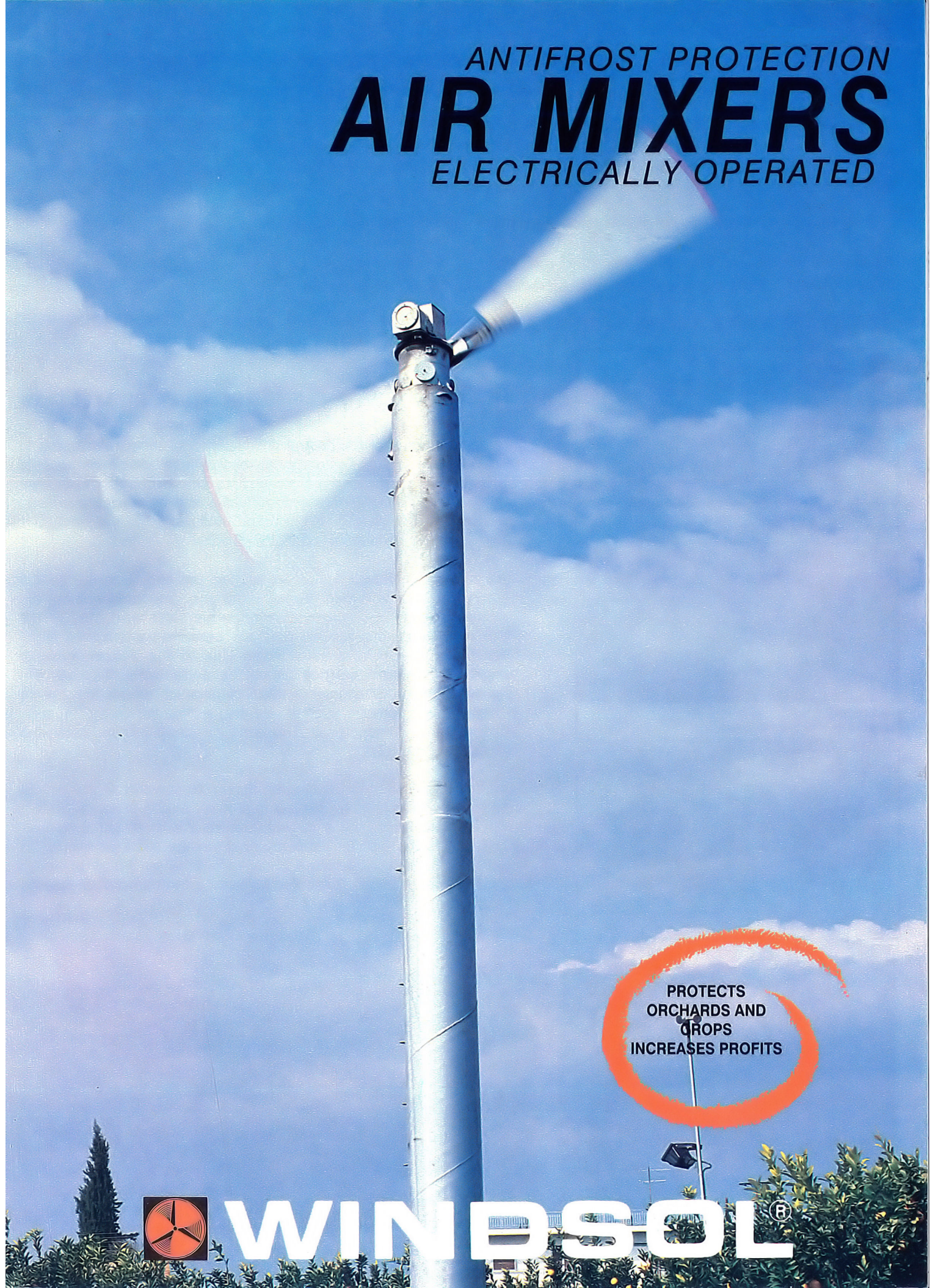
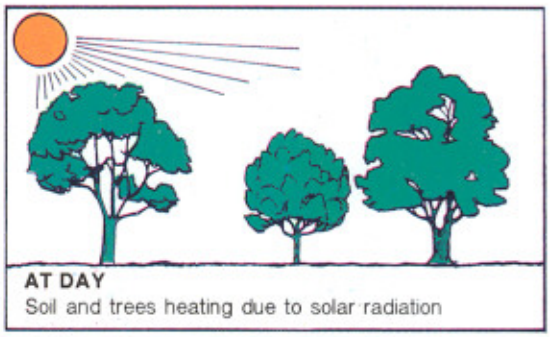
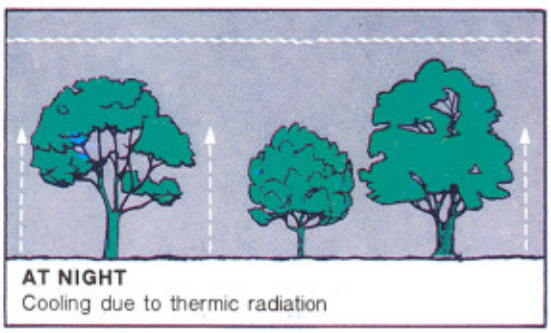

ANTIFROST PROTECTION
AIR MIXERS
ELECTRICALLY OPERATED
PROTECTS
ORCHARDS AND
CROPS
INCREASES PROFITS
WINDSOL®

A PROFILE OF WINDSOL LTD

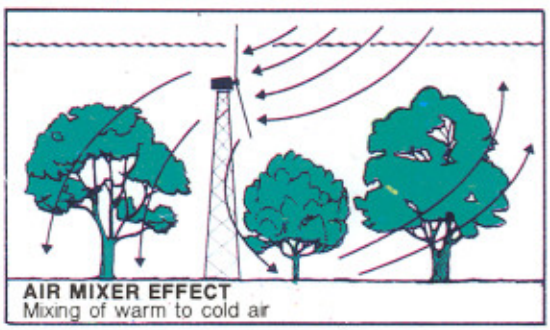
WINDSOL was founded in 1978 with the purpose to research, design and produce renewable energy systems for industrial and agricultural applications. The company focused its activity to the following sectors:
a) Design and development of WIND ENERGY SYSTEMS.
b) Design and development of ANTIFROST PROTECTION SYSTEMS for agricultural cultivations.
Following a long research and development period, the present production program of the company includes electricity generating WIND TURBINES (autonomous or coupled to the grid) and four types of ANTIFROST AIR MIXERS for covering areas of 5-40 acres.
The company also undertakes WIND SPEED DATA and THERMAL CEILING measurement projects and carries out relevant STUDIES.
Except of end products, WINDSOL also offers technical KNOW-HOW and separate components to those customers who would like to build their own constructions providing also full technical support.



AT DAY
Soil and trees heating due to solar radiation



AT NIGHT
Cooling due to thermic radiation



AIR MIXER EFFECT
Mixing of warm to cold air

RADIANT FROST AND THE AIR MIXER PROTECTION

Frost is the result of the natural phenomenon of temperature drop to 0° C or even lower. Temperatures of this level cause damage to agricultural crops and eventually to the orchard itself (see photographs 1 and 2). More specifically, low temperature causes freezing and a consequent breaking of the fluids inside the plant. This destroys the whole plant or part of it.

Radiant frost is caused as follows: at day, soil and trees are heated by sun rays and store heat. At night, soil and trees radiate losing the accumulated heat. Thus their own temperature and that of the surrounding air drops rapidly. Cold air, being heavier, moves down near the ground and creates frost. Due to the sudden drop of temperature, thermic balance cannot be achieved. In this way the "thermic inversion" phenomenon takes place,which means that the air in higher levels remains warmer, creating a "thermic ceilling" approx, 10-15 m, above ground level. This condition mostly occurs during the first hours of the day.

Air mixer role is to absorb warm air, bring it downwards to the ground and mix it with cold air by forced circulation. Mixing of warm to cold air results to an increase in temperature. Air mixer effectiveness increases as the existing temperature difference becomes higher. In other words, high temperature during day time will result to better effects of the air mixer. These can be seen in the relevant sketches.

Photo 1: Frost damage resulting to intense fruit drop.

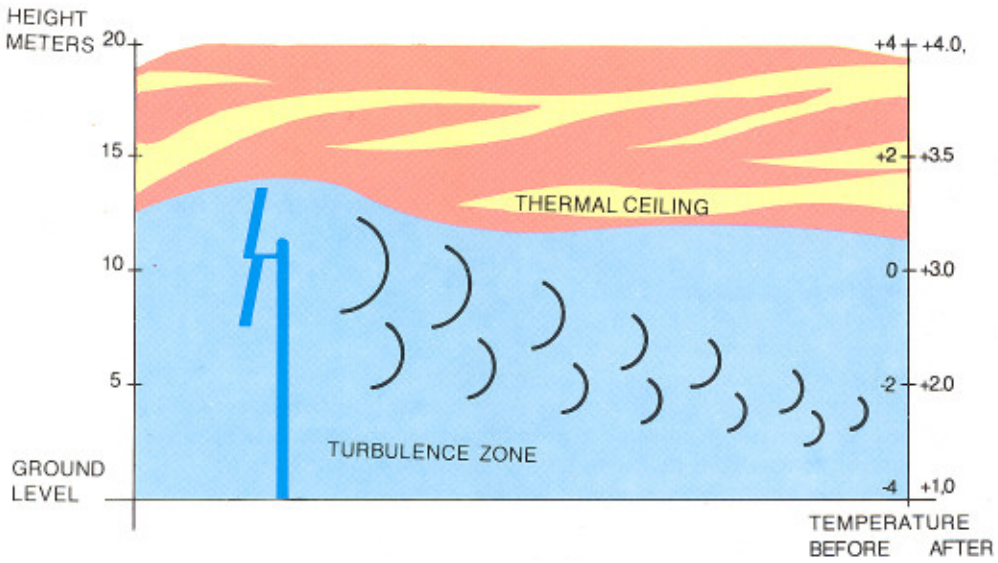
Photo 2: Non protected area. Complete damage to the orchard

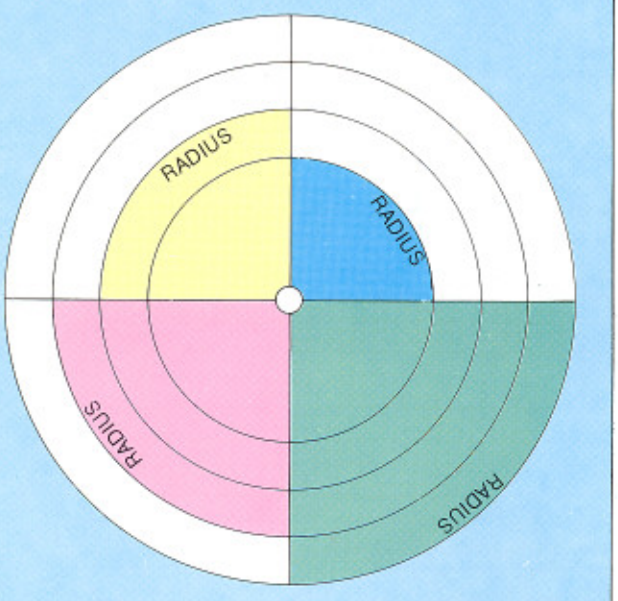
ESTIMATION AND SHAPE OF PROTECTED AREA

The area protected by an air mixer is dependent on four factors: a) swept area of blades, b) blade tilt in relation to axis of rotation, c) rotor speed and d) electric motor power. Combination of above factors makes it possible that the transferred air is equal to approx. 300 m^3 per acre. This quantity of air modifies local climate around the orchard. Since the upper part of the air mixer rotates slowly around its vertical axis (360° every 4 min) the protected area should theoretically have an absolutely circular shape.

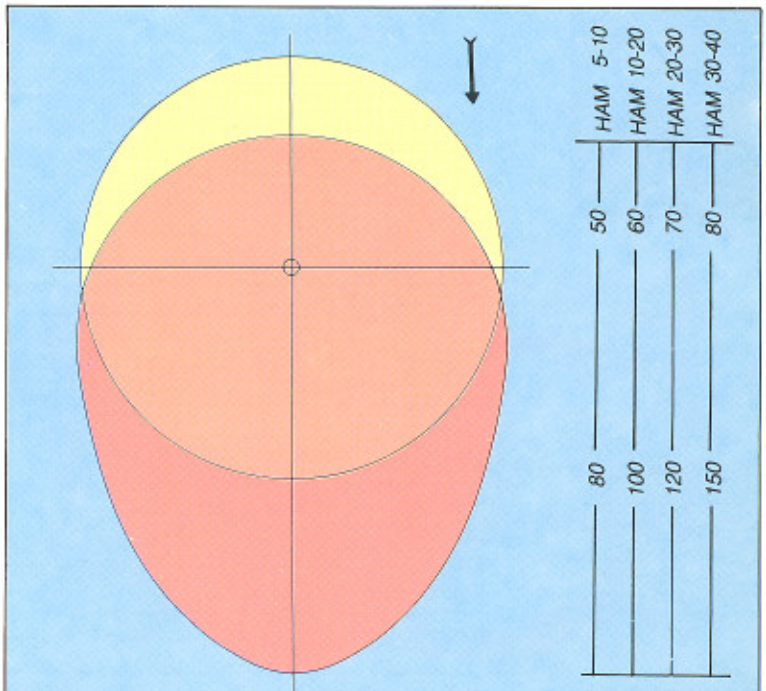
Practically, however, the area protected by the air mixer becomes egg-shapped, according to the prevailling drift blowing at night. Length of protected area depends on drift speed. Measurements have proved that the maximum length of coverage (parallel to the drift direction) is bigger than the width by 30-50% (see diagram). The produced air steam is more weak as the distance from the air mixer increases. Consequently, a change in direction, will change the limits of the area to be protected accordingly.

THERMAL CEILING - AIR MIXER OPERATION & EFFECTS





Radius and shape of protected area by air mixer size at calm conditions



Since absolute calm is only theoretical, drift speed and direction will determine shape of area to be protected.

TECHNICAL DESCRIPTION OF ELECTRIC AIR MIXER

The air mixer is a giant fan situated atop a 10 m. steel tower. The electric motor stands on the tower top too and transfers its torque to the blades through a geared speed reducer. Air mixer operation is supervised by an electronic unit inside the control box.

ROTOR BLADE

It is composed of the steel hub and two glassfiber reinforced polyester blades. Rotor construction allows regulation of each blade position to obtain maximum possible air supply. Rotor axis or rotation has a tilt angle of 96° so as to transfer warm air in the height of the trees. In models HAM 5-10 and HAM 10-20, this angle is adjustable up to 100° for maximum effect.

SPEED REDUCER

It's an angular geared speed reducer in the two bigger models and horizontal in the two smaller ones. Transmission ratio is 2,5:1, The gear has a built-in device which turns the rotor assembly horizontally every 4 min. to achieve continuous coverage of the cultivation area.

ELECTRIC MOTOR

In big models, the motor is located in a vertical position and is connected to the gear through a coupler. In small models the motor is horizontally placed and connected to the gear directly. Built-in thermistors in the three phases check the motor temperature.

TOWER

The tower is a tubular steel construction 10 m. high, founded on a steel reinforced concrete base through four anchor bolts. On special order a 3-legged lattice tower may be provided.

CONTROL PANEL

It is a specially designed unit to control the operation of the air mixer and also protect the motor under any conditions. Except of the star-delta motor starter, the unit also includes the following elements:

- General input switch and mains circuit breakers.
- Operation hours meter.
- Volt-meter, Amp-meter.
- Automatic and manual selection switch.
- Electronic unit controlling the following parameters:

• Mains malfunction (interrupts air mixer operation and restarts it automatically).
• Tower vibrations (if excessive vibration occurs, operation is interrupted).
• Operating temperature range (regulated thermostat switch).
• Wind speed (operation is interrupted above 2 beauforts).

For each of the above functions, there is a visual indication on the front view of the control panel.

TECHNICAL SPECIFICATION

	HAM 5-10	HAM 10-20	HAM 20-30	HAM 30-40
ROTOR BLADE				
Diameter, m.	4,3	4,6	5,0	5,6
Blade material	GFRP	GFRP	GFRP	GFRP
Hub material	Steel	Steel	Steel	Steel
Revolutions/min.	600	600	600	600
Air supply m^3/min.	5500	7800	9000	12300
Nominal area protected, acres	10	20	30	40
TRANSMISSION				
Ratio	1:2,5	1:2,5	1:2,5	1:2,5
Reducer power, HP	90	90	160	160
ELECTRIC MOTOR				
Power, HP	35	50	75	100
Voltage, V	380	380	380	380
Revolutions/min.	1465	1465	1465	1465
DURATION OF HORIZONTAL TURN	4'	4'	4'	4'
TOWER				
Type	Tubular or	3-legged	lattice	construction
Material	Steel	Steel	Steel	Steel
Height, m.	10	10	10	10
CONTROL PANEL.	See detailed technical description.			

Technical specifications may be changed without prior notice.

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