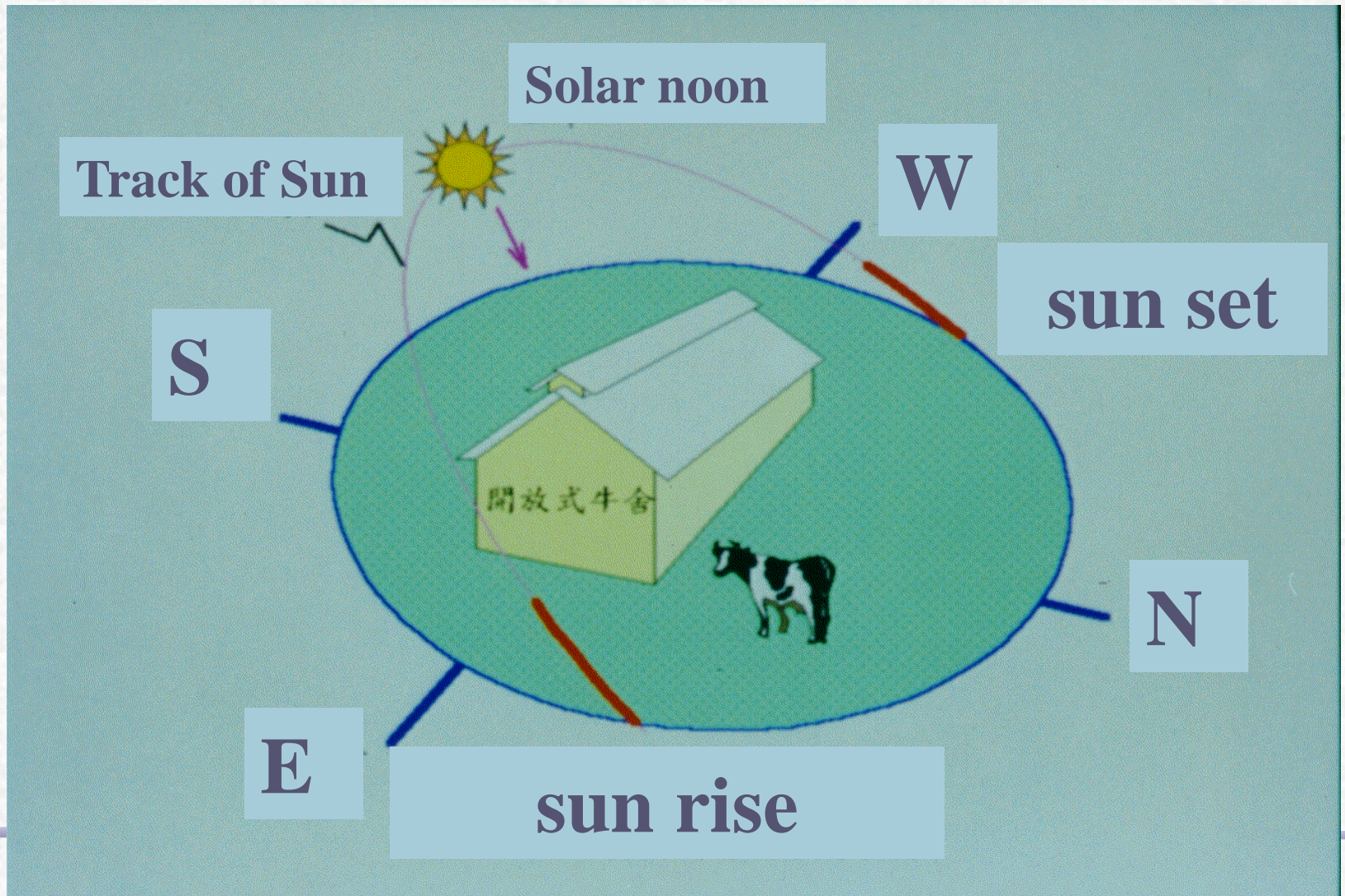


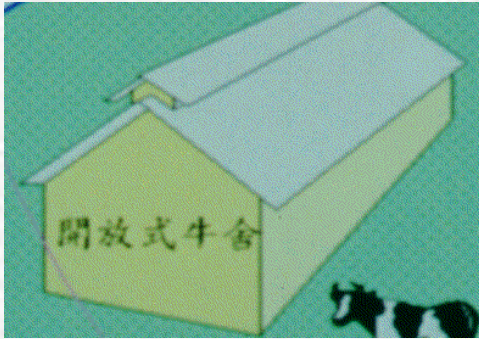
Integrated Approaches

- **Orientation**
- **Shading:** vertical & extended
- **Natural ventilation:** roof vents
- **Forced ventilation**
- **Evaporative cooling**
 - Pad and fan system
 - Multi-layer nets with fan system

E-W orientation to minimize direct sunlight



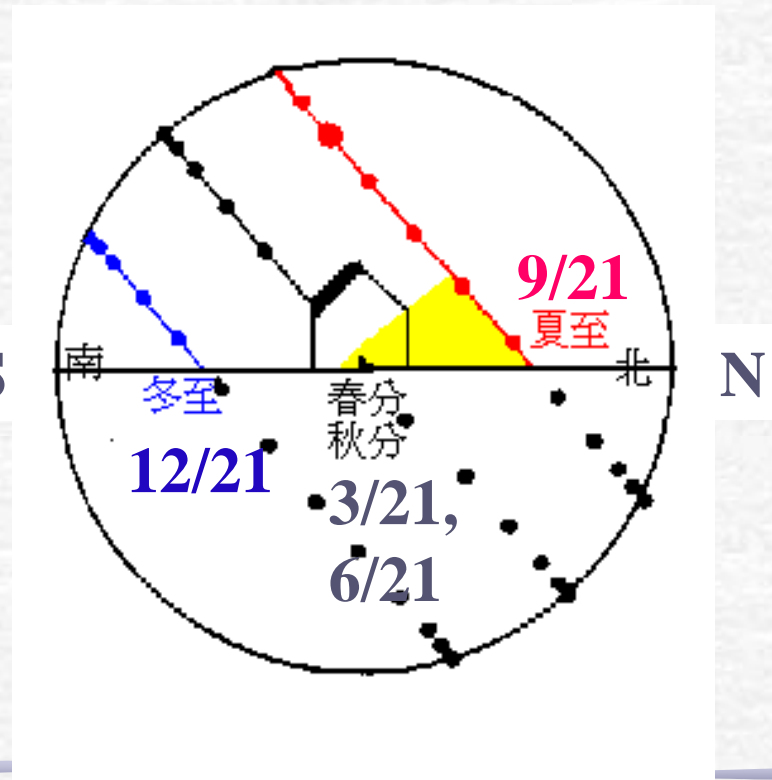
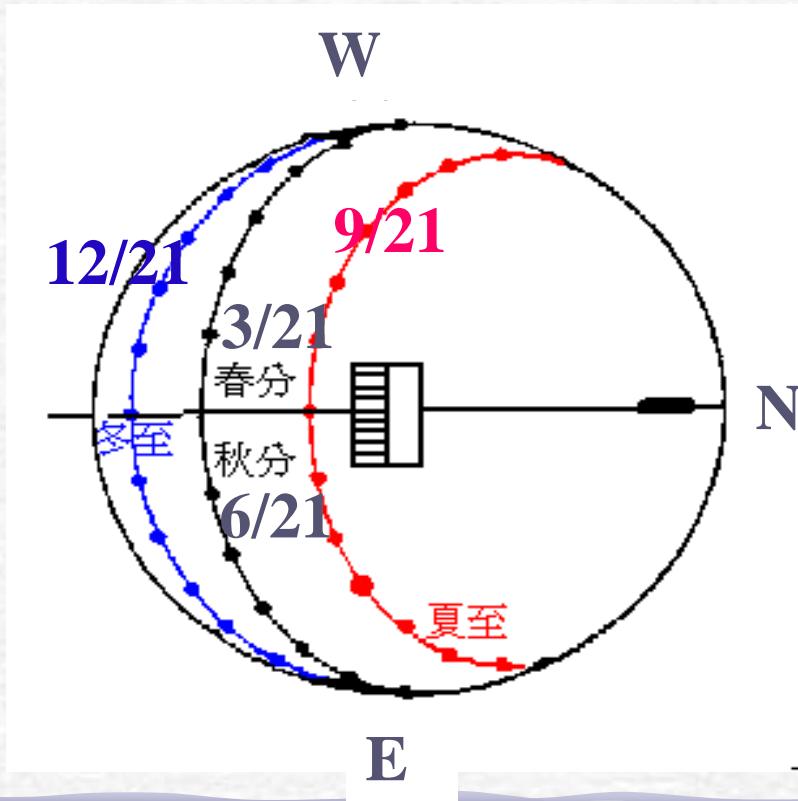
Before shading



Most of the Dairy barns in Taiwan are the open structure type with 4 ends open.

Known Facts

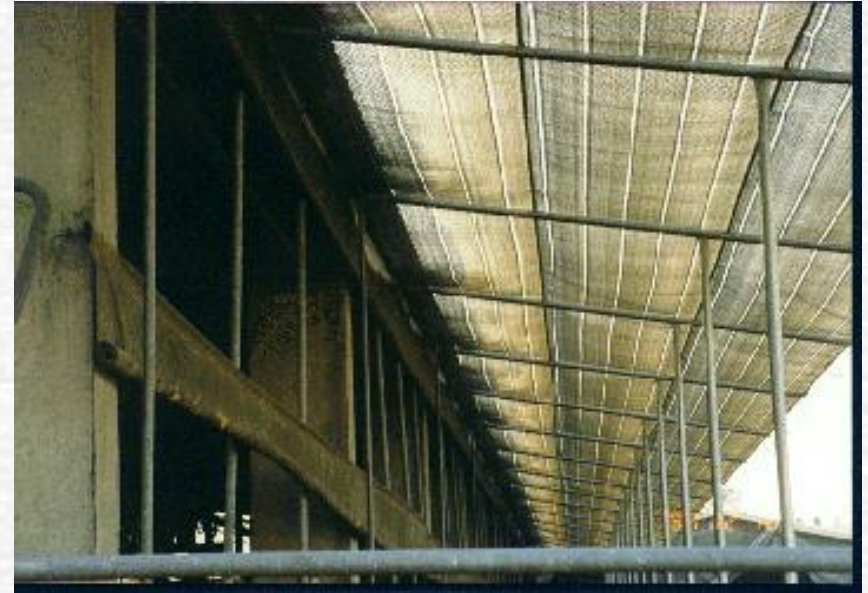
- Taiwan is at Northern Hemisphere in between 20 – 25 deg. Latitude.



West end extended shading



South end extended shading

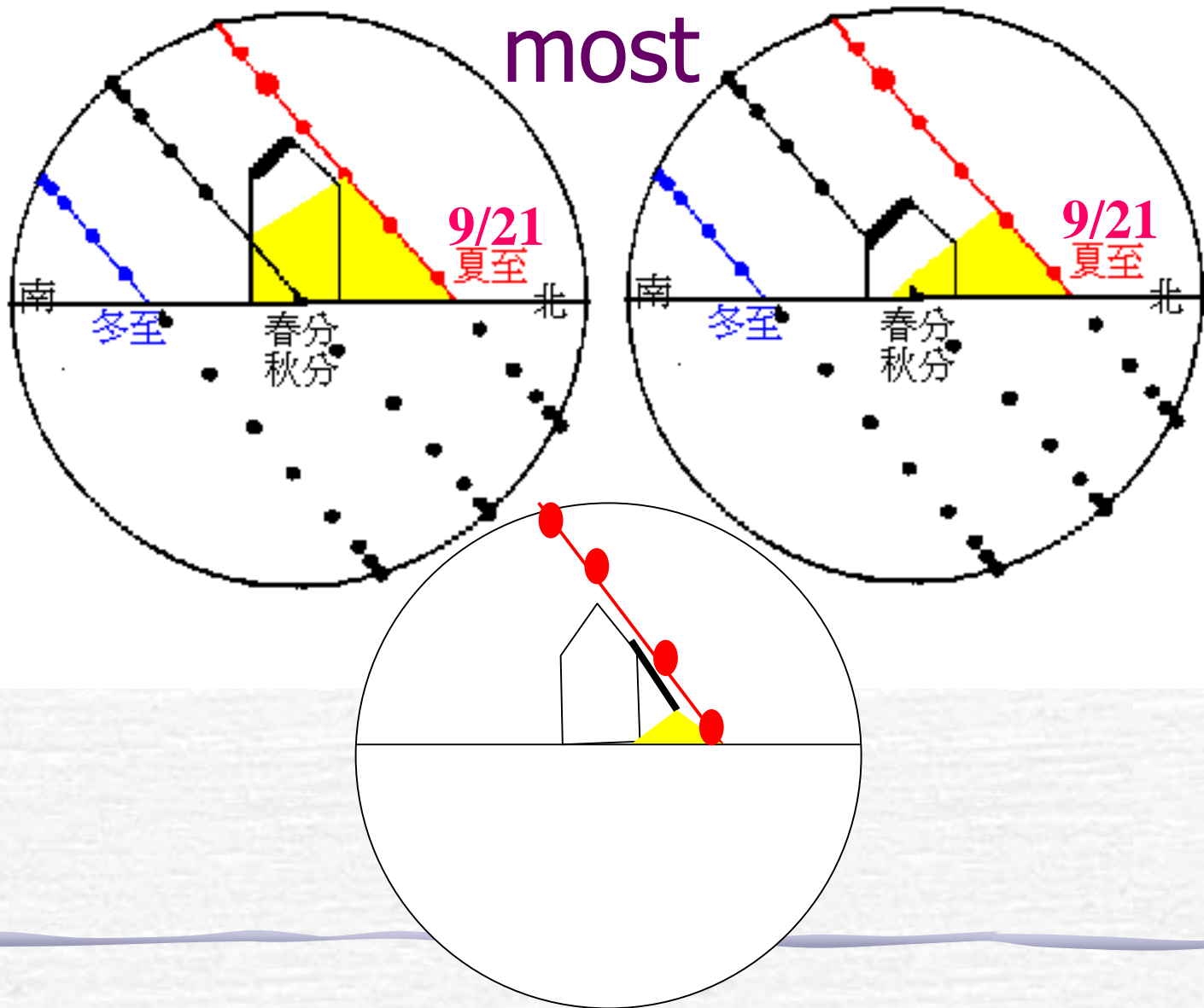


North end vertical shading

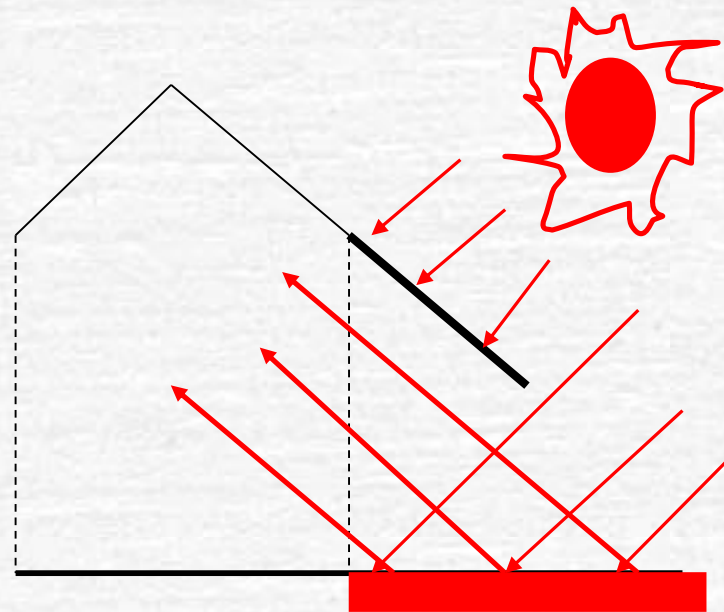
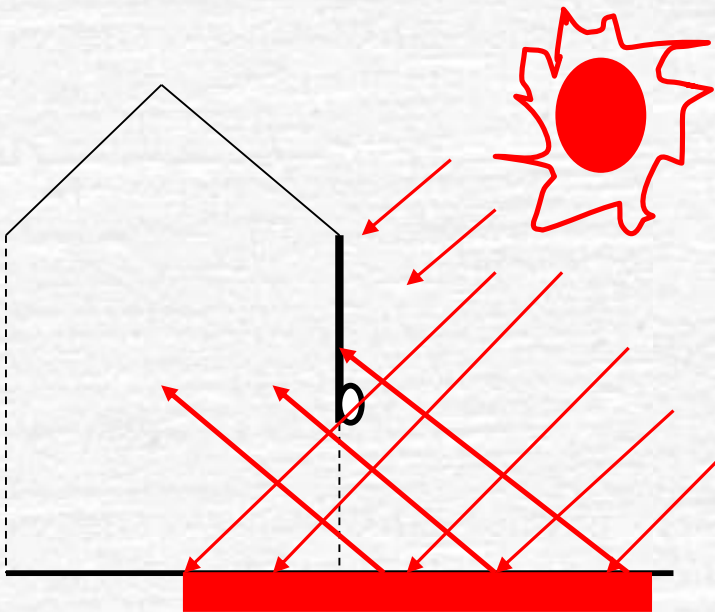
After shading: almost no direct sunlight into the dairy barn



Tall buildings need side shading the most




Two types of side shading



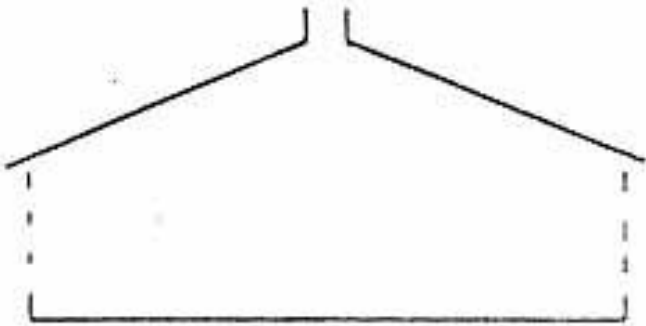
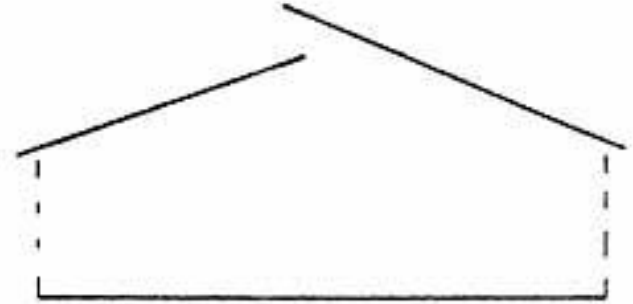
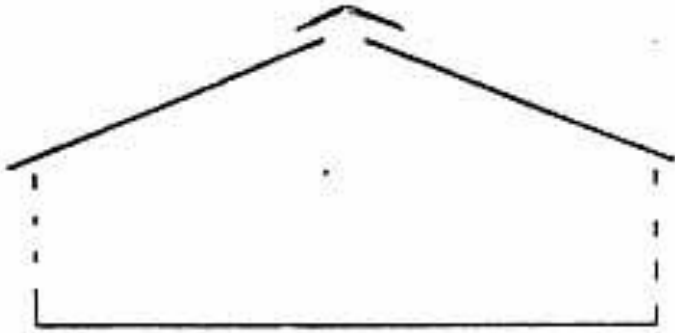


With proper design

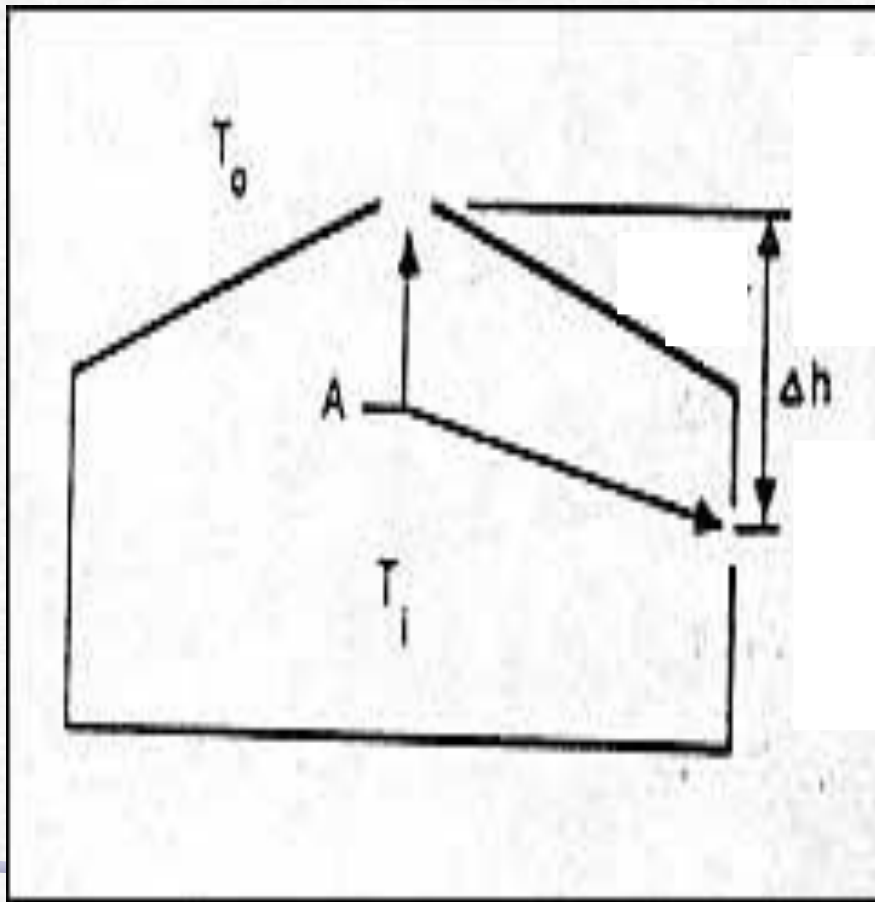
Tall building with eave height >
3.5 m is not necessary.



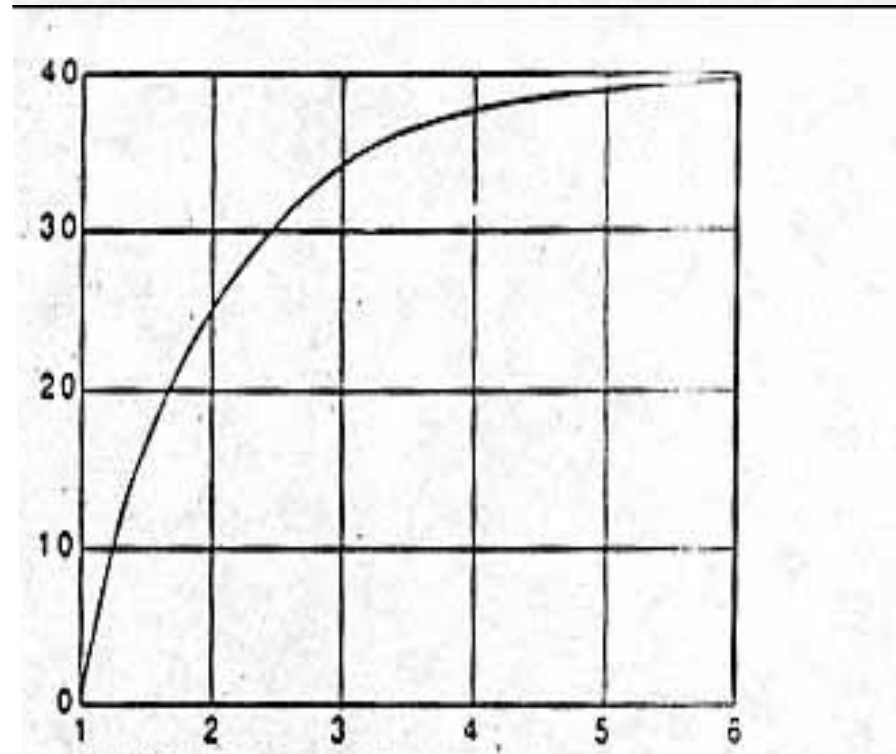
Natural Ventilation : roof_1



ΔT , Δh and ratio of opening area are critical factors in natural ventilation

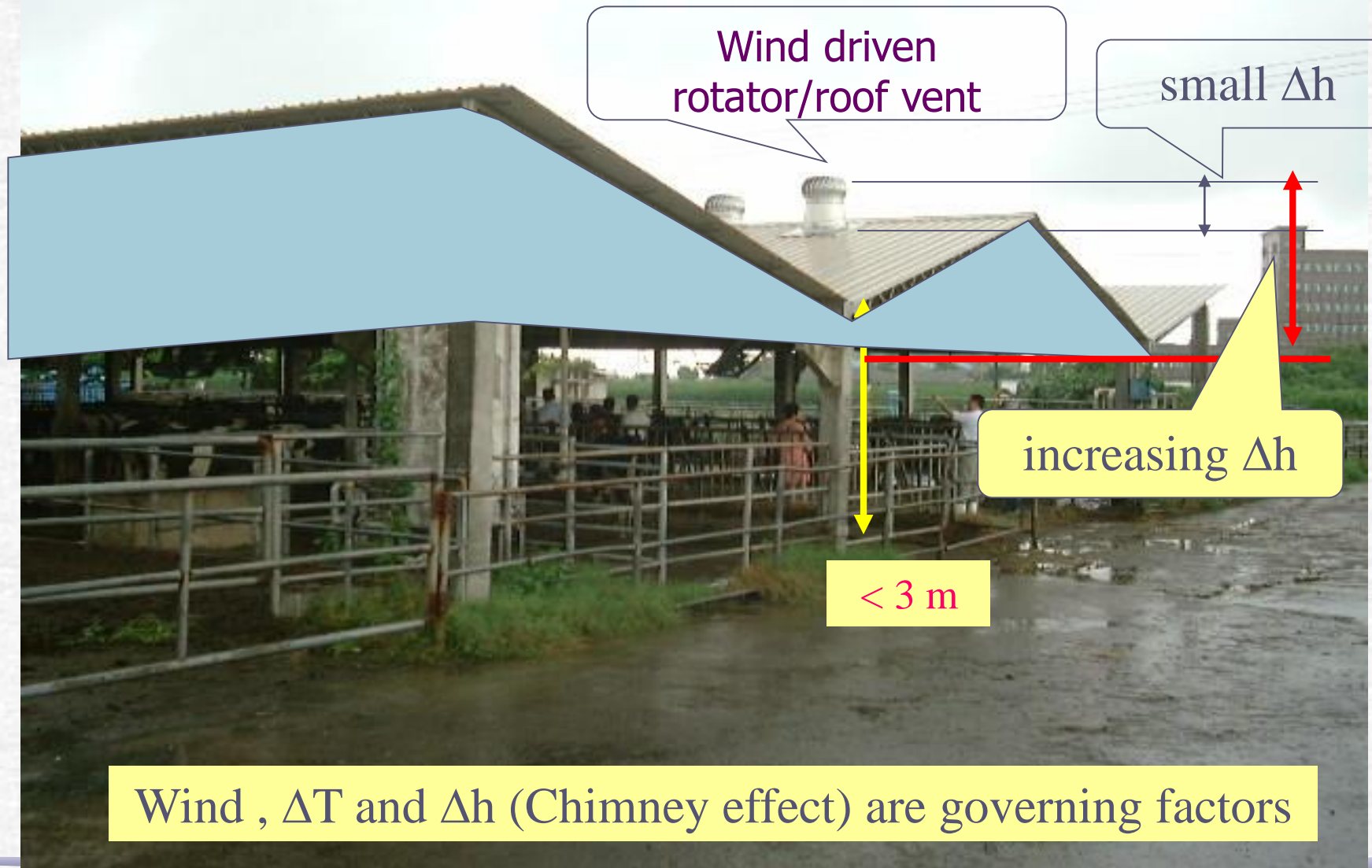


% of increase air flow rate



Large opening area / small opening area

Natural Ventilation : roof_2



Propeller inside to enhance up-flow air movement



Some without propeller and some install it in wrong orientation



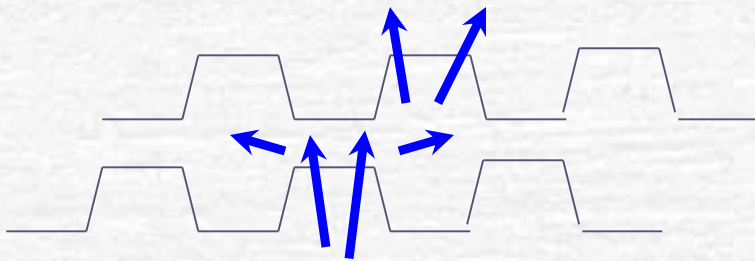
Wrong color



Painted black, Absorbing heat as much as possible to enhance the chimney effect by increasing ΔT .

Natural Ventilation : roof_3

- Double skins porous roof



Roof with many small holes is superior than roof with some big holes even when the total opening area are the same.

Patented double skins porous roof

- ✔ Can be recycle, environmental friendly.
- ✔ Non-flammable
- ✔ Uniform openings throughout entire roof.
- ✔ Air within double skins become thermal barrier.
- ✔ Heated air within double skins enhance natural convection.
- ✔ No odd looking appearance compare with



Comparison of 3 types of roof materials

Regular

Porous roof

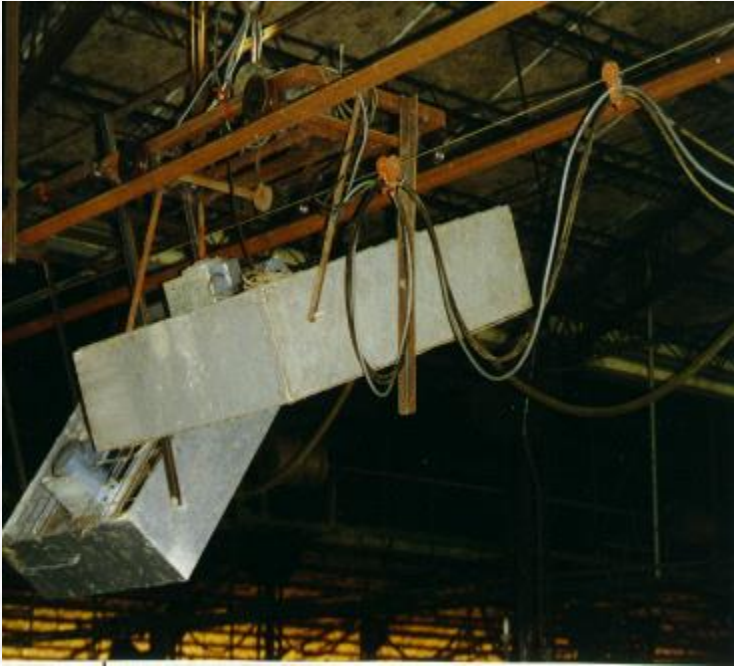
PU added



Can be recycle. Non-flammable

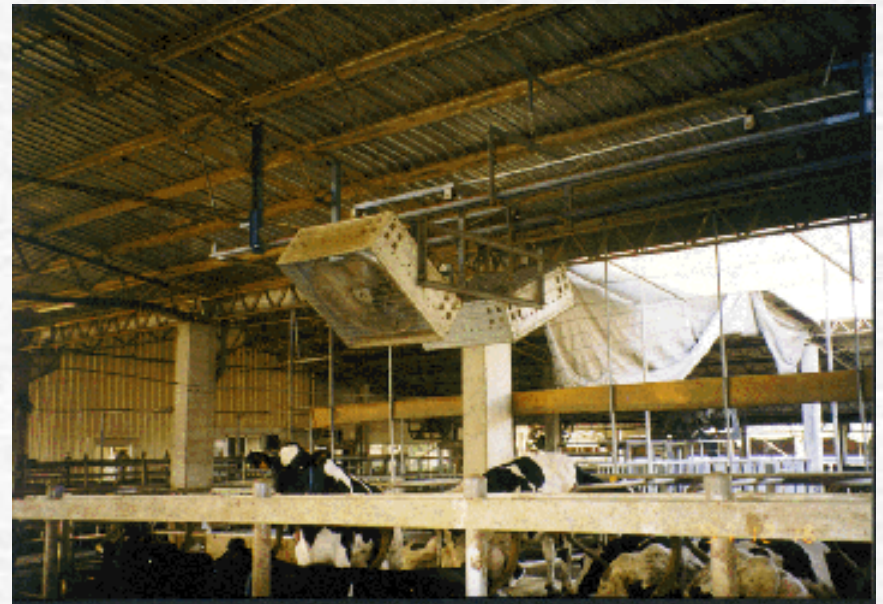
More expensive. Can not recycle. Flammable.

Forced Ventilation



Titled Fan will draw down the hot air from the upper portion under roof

High pressure fogging with movable fans



Movable fans

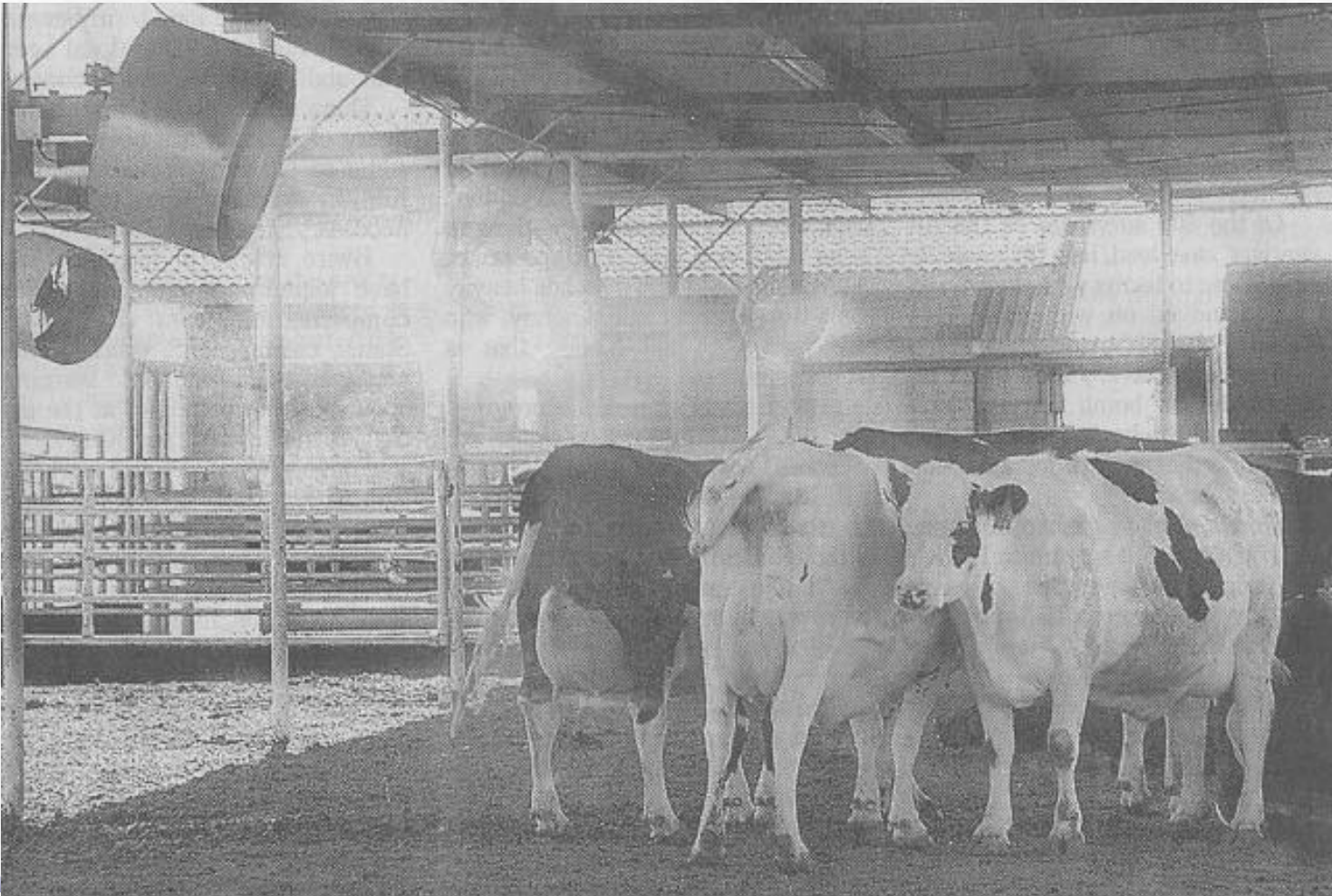
Design criteria

- Reduce # of fans required
- Provide varying air velocity
- Blow to the necks of the cattle and the feeds

Intermittent high pressure fogging

- To reduce air temperature at the top portion under roof
- Reducing downward radiation
- Prevent the fan from drawing hot air
- Enhance air movement
- Should not increase the RH around cattle

Fogging directly to the cows



perspective
of the Western states

THE WEST



Air conditioning rules Arizona life

By Bill Aronson
The Associated Press

SUN CITY, Ariz. — Long before our grandparents were born, the Sun God smiled upon the land. And there was warmth.

Trouble was, the Sun God didn't know when to stop smiling. There were 300 sunny days a year. They named this place the Valley of the Sun.

And from the desert rose a wide-spread civilization called the Phoenix Metropolitan Area. But the asphalt and glass only made it worse.

Just how hot was it? Birds lay on their backs to stay cool. Drivers chanted gas-billlers while steering. People rose at 4 a.m. to mow and garden and grill, then retreated from the searing morning sun. "Are you getting enough shade?" became a pleasantry.

Finally they found a tool that could keep the blistering days at bay — but only outdoors. There came to be two distinct realities in the valley. Outside, the Sun God still prevailed. But inside, at last, it was cool.

They called their tool air conditioning. By the time of the month, they put it to use. It changed the Valley of the Sun forever.

Flurry of mad dashes

From June to August, this is how metropolitan Phoenix starts — a flurry of mad dashes from air-conditioned homes to air-conditioned cars to



With the temperatures at 100 degrees, these cows at a dairy near Casa Grande, Ariz., are spending most of their day under high-powered mixers.

and who are sure it's a life-and-death issue. It can be

Jim Beckup has heard all the pleas: "I have an elderly mother." "I have

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Intermittent spraying/forced ventilation has better cooling effect compare with fogging fan



Intermittent spraying/forced ventilation

	Berman	Bucklin	This study
Spraying	1 min	30 sec	1 min
Forced vent.	5 min	4.5 min	9 min
S/F Time ratio	1 : 5	1 : 9	1 : 9
Replication	5 times	3 times	5 times
Duration	30 min	15 min	50 min
Interval	1-2 hrs	45 min	1-2 hr
Location	Inside barn	Inside barn & holding area	Holding area

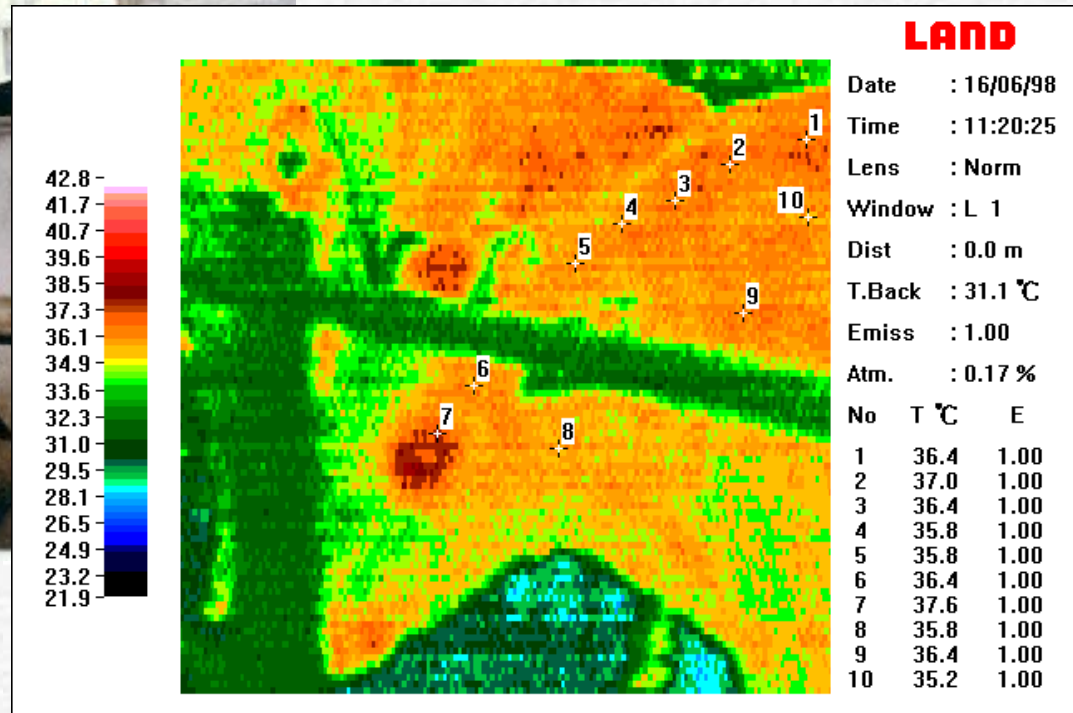
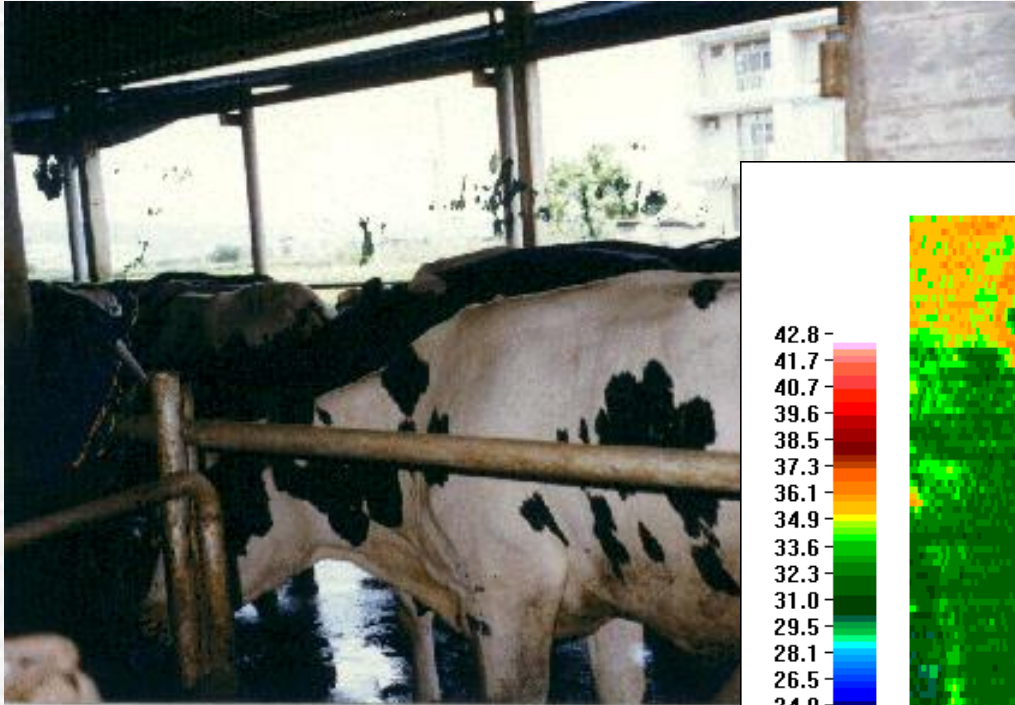
Intermittent spraying/forced ventilation

Strategies	Spray & vent 5/10min 3times	Spr+vent 5/10min 3times	Spr+vent 3/12min 3times	Spr+vent0 .5/4.5min 10 times	Spr+vent 1/9min 5times
Total Spray	15 min	15 min	12 min	5 min	5 min
Total Vent.	30 min	30 min	36 min	45 min	45 min
Spray/Vent	1 : 2	1 : 2	1 : 4	1 : 9	1 : 9
Duration per treatment	30 min	45 min	45 min	50 min	50 min

Intermittent spraying/forced ventilation (cont.)

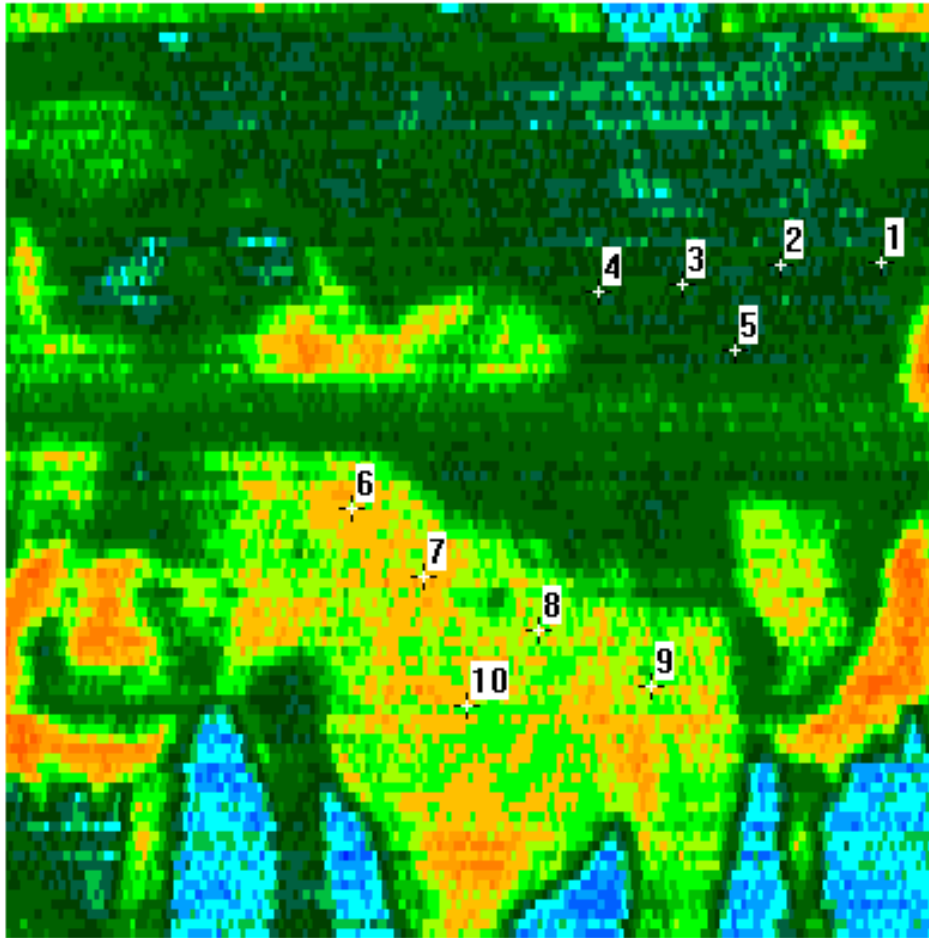
&: concurrent +: alternating	5&10 x3	5+10 x3	3+12 x3	0.5+4.5 x10	1+ 9 x5
Rectal Temp. reduction in 80 min	0.4 °C	0.4 °C	0.4 °C	1.2 °C	1.2 °C
Rectal Temperature recovery after treatment				0.4 °C per 30 min	0.4 °C per 50 min
Cooling effect	Worst	poor	Good	best	best
Rel.water consumption	3	3	2.4	1	1
Rel.Power consumption	1	1	1.2	1.5	1.5

Before spraying



Average body Temperature: 36.8 °C

After Spraying + Venting

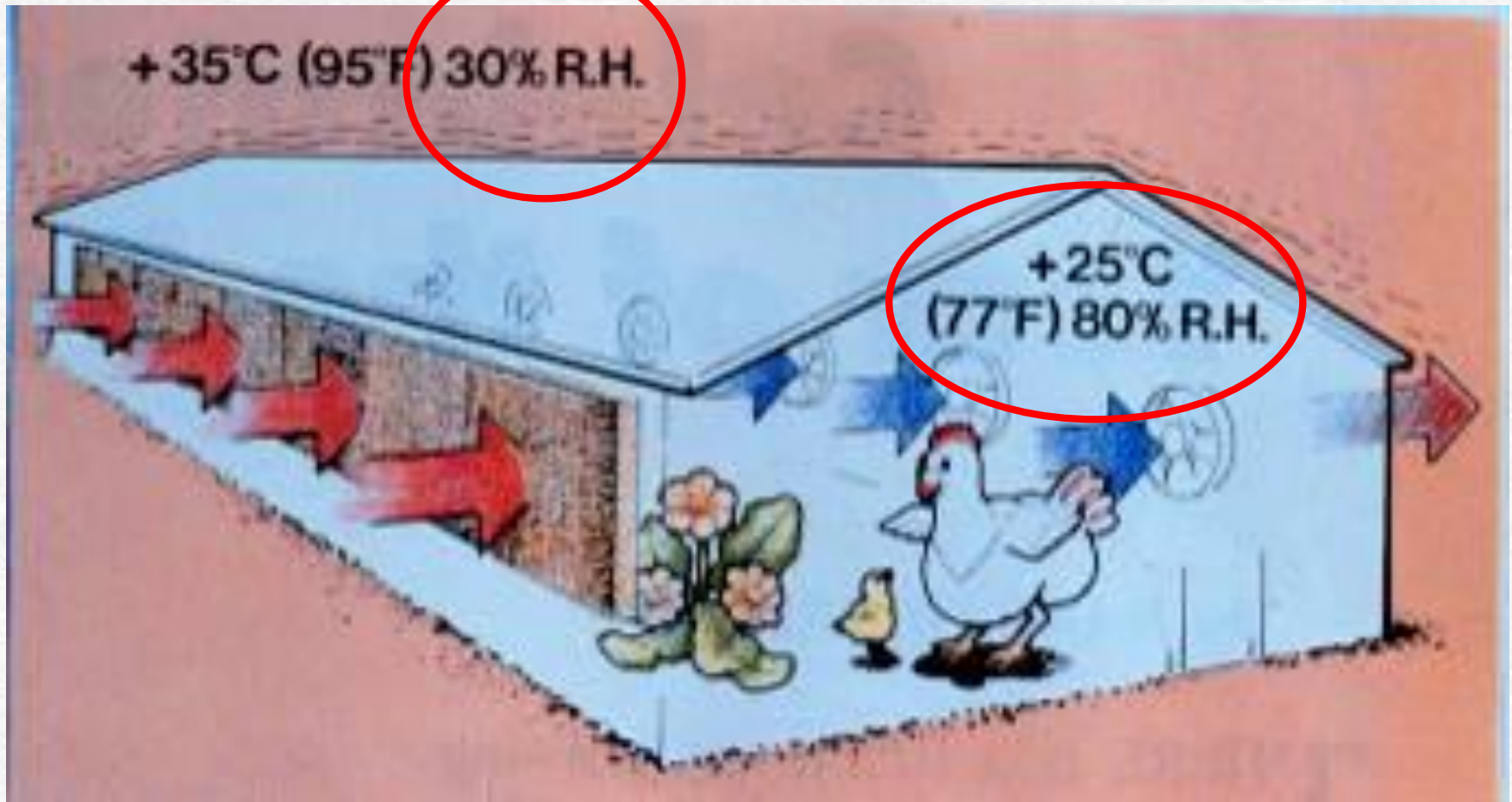


Date : 16/06/98
Time : 11:36:40
Lens : Norm
Window : L 1
Dist : 0.0 m
T.Back : 27.4 °C
Emiss : 1.00
Atm. : 0.17 %

No	T °C	E
1	32.5	1.00
2	31.1	1.00
3	31.1	1.00
4	31.8	1.00
5	31.1	1.00
6	35.1	1.00
7	35.7	1.00
8	35.1	1.00
9	35.7	1.00
10	34.4	1.00

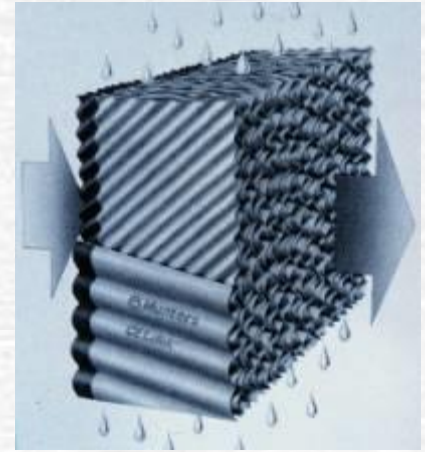
Should spray from both top and down

Pad and Fan system



Drawbacks of the pads

- Rely on import, expensive
- algae and Dirt



Solution to prevent algae: Coated Pad



Search for the substitution of the traditional pads



Palm tree fibers

Stack of plastic cages

Stack of hollow bricks



Patented Muti-Net to replace traditional pads



Negative pressure type used in Greenhouses



Positive pressure type used in Dairy barn

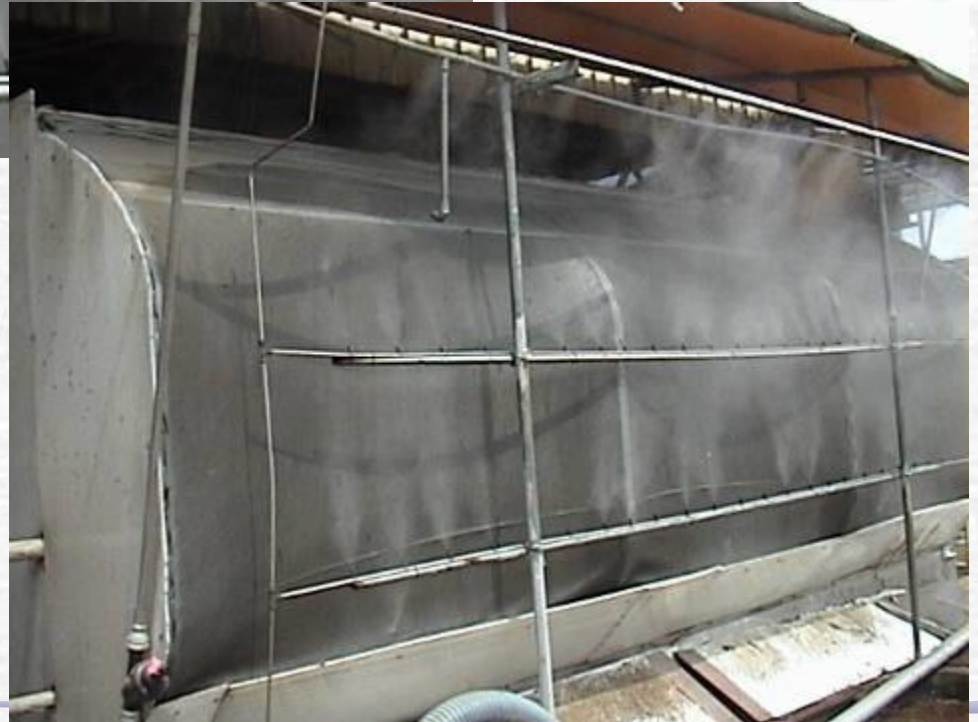
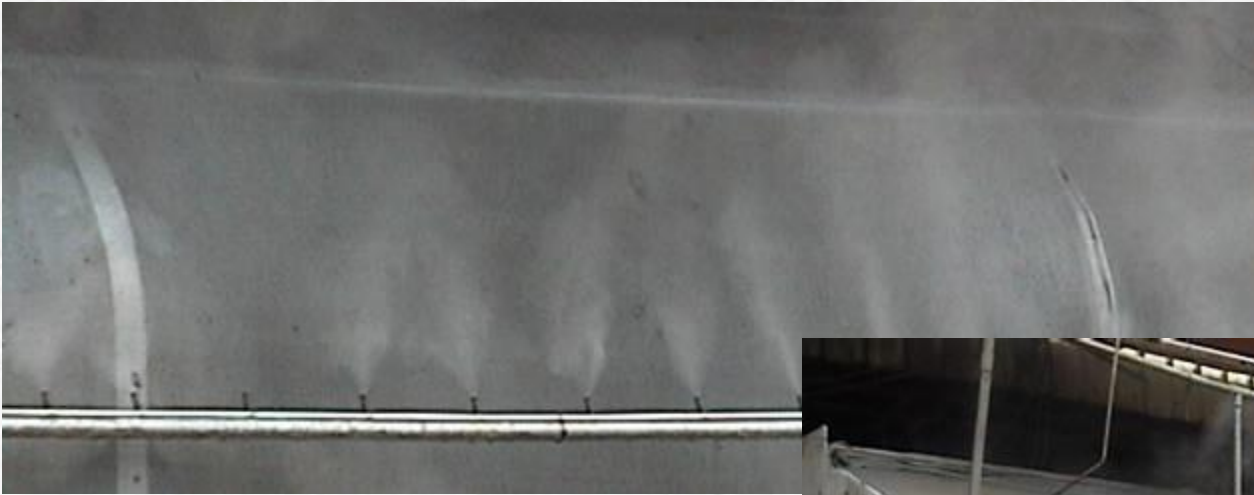


Fogging is better than misting

Positive pressure type for non-air-tight dairy barns



Nozzles in function



Multi-Net fogging and fan vs. Pad and fan

Tdb: 32 °C RH : 55 %	After_Pad Tdb	Wind Velocity m/s	Eff.
10cm Pads	26.37 °C	1.5-2.5	75 %
	28.25 °C	8 - 10	50 %
6 layer Nets	25.0 °C	8-10 (3 AC/min)	92.5%

Conclusions

- Genetic breeding, Nutrition and management were not mentioned. But are important as well.
- Cost Effective Integrated approaches:
 - Means with no energy consumption: 1st choice
 - Orientation, roof vent, shading
 - Means with high cooling effect but low cost: 2nd choice
 - Intermittent spraying/vent,
 - multi-net spraying and fan system
 - multi-net fogging and fan system

Cost effective Integrated Approaches

Approaches

Installation Cost

-
- East-West orientation
 - Double skin porous roof
-
- North side vertical shading
 - West/South sides extended shading
 - Intermittent spray/ forced ventilation
 - Multi-Net spraying and fans
 - Intermittent fogging with tilted fixed fans
 - Multi-Net fogging and fans
 - Pad and fan
 - Tilted Movable fans



