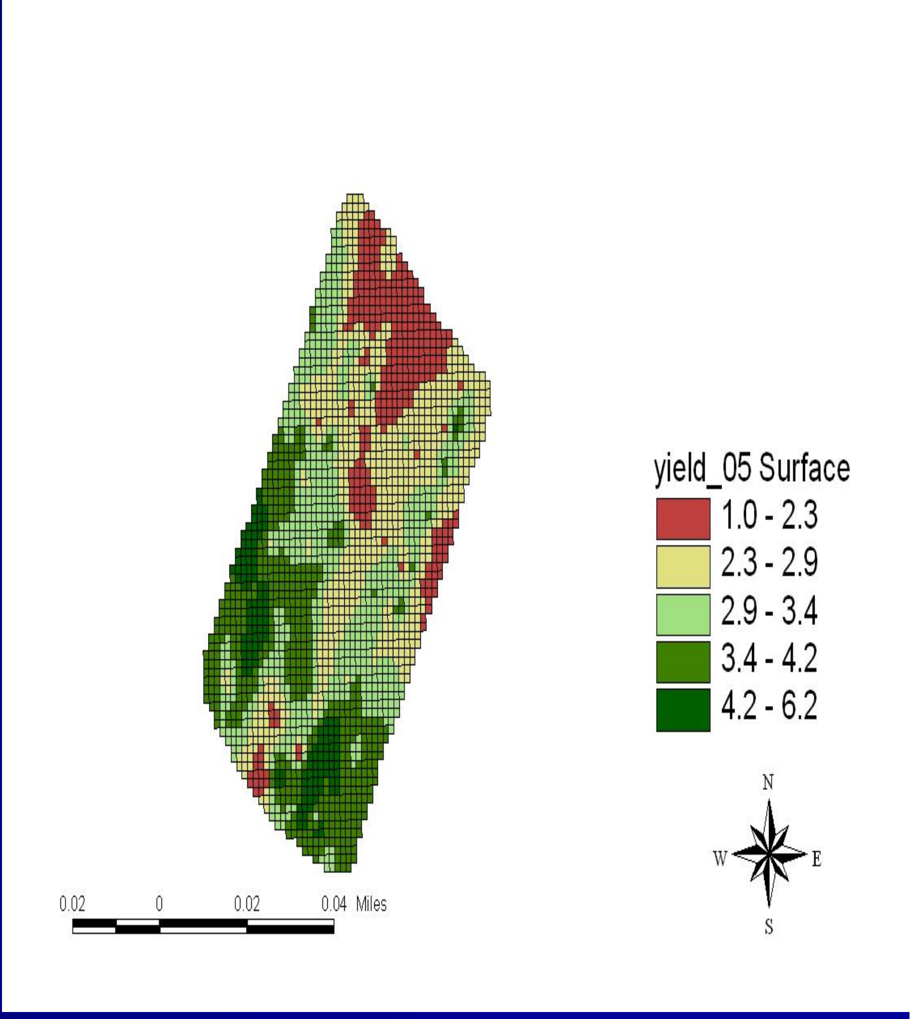
Normalized Yield 2004 Normalized Yield 2005





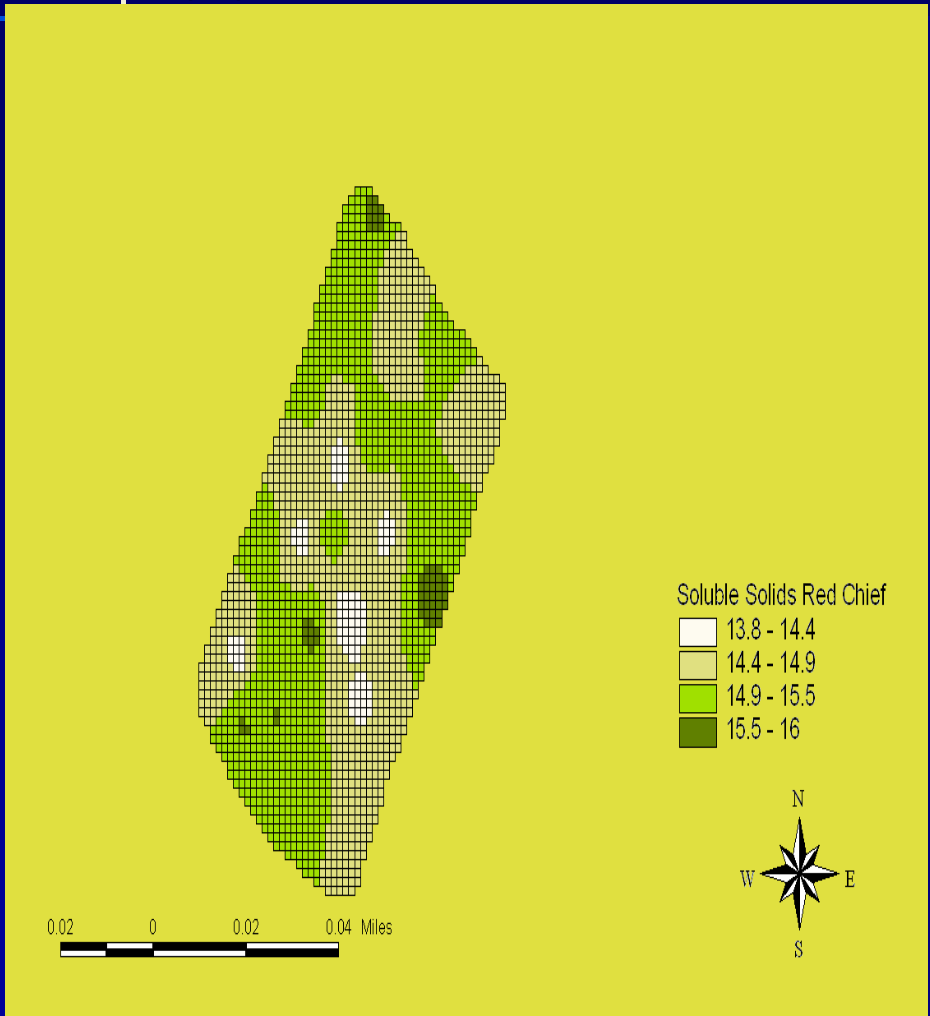
Flowers/m² 2005 Yield 2005(ton/(1/10ha)) r= 0.67

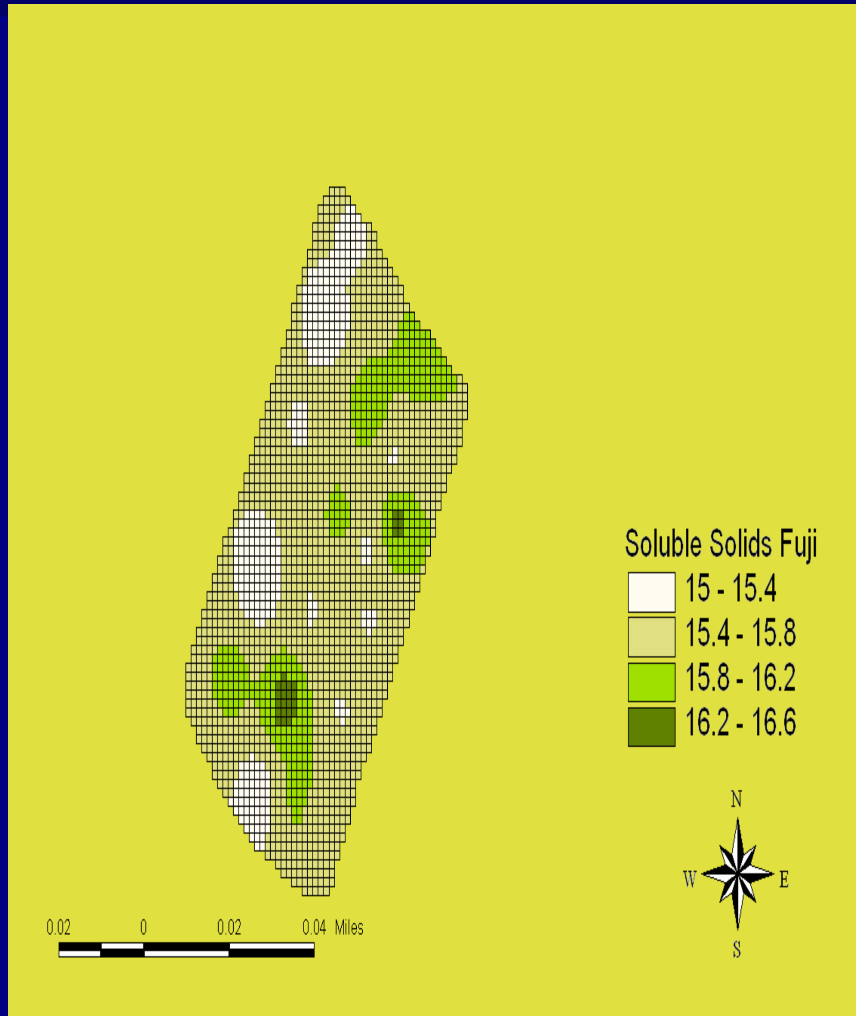




Soluble solids content

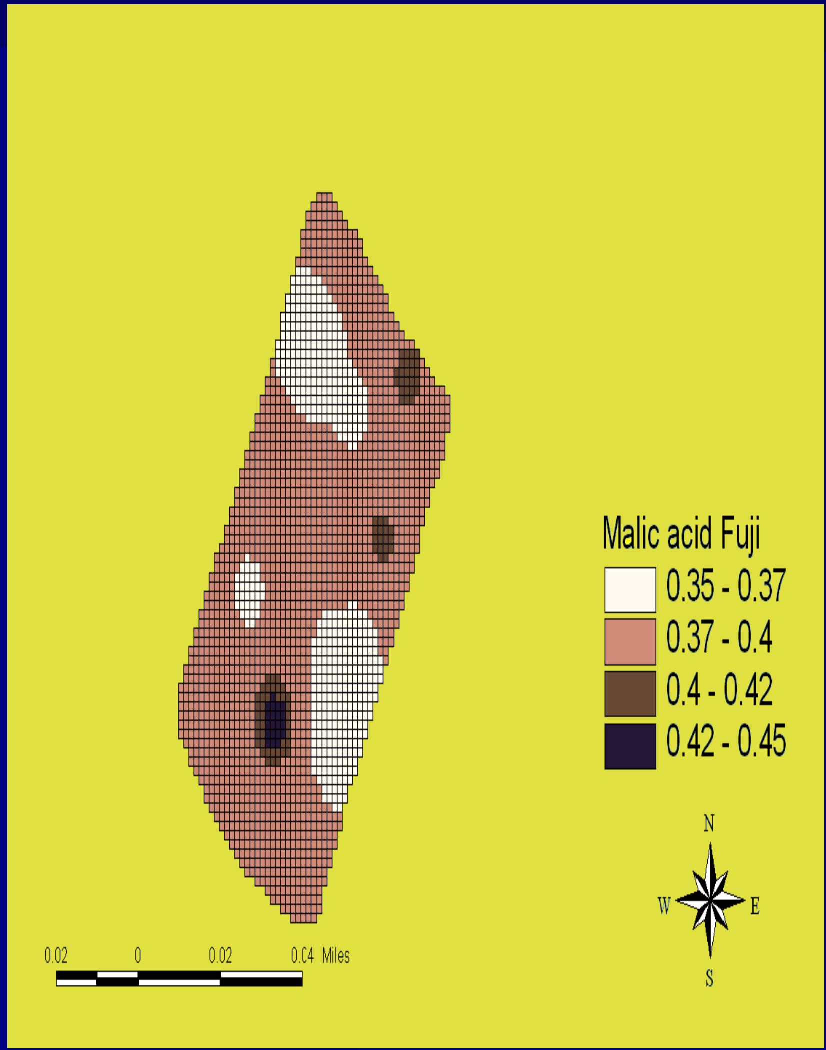
cv. Red Chief 2004 2004 cv. Fuji





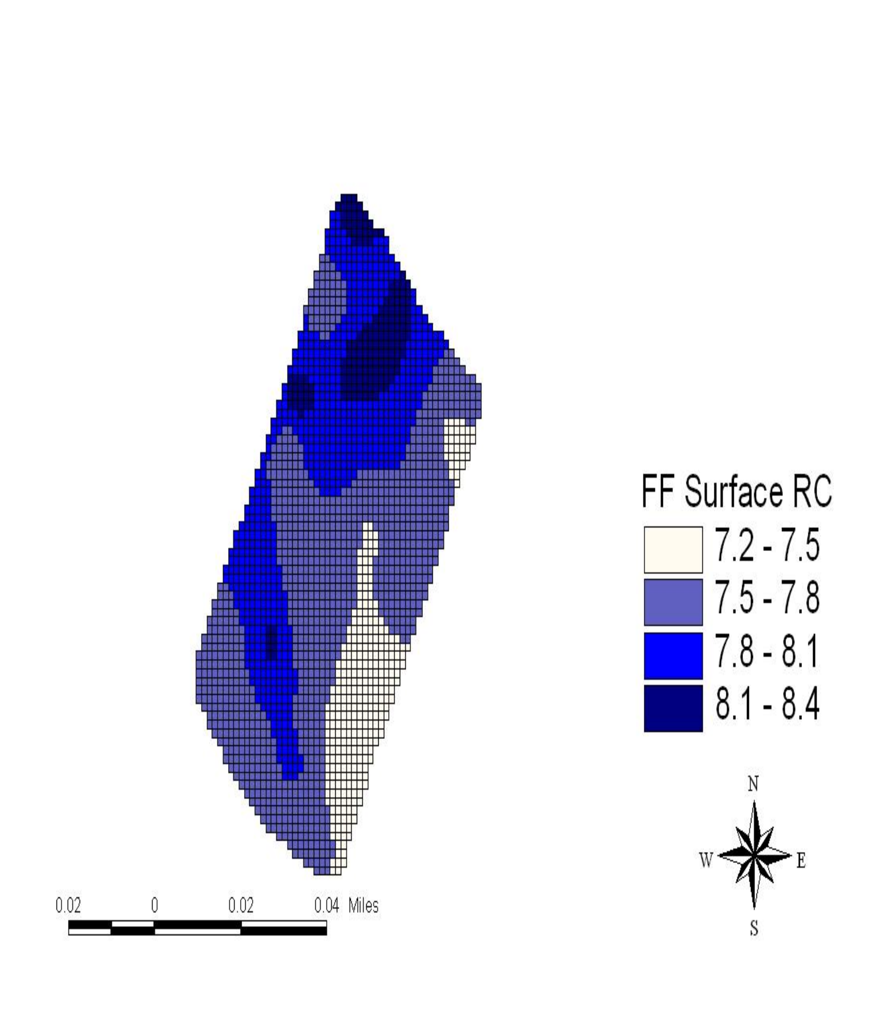
Malic acid content

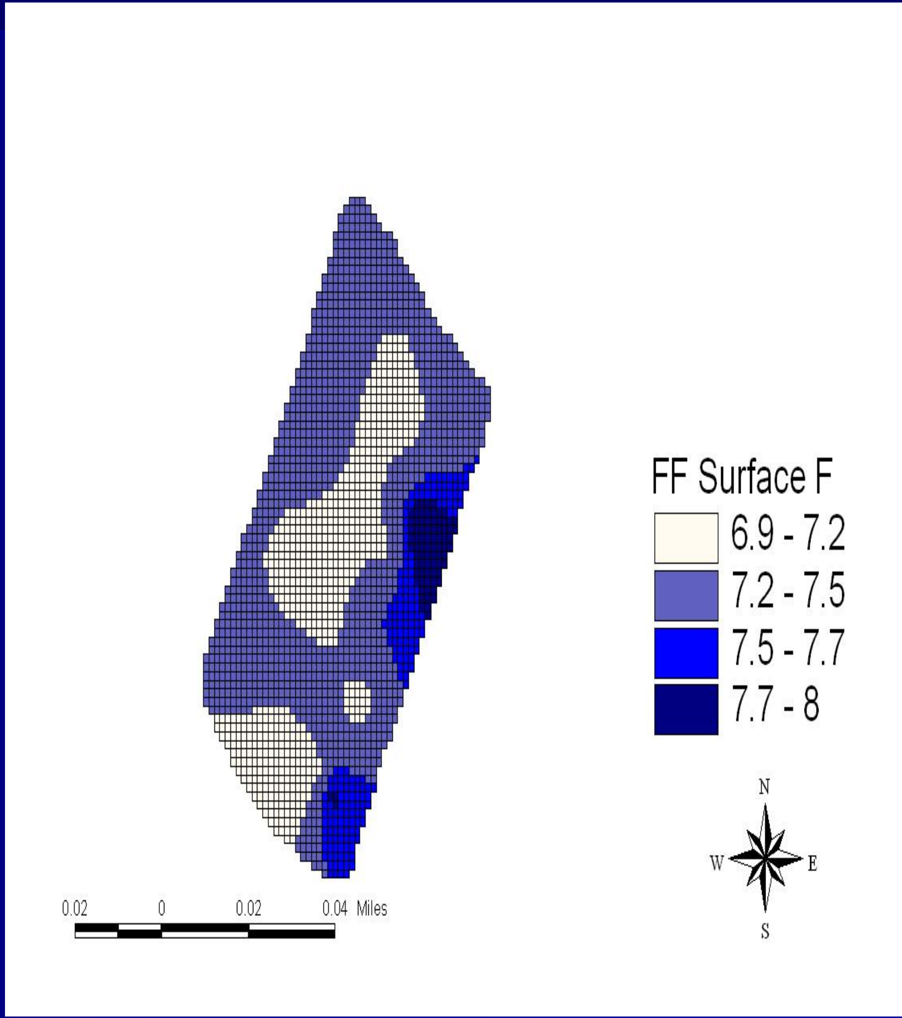
cv Red Chief 2004 **cv. Fuji 2004**



Flesh Firmness (N)

cv Red Chief 2004 **cv. Fuji 2004**





Correlations Red Chief 2004

	Yield/tree	Fruit mass	Malic acid	Flesh Firmness	Soluble Solids	Juice pH	Tree diameter
Yield/ tree	1						
Fruit mass	0.13	1					
Malic acid	-0.04	-0.22	1				
Flesh firmness	-0.16	-0.78*	0.29	1			
Soluble solids	-0.44*	-0.04	0.08	0.24	1		
Juice pH	-0.30	0.05	-0.22	0.01	0.26	1	
Tree diameter	0.74*	-0.01	0.28	0.18	-0.14	-0.28	1

Significant at 0.05 level

Correlations Fuji 2004

	Yield/ tree	Fruit mass	Malic acid	Flesh firmness	Soluble Solids	Juice pH	Tree diameter
Yield/ tree	1						
Fruit mass	-0.03	1					
Malic acid	-0.26	-0.16	1				
Flesh firmness	-0.25	0.09	0.29	1			
Soluble solids	-0.49*	-0.07	0.61*	0.43	1		
Juice pH	0.13	0.16	-0.32	-0.37	-0.37	1	
Tree diameter	0.38	-0.25	0.03	-0.44	-0.19	0.26	1

Significant at 0.05 level

Correlations Red Chief 2005

	Fruit mass	L	C	Hue	Flesh firmness	Soluble Solids	Juice pH	Malic acid	Yield /tree
Fruit mass	1								
L	0.32	1							
C	0.38*	0.68*	1						
Hue	0.37*	0.85*	0.78*	1					
Flesh Firmness	-0.50*	-0.39*	-0.61*	-0.69*	1				
Soluble Solids	0.12	-0.07	0.02	0.18	-0.28	1			
Juice pH	0.26	0.02	0.01	-0.07	0.11	-0.06	1		
Malic acid	0.34	0.13	0.13	0.09	-0.21	0.17	-0.18	1	
Yield /tree	-0.01	0.04	-0.02	-0.04	-0.02	-0.34	0.11	-0.02	1

*Significant at 0.05 level

Correlations Fuji 2005

	Yield/ tree	Fruit mass	Flesh Firmness	Soluble Solids	Juice pH	Malic acid
Yield/ tree	1					
Fruit mass	-0.19	1				
Flesh firmness	-0.69*	-0.01	1			
Soluble solids	-0.77*	0.10	0.44	1		
Juice pH	0.38	-0.30	-0.30	-0.37	1	
Malic acid	-0.80*	0.13	0.72*	0.54*	-0.29	1

*Significant at 0.05 level

Εφαρμογή στο αμπέλι


2004.10.09


2004.10.09


2004.10.09

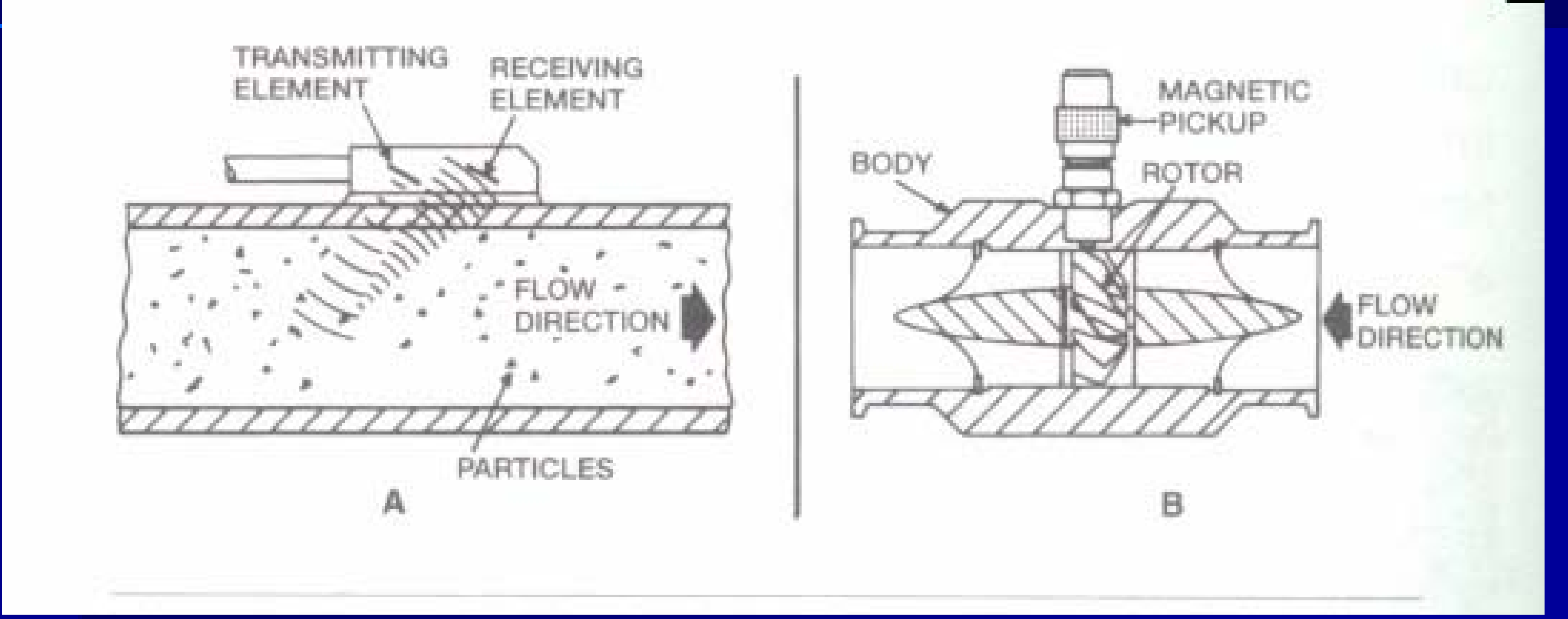
Αισθητήρες υγρασίας

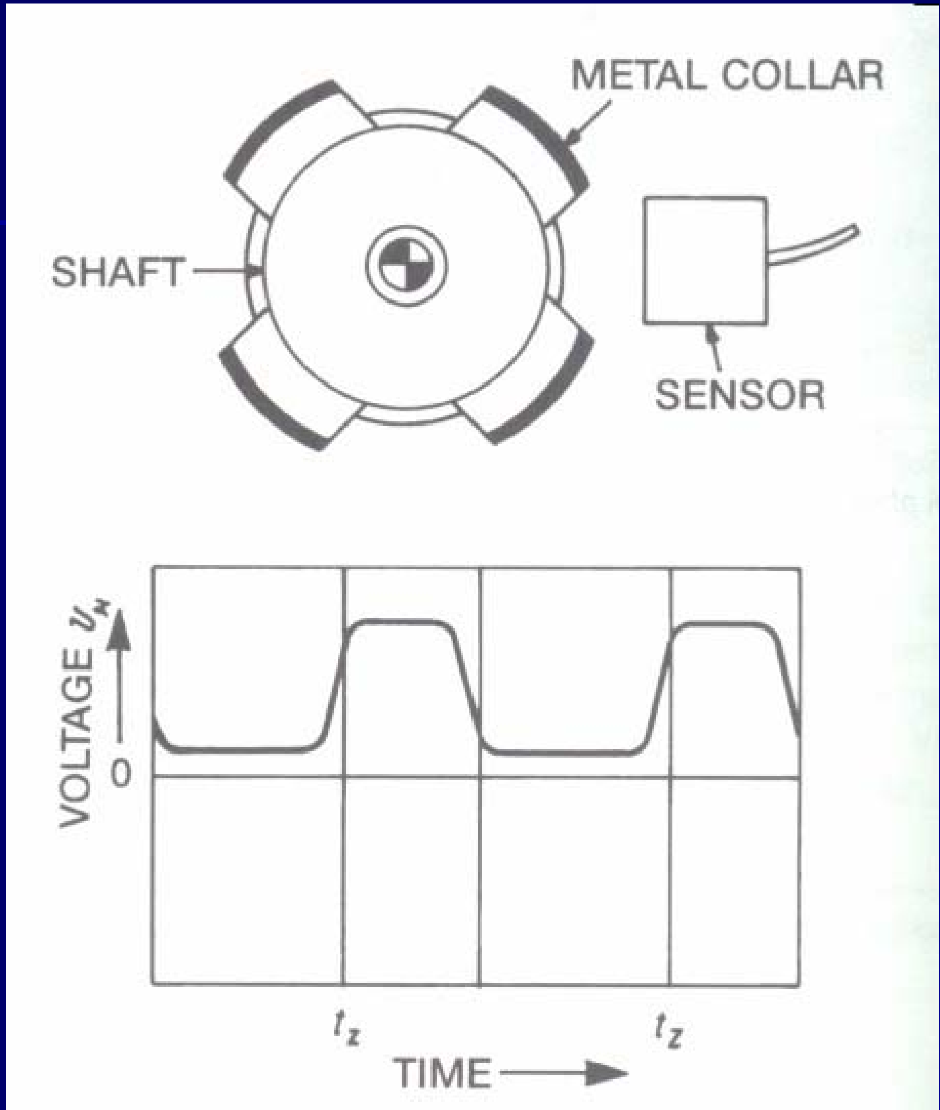
- Σημαντική κυρίως σε Θεριζοαλωνιστικές
- Μέτρηση διηλεκτρικής σταθεράς των σιτηρών με τοποθέτηση δύο ακροδεκτών στις παρειές του αναβατορίου του σπόρου
- Συνήθως γίνεται με τοποθέτηση των στοιχείων ενός πυκνωτή στις πλευρές του σωλήνα μεταφοράς

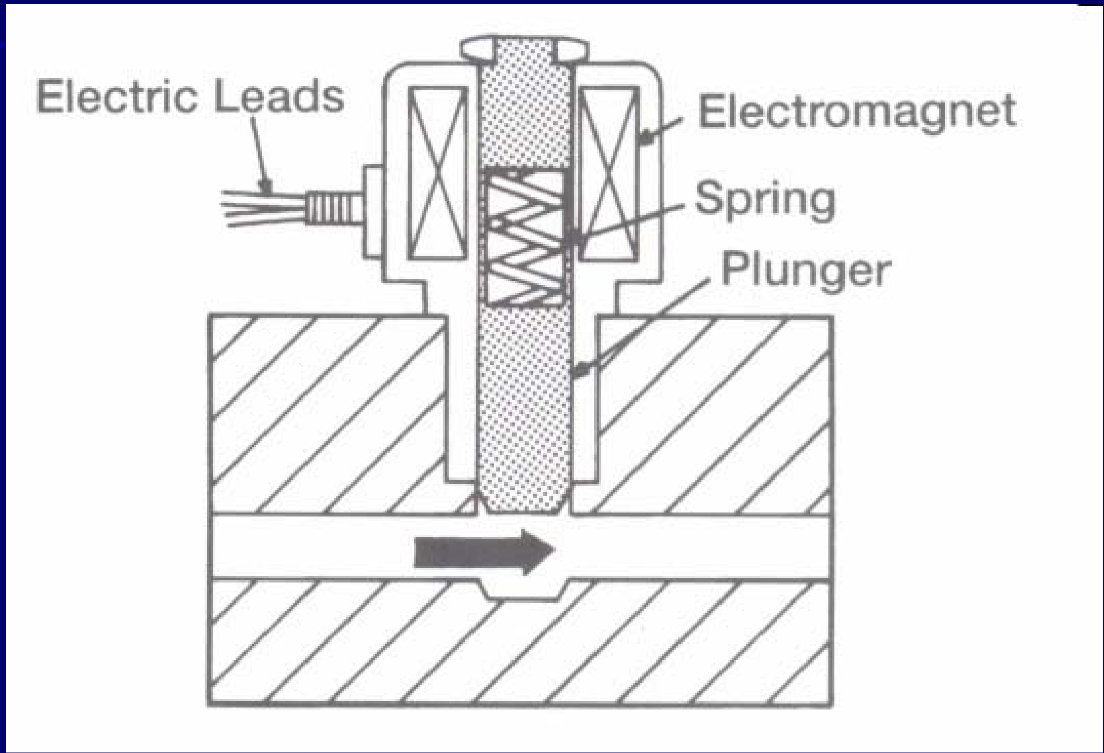
- $C = K*C_0$
- $V = Q_0/C = C_0*V_0/K*C_0$
- $K = V_0/V$
- K = συνάρτηση υγρασίας

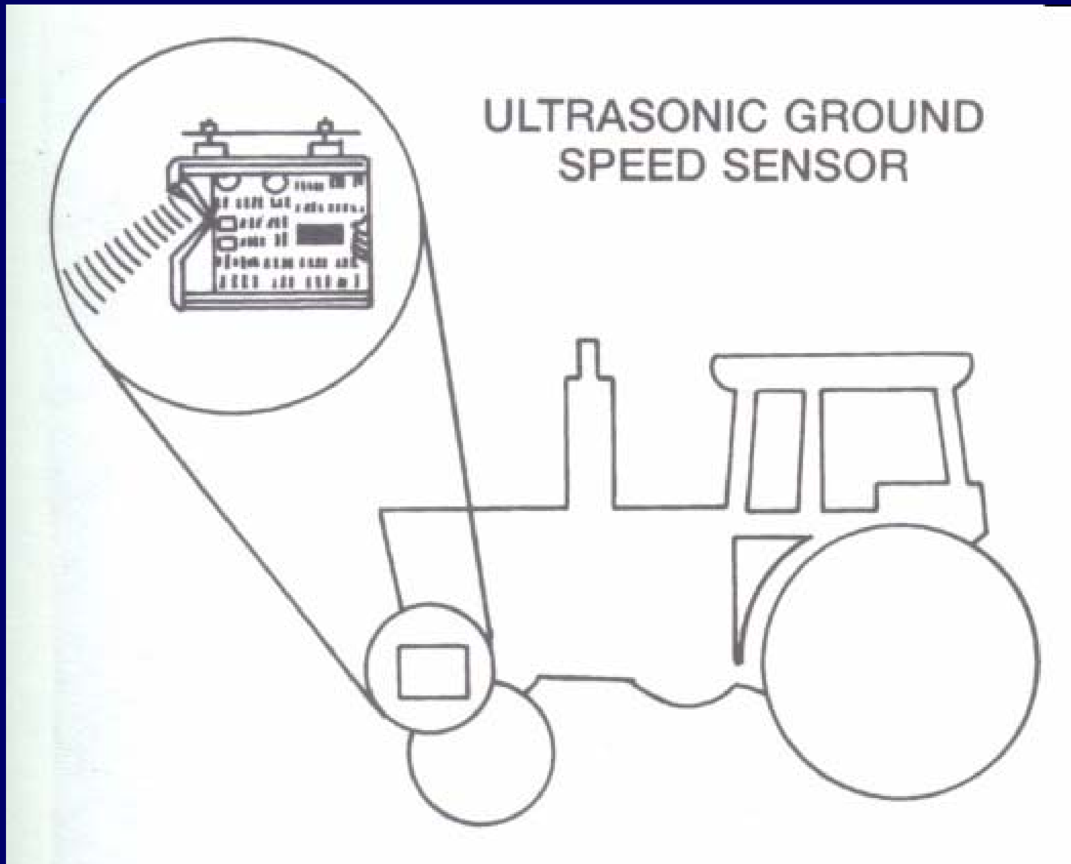
Αισθητήρες ταχύτητας εργασίας

- Μέτρηση αριθμού στροφών των τροχών
- Προβλήματα από:
- Ολίσθηση
- Μεταβολή διαμέτρου κατά την φόρτωση της αποθήκης
- Χρήση Ραντάρ
- Εκτίμηση από στοιχεία GPS


TRANSMITTING ELEMENT
RECEIVING ELEMENT
FLOW DIRECTION
PARTICLES
A
MAGNETIC PICKUP
BODY
ROTOR
FLOW DIRECTION
B


METAL COLLAR
SHAFT
SENSOR
VOLTAGE v_N
0
t_z
t_z
TIME


Electric Leads
Electromagnet
Spring
Plunger


ULTRASONIC GROUND
SPEED SENSOR

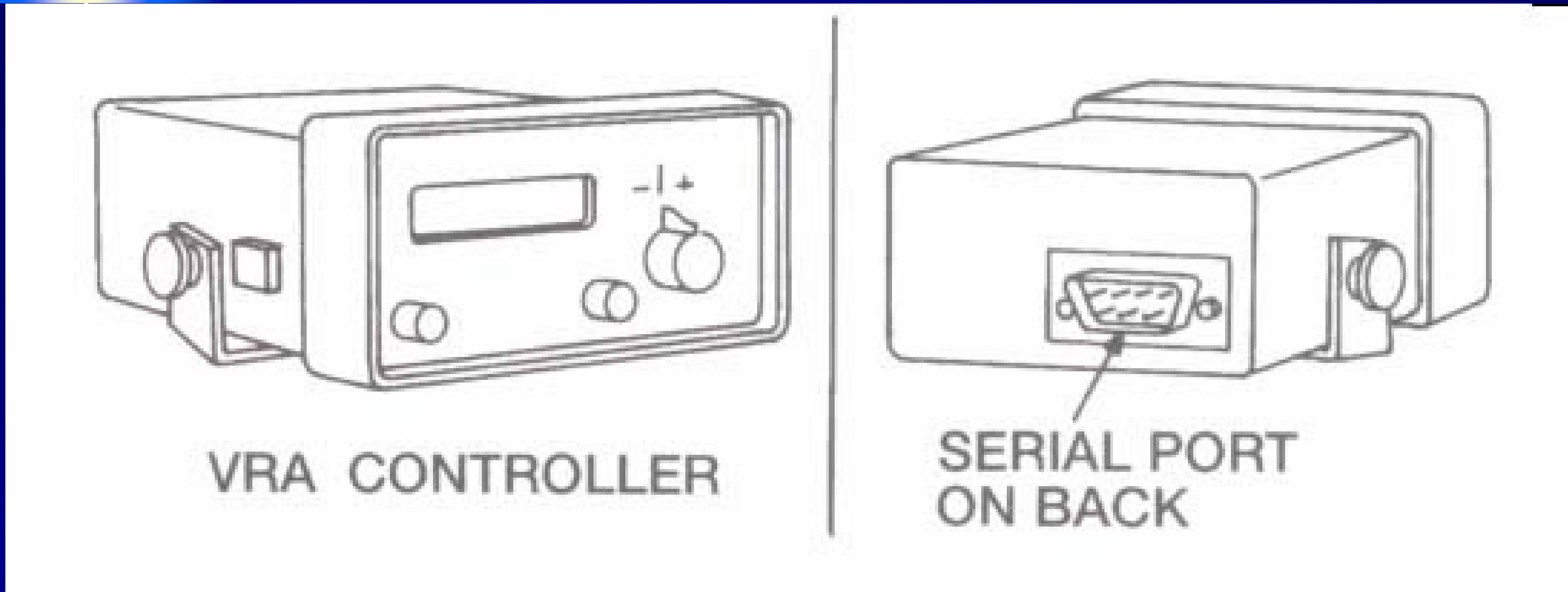
Αισθητήρας θέσης μηχανισμού συλλογής

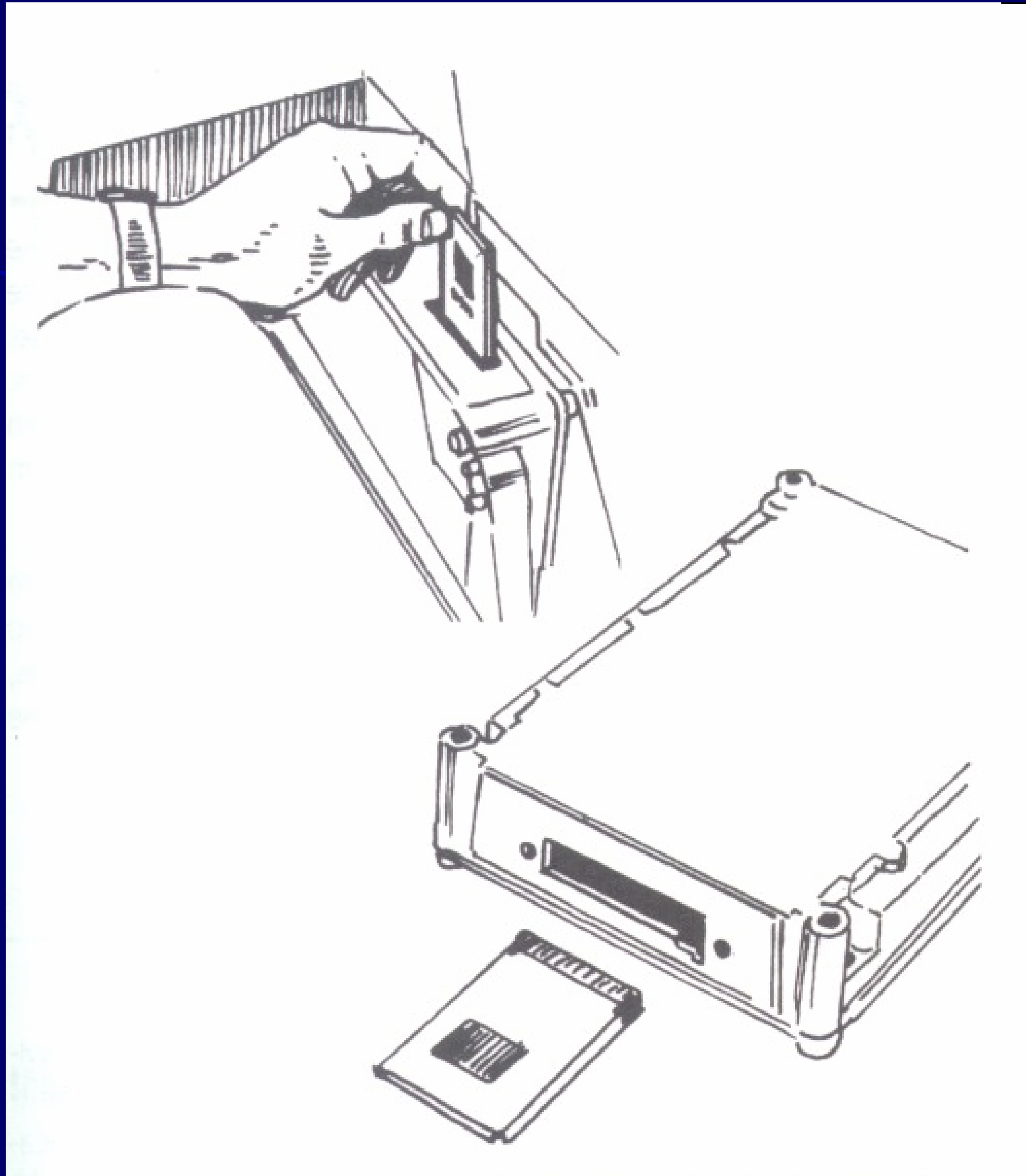
- Ουσιαστικά ορίζει τους χρόνους λήψης και καταγραφής στοιχείων

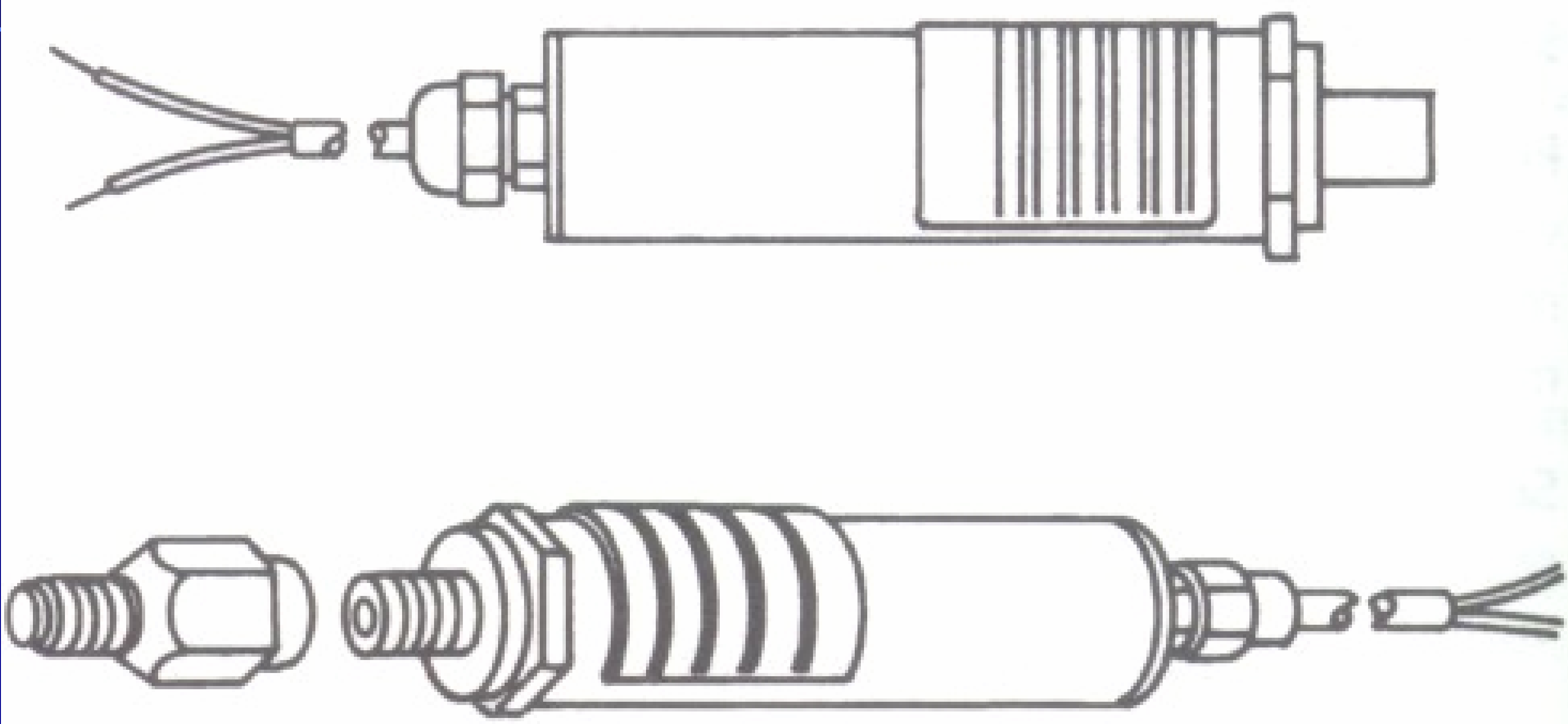
Πλάτος εργασίας μηχανήματος

- Εύκολο στις γραμμικές καλλιέργειες που κάθε μονάδα συγκομίζει μια σειρά ορισμένου πλάτους
- Δύσκολη εκτίμηση στις Θ/Α

Μονάδα λήψης, επεξεργασίας και καταγραφής στοιχείων

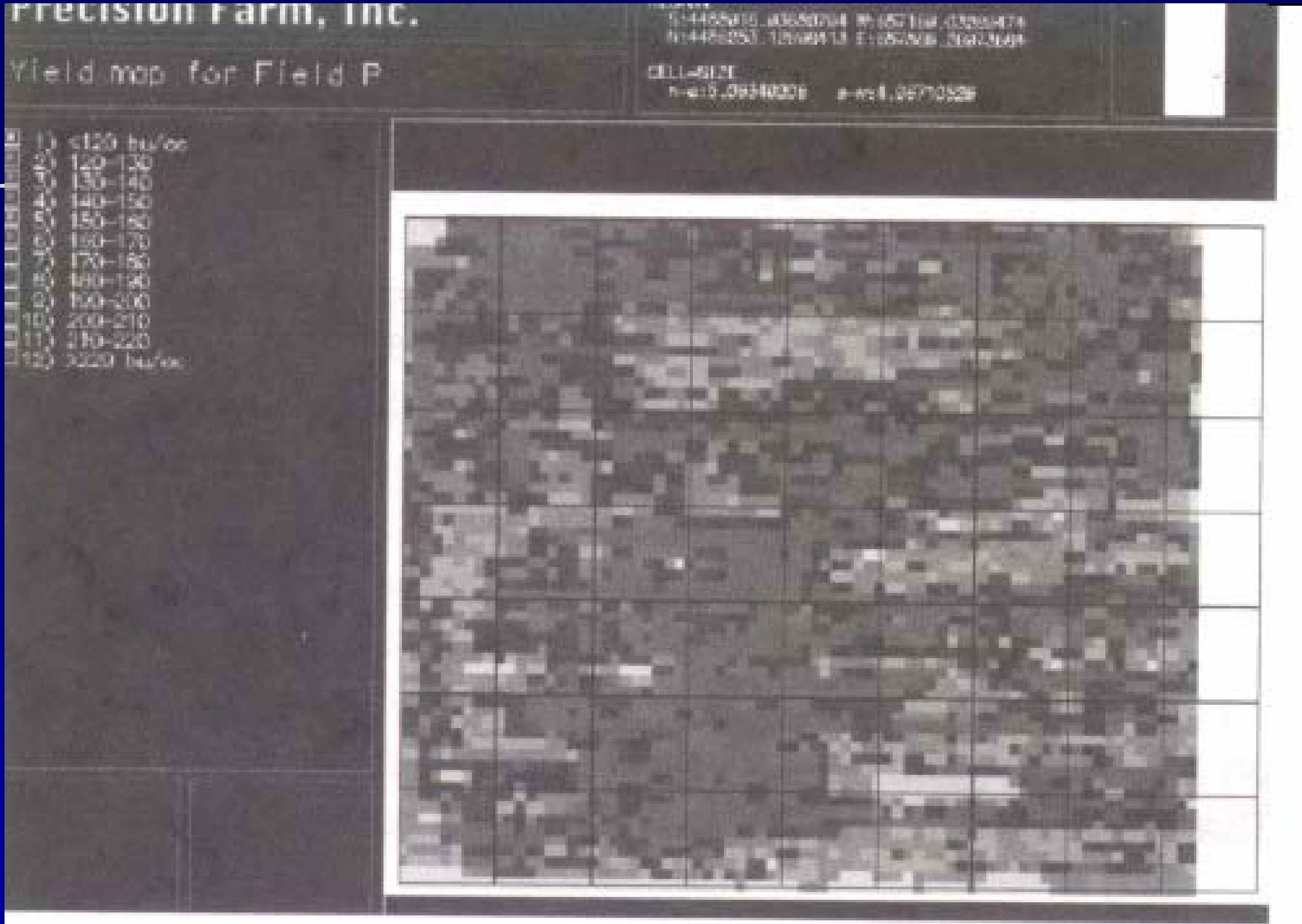

–|+
VRA CONTROLLER
SERIAL PORT
ON BACK

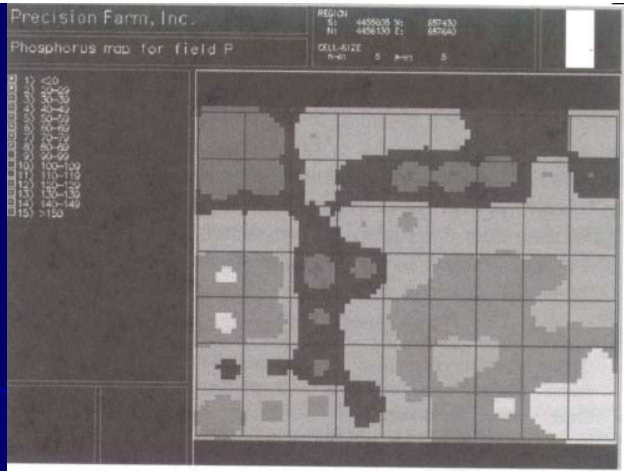


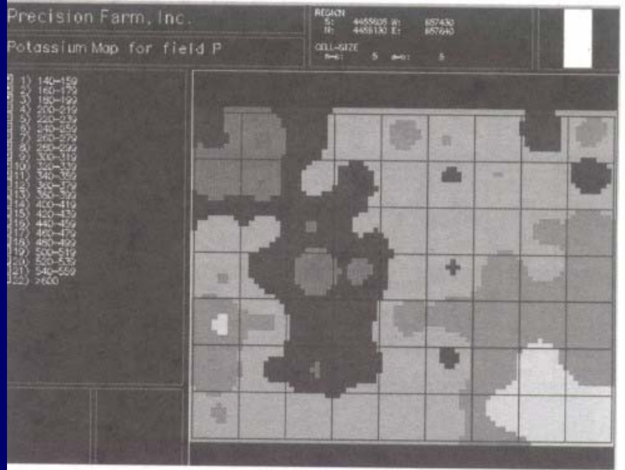


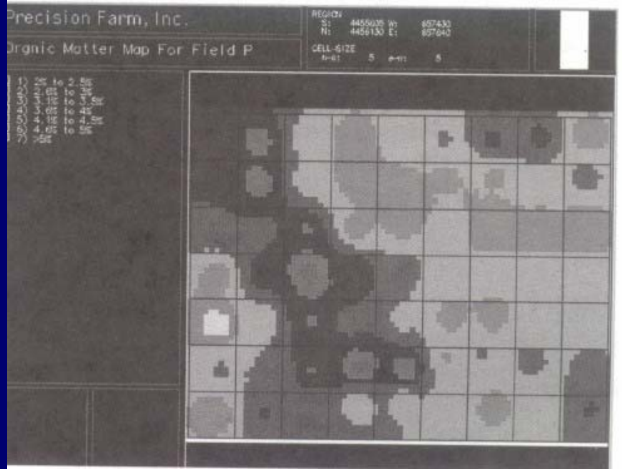
Προβλήματα ακρίβειας χαρτογράφησης

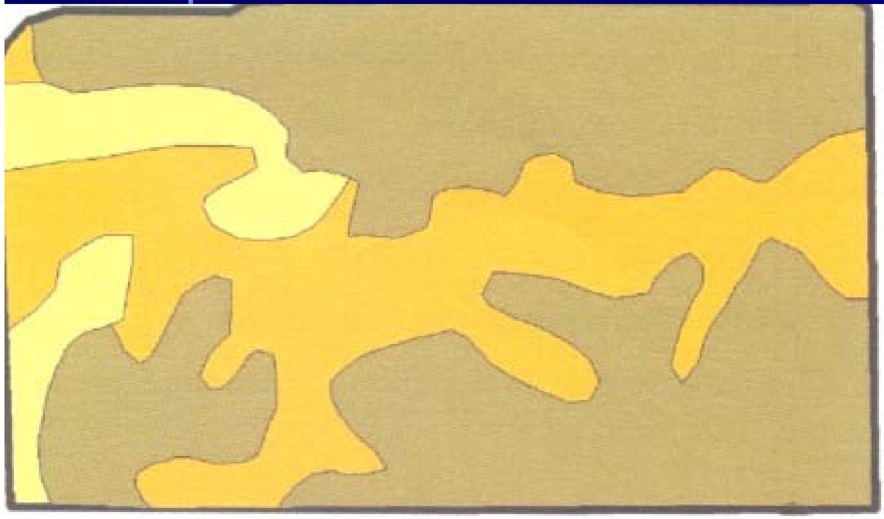
- Εκτίμηση πλάτους εργασίας
- Χρόνος εισόδου προϊόντος και χρόνος μέτρησης

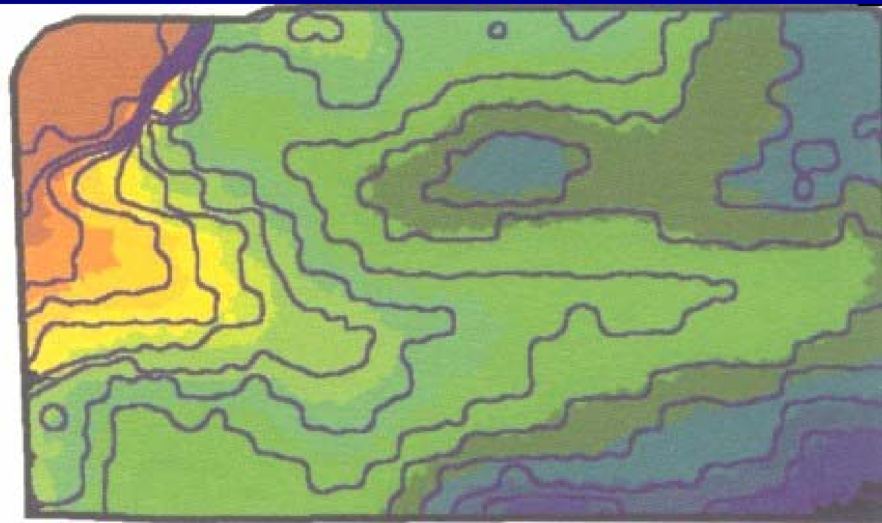

Precision Farm, Inc.
Yield map for Field P
CELL-SIZE
1) <120 bu/ac
2) 120-130
3) 130-140
4) 140-150
5) 150-160
6) 160-170
7) 170-180
8) 180-190
9) 190-200
10) 200-210
11) 210-220
12) >220 bu/ac

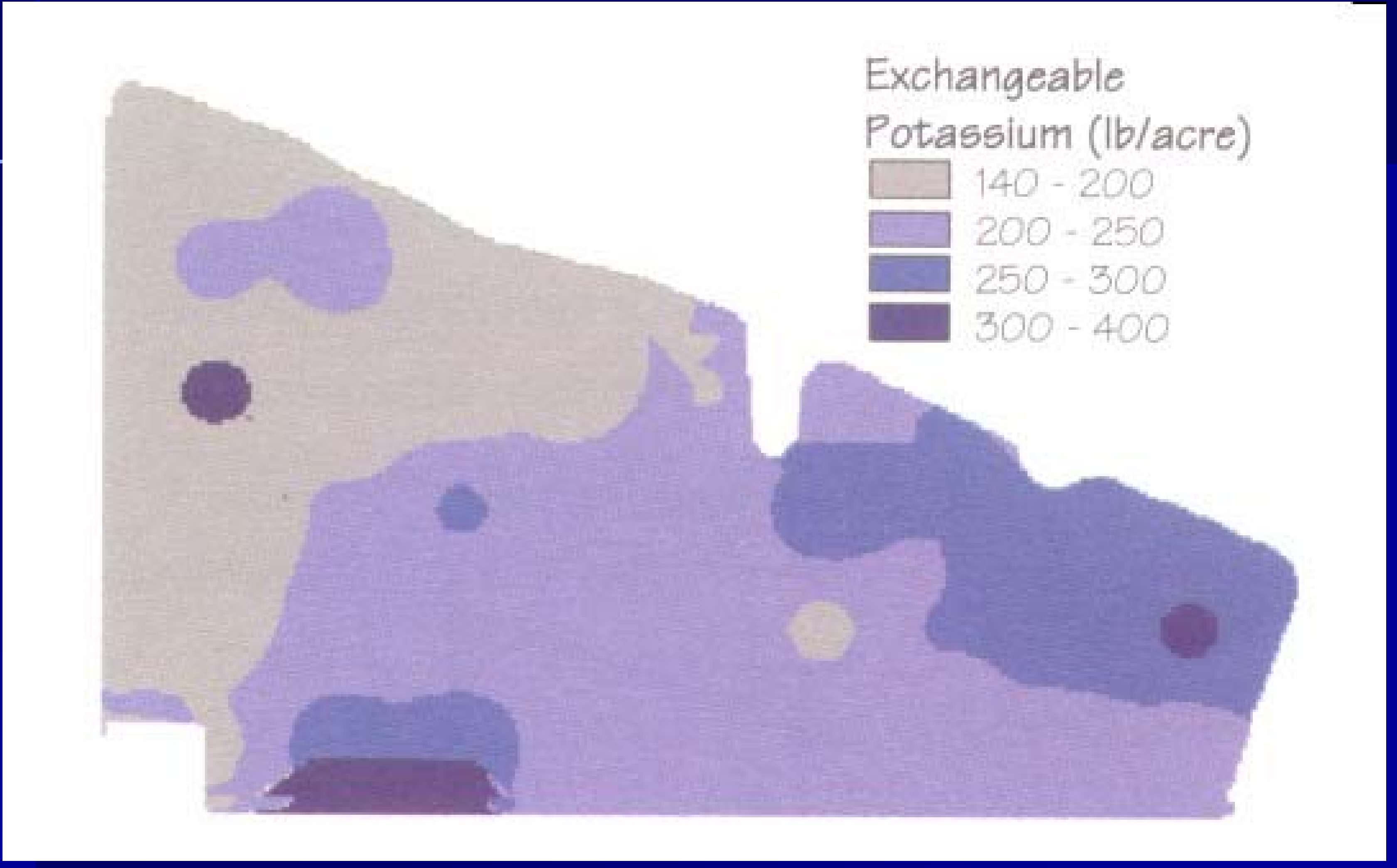

Precision Farm, Inc.
Phosphorus map for field P


Precision Farm, Inc.
Potassium Map for field P


Precision Farm, Inc.
Orgnic Matter Map For Field P






Exchangeable
Potassium (lb/acre)
140 - 200
200 - 250
250 - 300
300 - 400