Workshop Results of the EU Project
"Euphoros- Efficient Use of Inputs in Protected Horticulture

Design of greenhouse ventilation systems. A web tool for air exchange calculations

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estación experimental cajamar

Donnalucata, 6 October 2011

Airflow through a ventilator

$$Q = S\,Cd\,(Cw)^{1/2}\,u$$

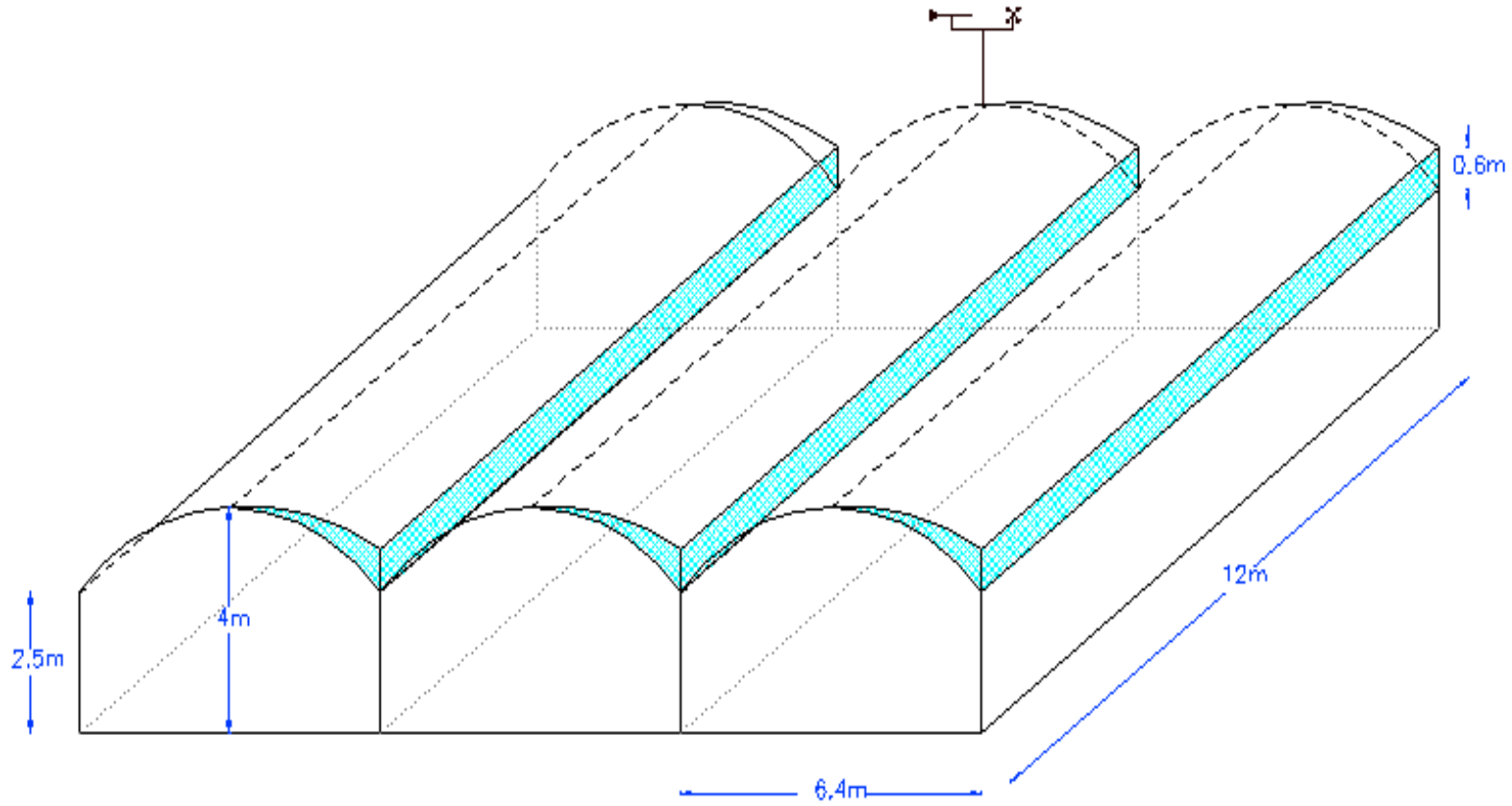
Q = airflow through the ventilator

S = surface of the opening

Cd = discharge coefficient

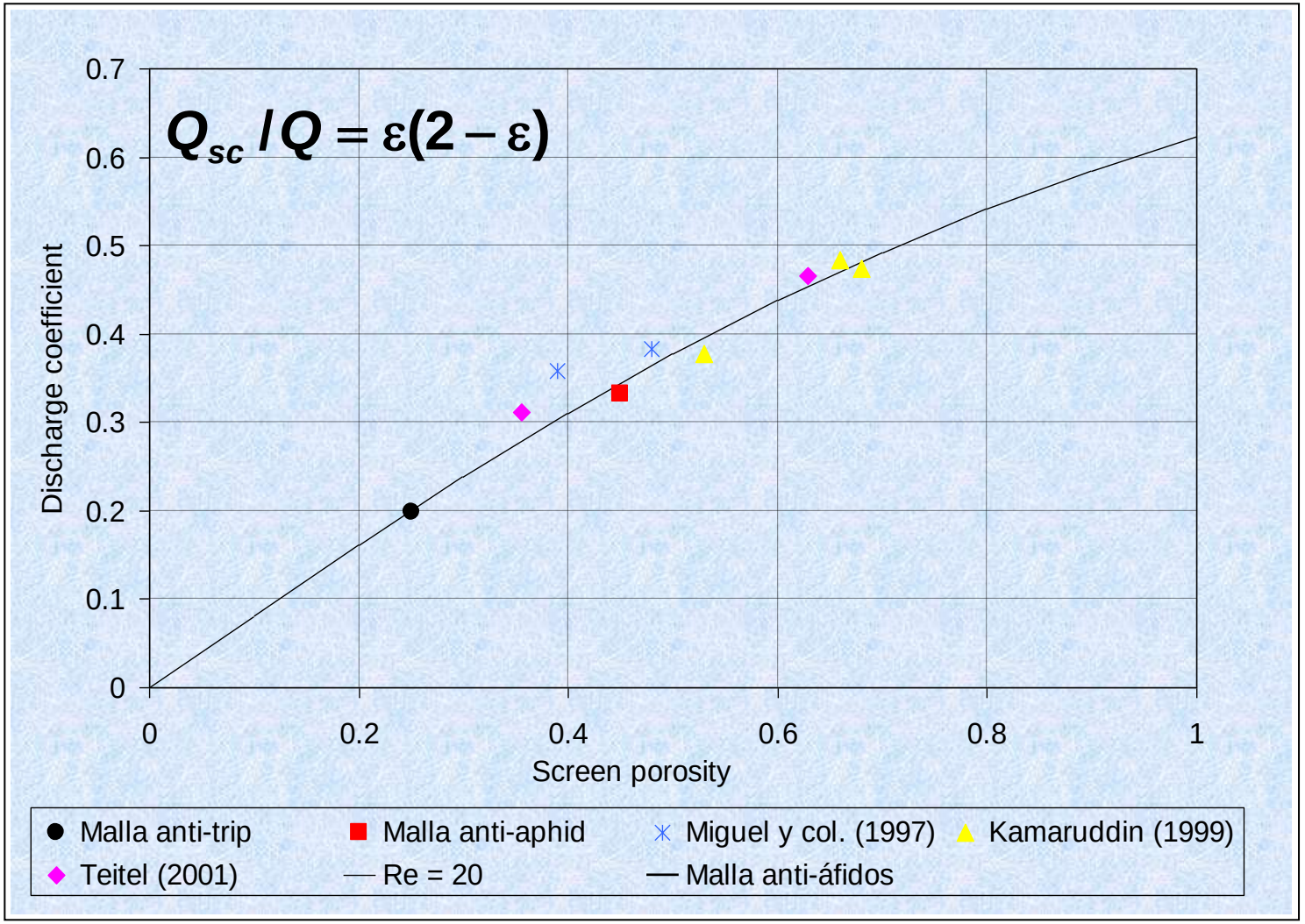
Cw = Wind pressure coefficient

u = wind speed

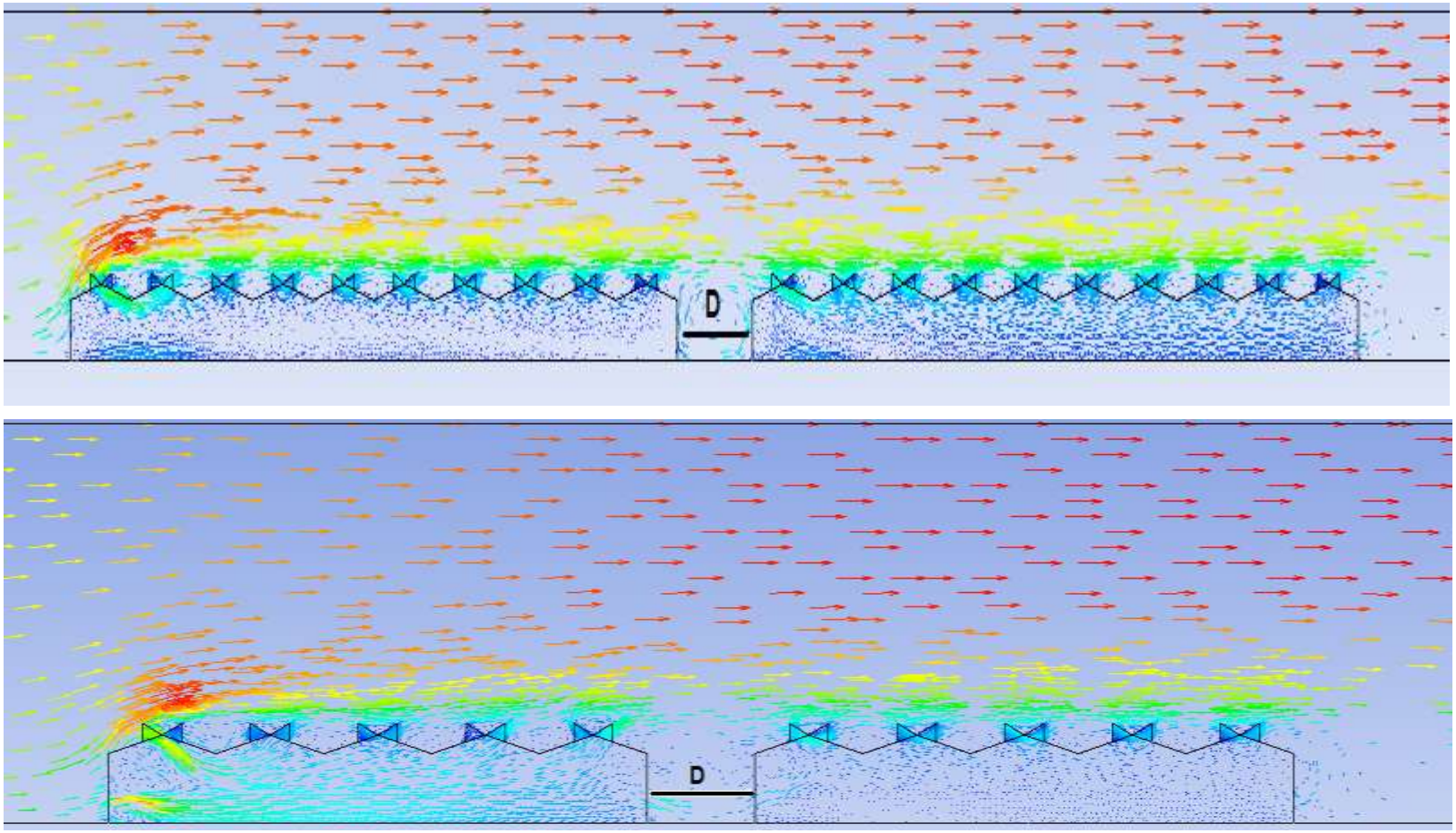


C_d: 0.55 **C_d: 0.70**

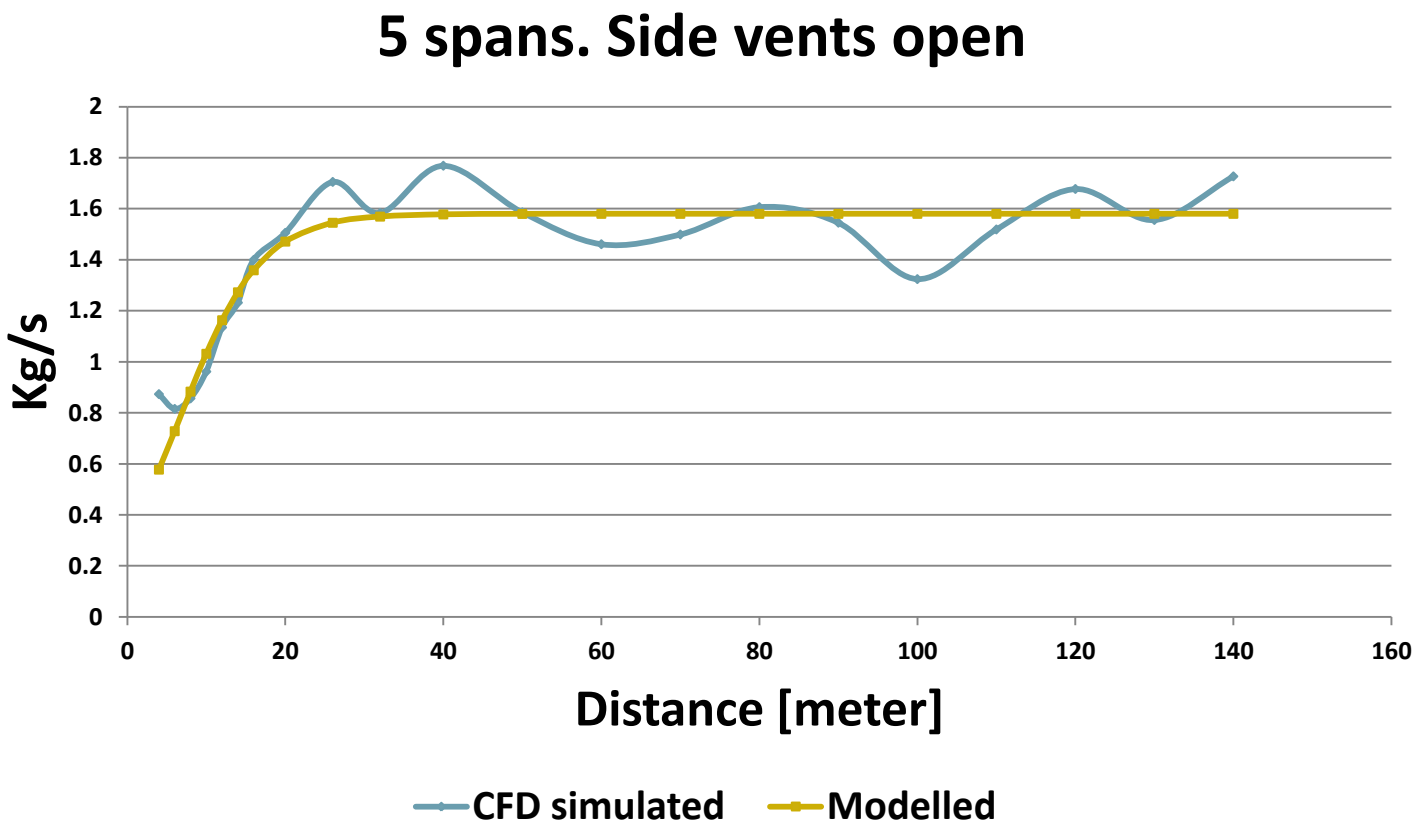
Discharge coefficients for screened openings



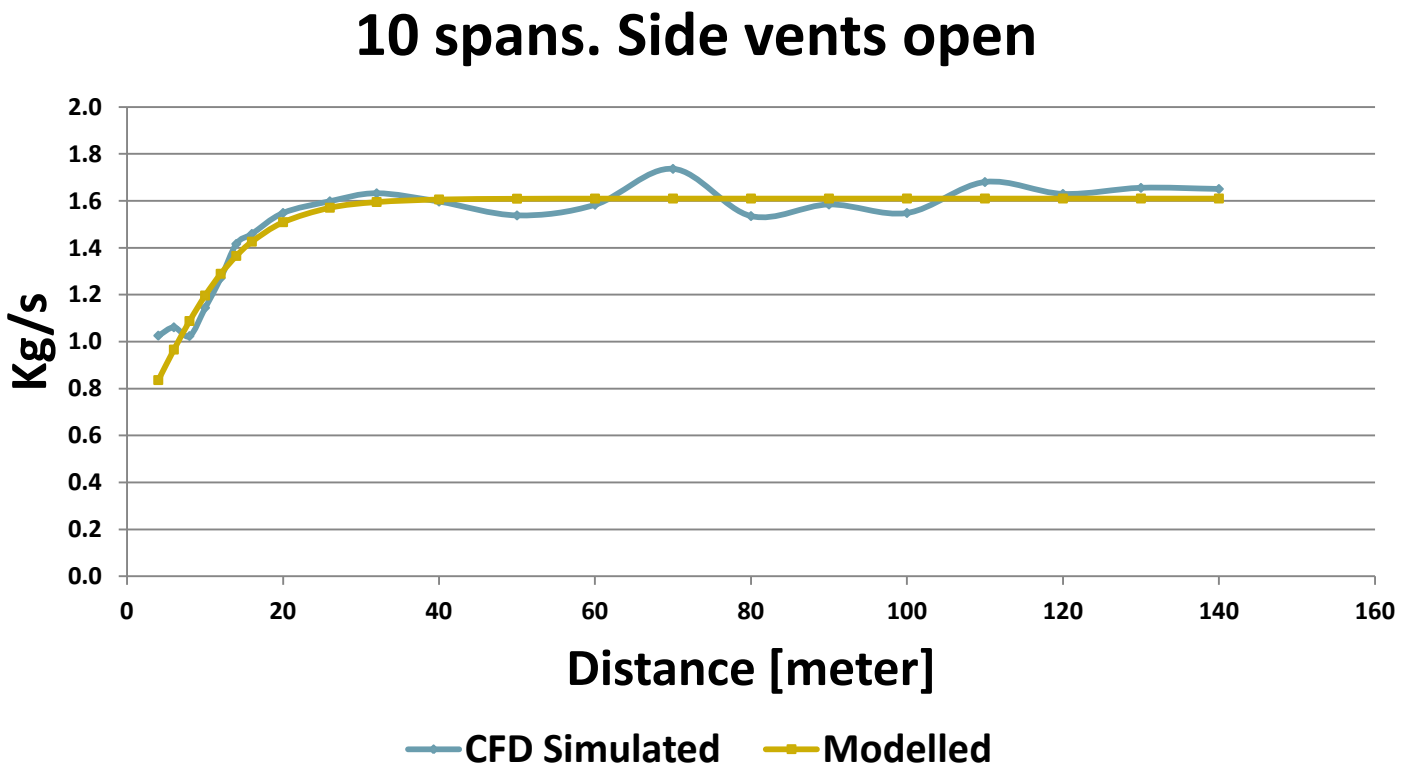
Effect of obstructions on air movement



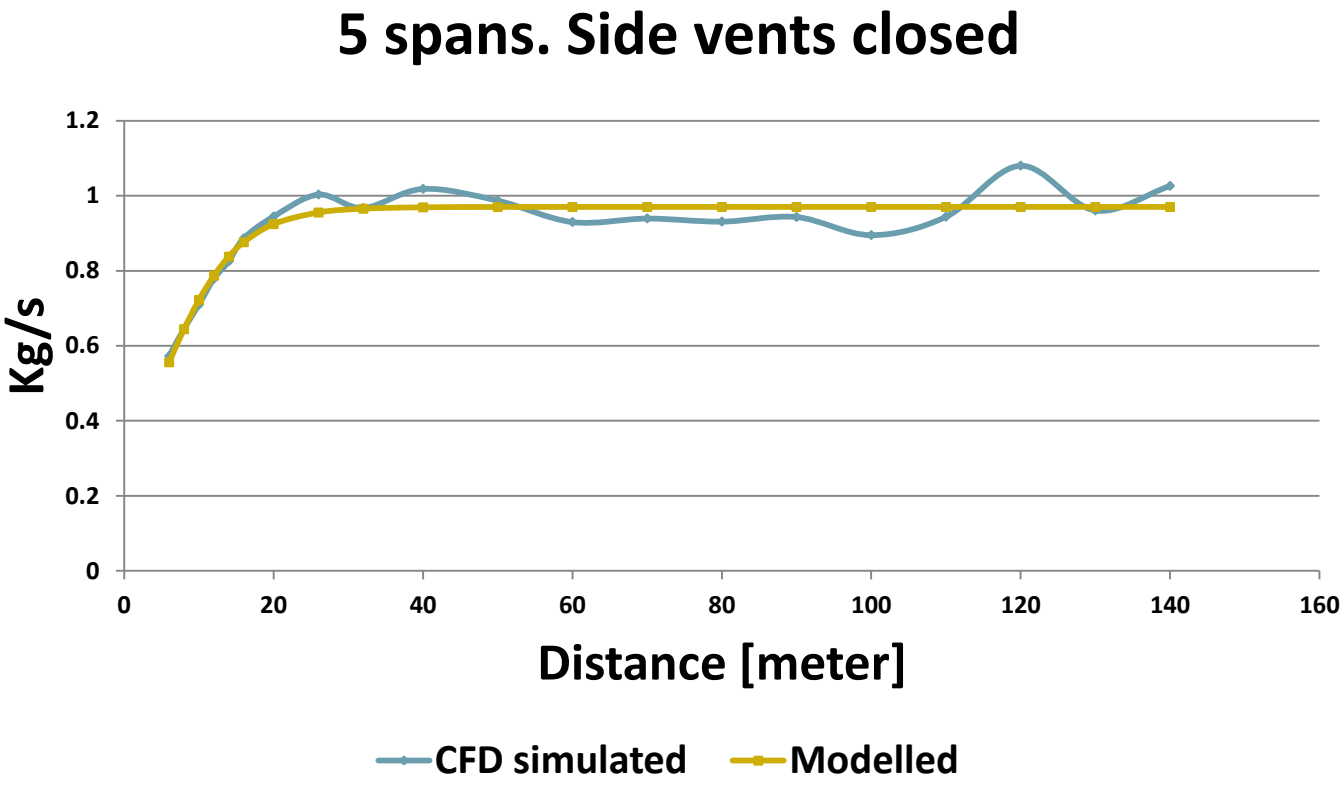
Reduction in ventilation due to obstructions



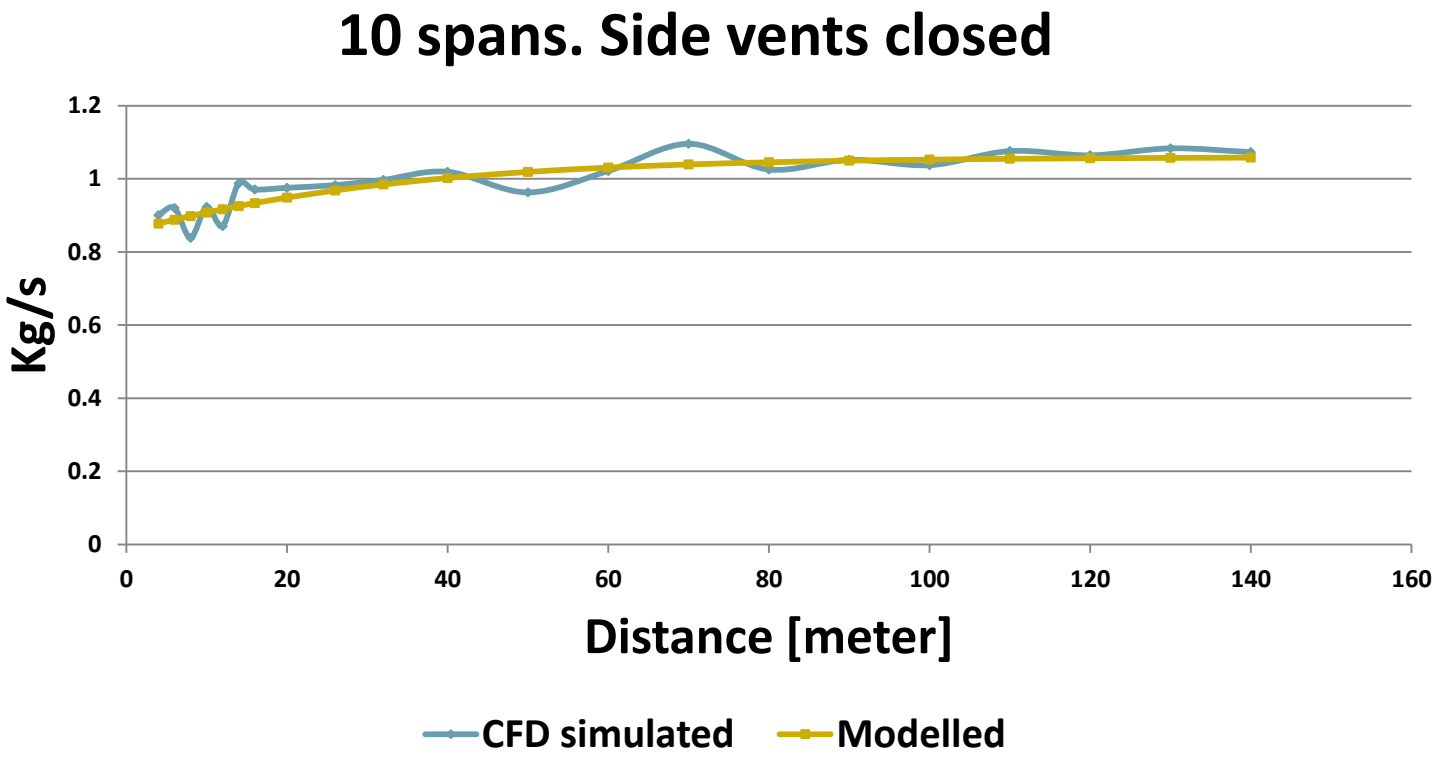
Reduction in ventilation due to obstructions



Reduction in ventilation due to obstructions



Reduction in ventilation due to obstructions



1. Input greenhouse characteristics	Number of spans	Span width	Length	Gutter Height	Ridge Height
	u	m	m	m	m
	10	8	12	3	5

2. Input opening characteristics	Height of roof vent (outer spans)	Height of roof vent (inner span)	Height side wall vent	Side wall lenght	Number of roof vents (outer spans)	Number of roof vents (inner spans)	Number of side wall vents	Insect-proof screen porosity
	m	m	m	m	m	m	m	m
	1	1	4	100	2	8	2	0.4

Porosity values:
Without screen: 1
Anti-aphid screen: 0.4
Anti-trip screen: 0.25

3. Input wind speed	wind speed
	$m \cdot s^{-1}$
	2

4. Input wind direction	wind direct	1	

5.Input distance between greenhouses
m
12

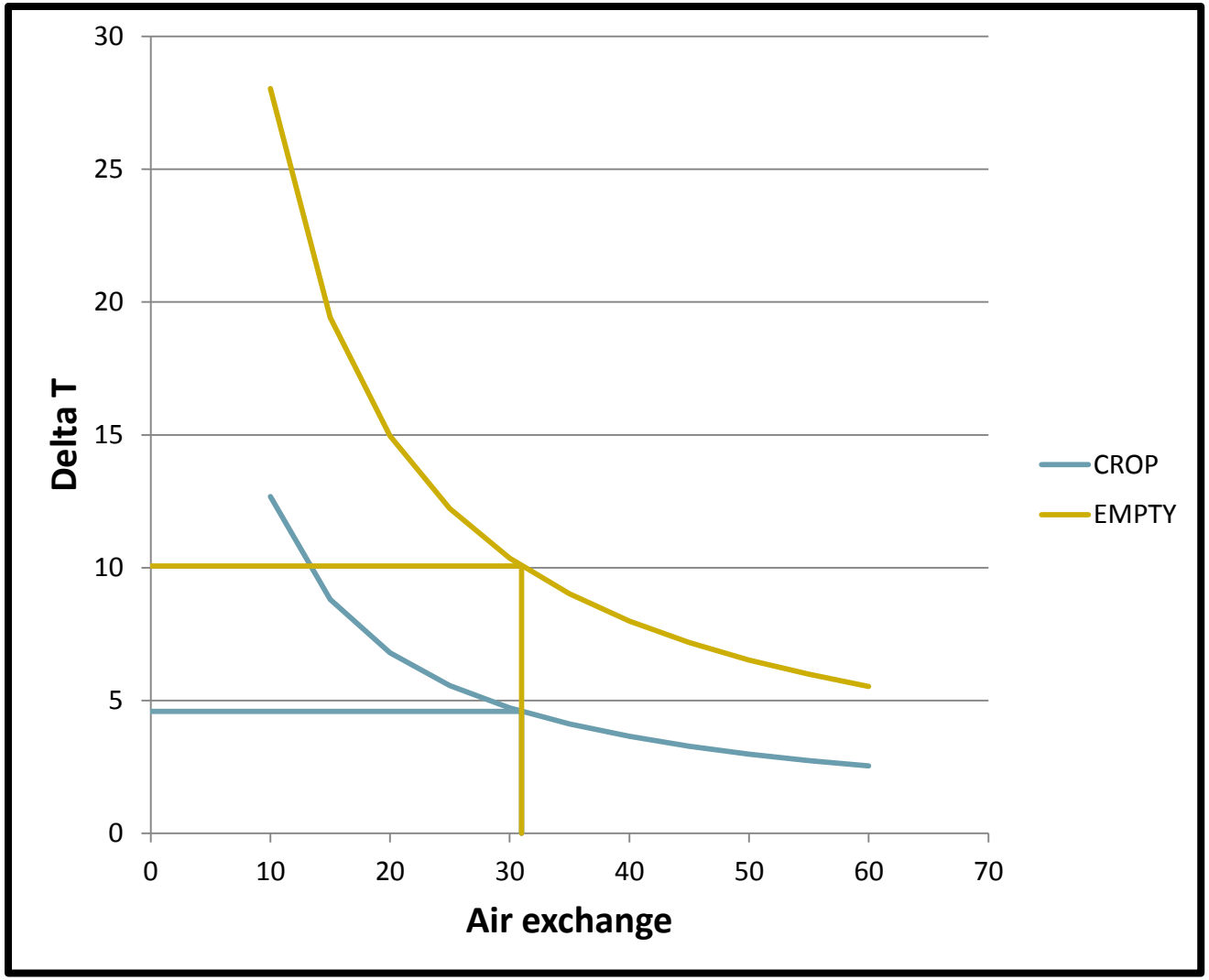
Greenhouse data		
Number of spans	10	
Span width	8	m
Length	12	m
Soil surface	960	m^2
Gutter Height	3	m
Ridge Height	5	m
Volume	3840	m^3
Openings		
Height of roof vent (outer spa	1	m
Height of roof vent (inner spa	1	m
Height side wall vent	4	m
Side wall lenght	100	
Roof vents surface (outer spa	12	m^2
Roof vents surface (inner spa	12	m^2
Side wall vent area	48	m^2
Number of roof vents (outer s	2	
Number of roof vents (inner s	8	
Number of side wall vents	2	
Aspect ratio (outer roof vents	12	
Aspect ratio (inner roof vents)	12	
Aspect ratio (side wall vents)	25	
Insect-proof screen porosity	0.4	
Distance between greenhouses	12	m

wind speed	2	$m\ s^{-1}$
wind direction	1	
$C_{d\ outer\ spans}$ (1)	0.698	
$C_{d\ inner\ spans}$ (1)	0.551	
$C_{d\ side\ vents}$ (2)	0.30	
C_{w} (1)	0.43	
$C_{w\ side\ vents}$ (2)	0.073	
$F_{roof\ ventilation}$	29.2	$m^3\ s^{-1}$
$F_{side\ ventilation}$	3.8	$m^3\ s^{-1}$

F_T	33.05	$m^3\ s^{-1}$
Nº air exch.	30.99	$vol\ h^{-1}$
vents/ soil surface	0.23	

Correction due to obstruction

$F_{corrected}$	17.63	$m^3\ s^{-1}$
Nº air exch.	16.52	$vol\ h^{-1}$


30
25
20
15
10
5
0
Delta T
0
10
20
30
40
50
60
70
Air exchange
CROP
EMPTY