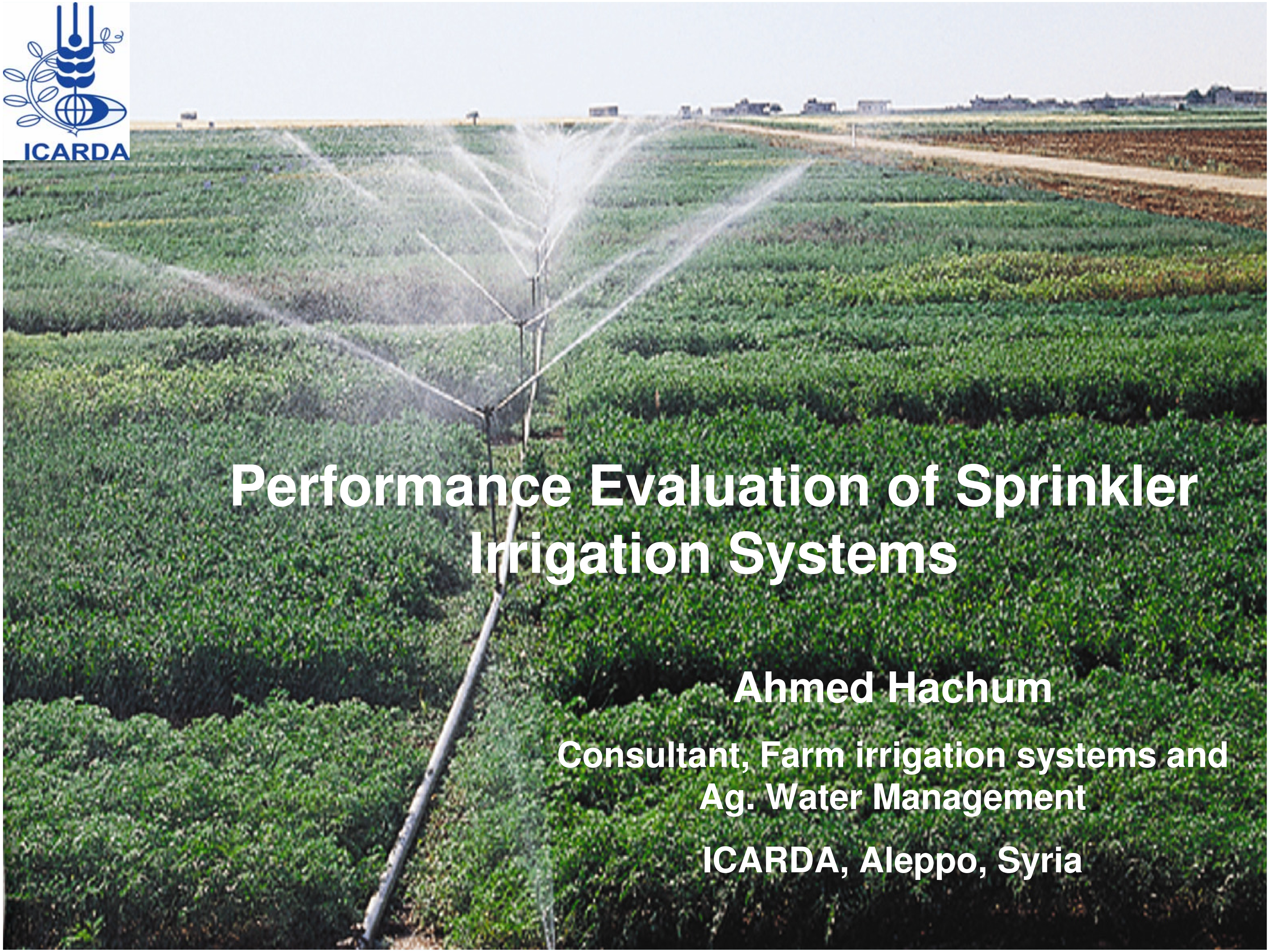

Performance Evaluation of Sprinkler Irrigation Systems

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System Performance Evaluation (SPE):

What?

Why?

How?

Then, *What*!

SPE is the analysis of certain measurements taken in the field while the system is operating under actual field conditions. It is analogues to human health checkup.

Why ?

- To identify the operational problems and performance deficiencies experienced by irrigators

- To provide directions to management in deciding whether to continue existing practices or to improve them.

How?

Depends on Level of Evaluation:

- Rapid (Preliminary) Evaluation

  (Simple, Quick, minimal cost, but requires skill)

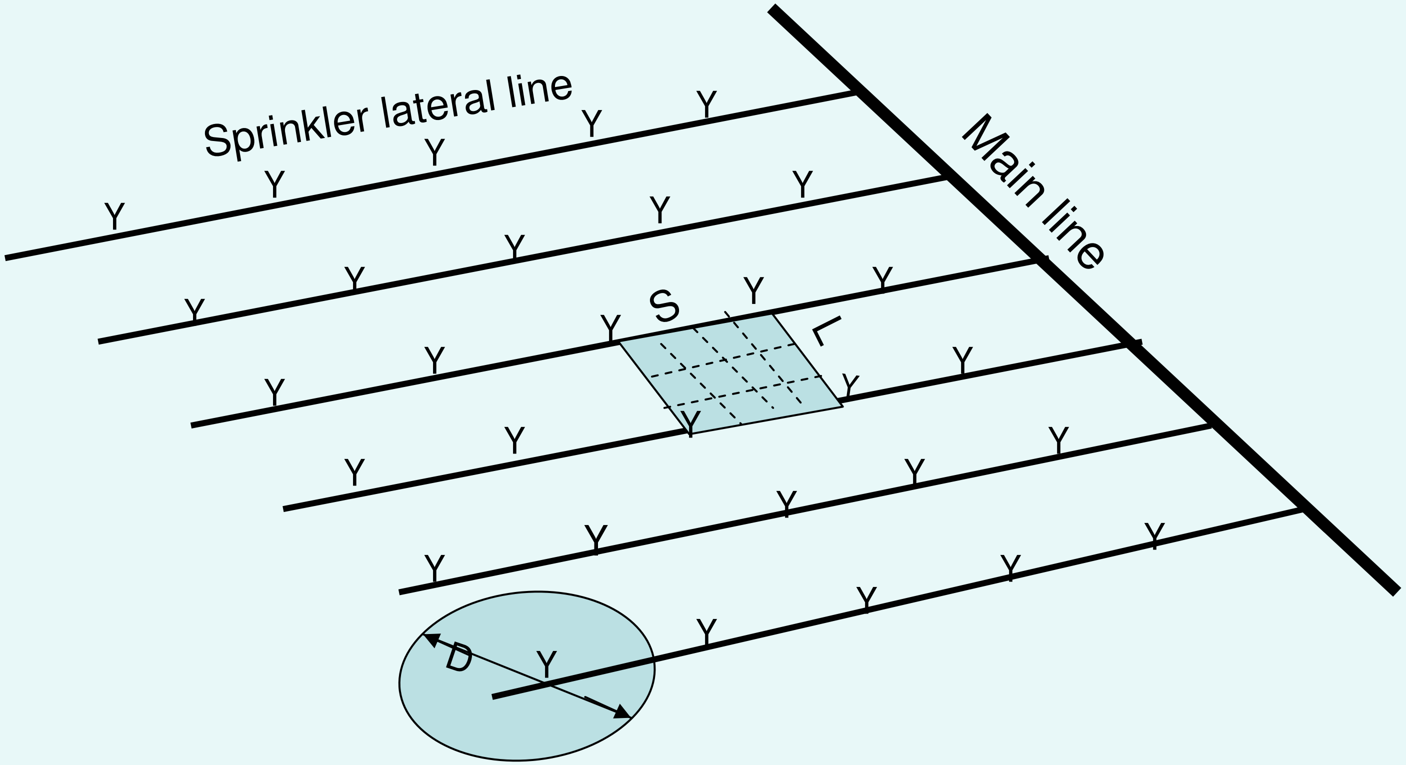
- Full (Detailed) Evaluation

  (Instrumentation, Measurements, time, Cost, Skill, etc.,)

Rapid (Preliminary) Evaluation

1. Inconsistency of sprinklers spacing
2. Unequal Number and size of nozzles per sprinkler head, in fixed grid systems
3. Unequal risers’ height
4. Riser pipes are not vertically erect
5. Lateral lines are not straight, but assembled crookedly
6. Excessive water leak
7. Improper operating pressure (Jet break up)
8. Poor water coverage (spots not receiving water)
9. Notable surface runoff in many places in the field
10. Missing or defective (plugged or worn out) nozzles

Catch cans layout for solid set sprinkler system



$$UC = [\,1 - (d/D)] \cdot 100\%$$

$S^2 + L^2 < D^2$ (low wind)

Full (Detailed) Evaluation

Basic evaluation indices

The principal indices for evaluating the performance of farm irrigation systems are

- ***Uniformity*** *of water distribution* (the key index in the evaluation)
- ***Adequacy*** *of irrigation, and*
- ***Efficiency*** *of irrigation*

Sprinkler Irrigation Basics

For Stationary (Fixed grid) systems:

Sprinkler intensity (application rate) < Basic infiltration rate of soil (I_b)

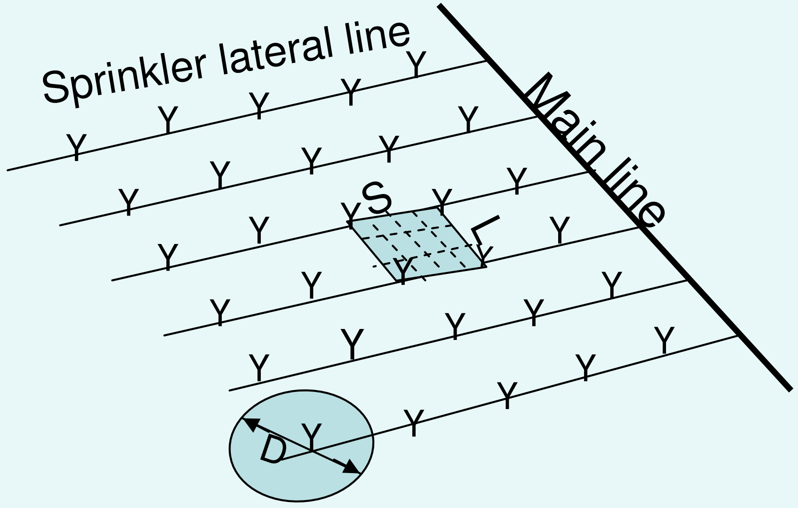
Discharge of one sprinkler head / (S x L) $< I_b$

$S^2 + L^2 < D^2$ (Low wind)

Average depth falling on the soil surface (d caught) = Sum of depths caught in the cans / number of cans

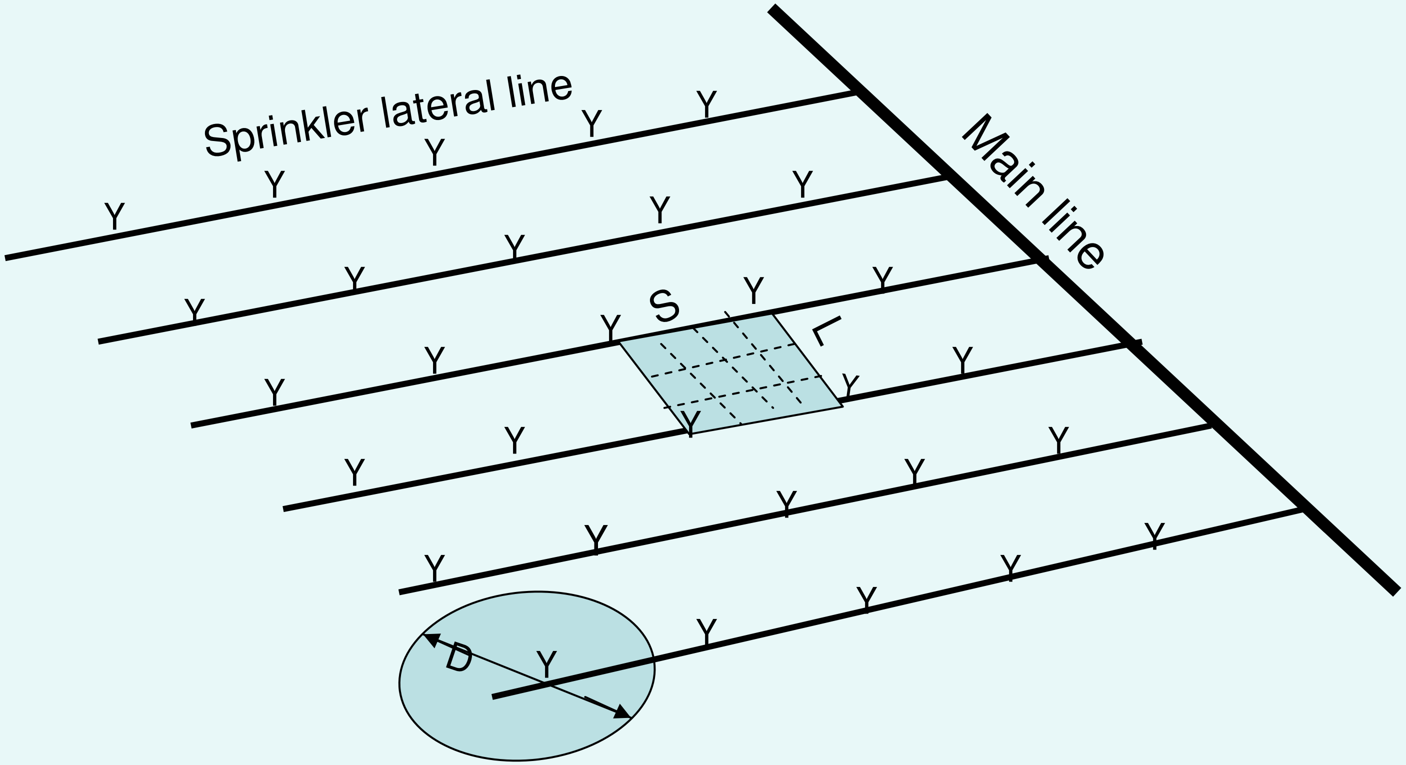
Sprinkler spray losses (SSL as mean depth)= d sprinkled – d caught on the ground

d sprinkled = q per sprinkler / (S x L)



Test grid size 2mx2m if spks spacing (S & L) are even numbers or 3mx3m if spks spacing are multiple of 3. A trade-off between accuracy and cost should be sought.

Catch cans layout for solid set sprinkler system



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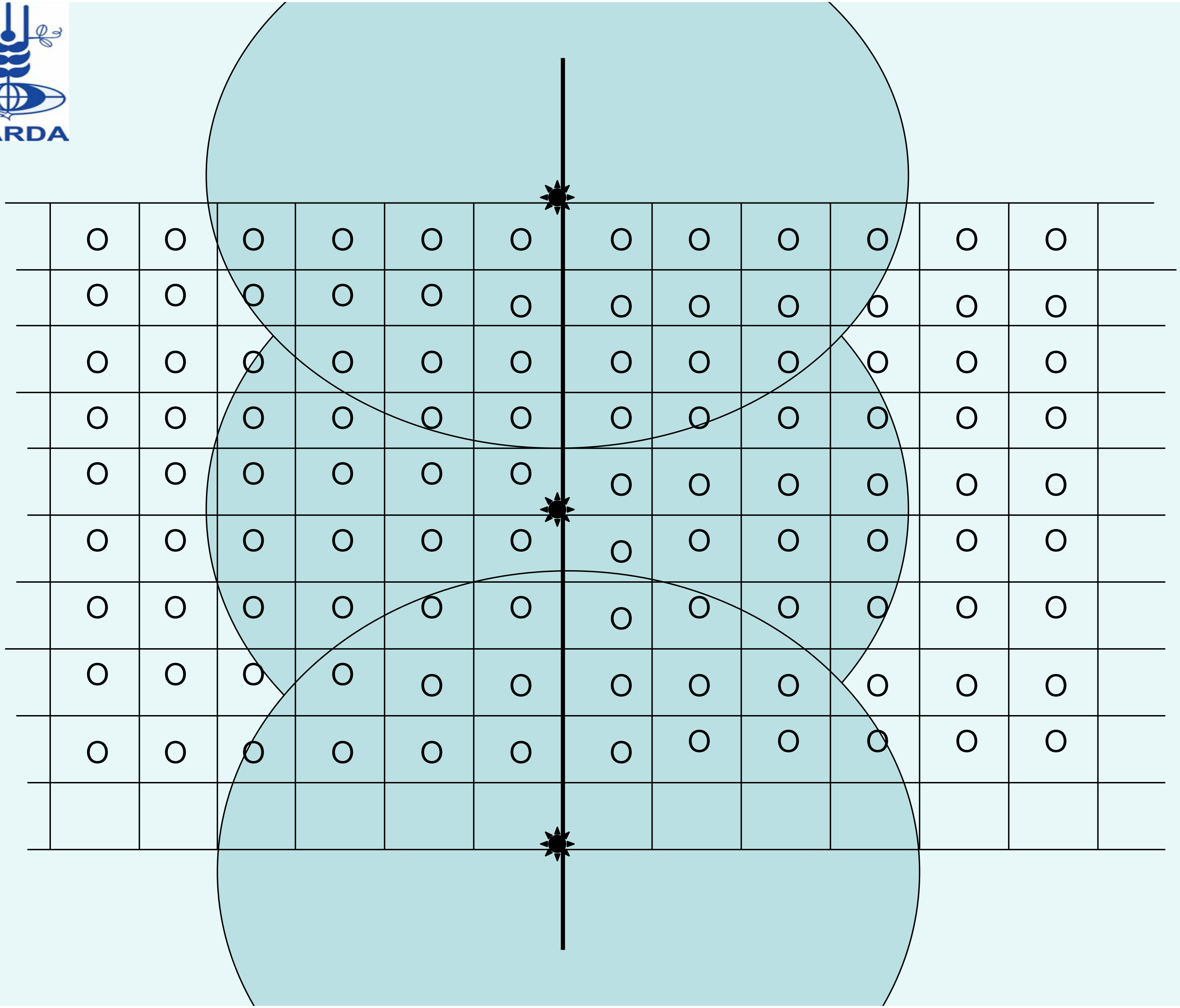
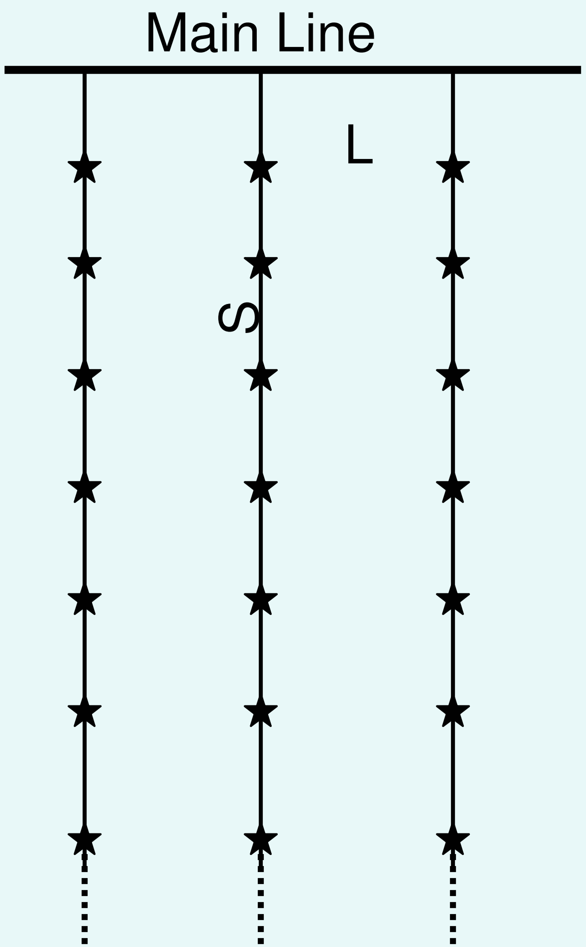
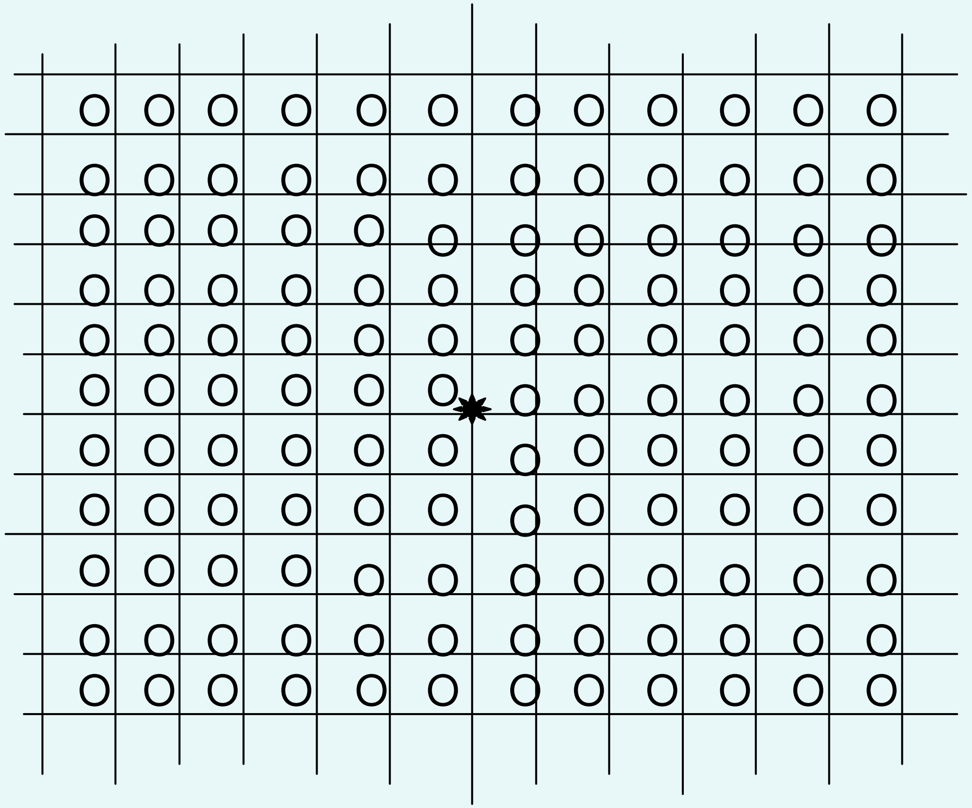
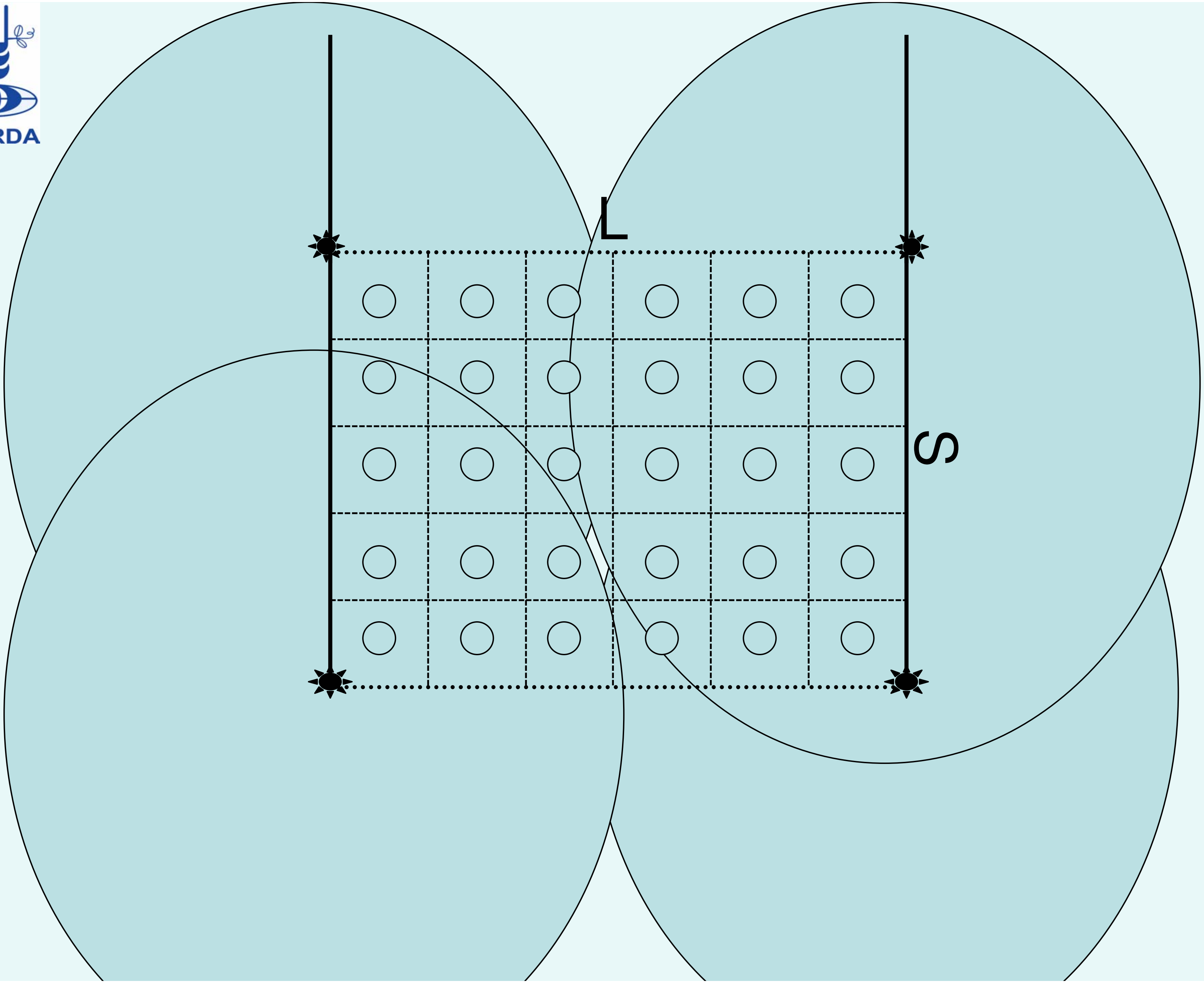


Testing Single Sprinkler Water Distribution Pattern





Catch cans layout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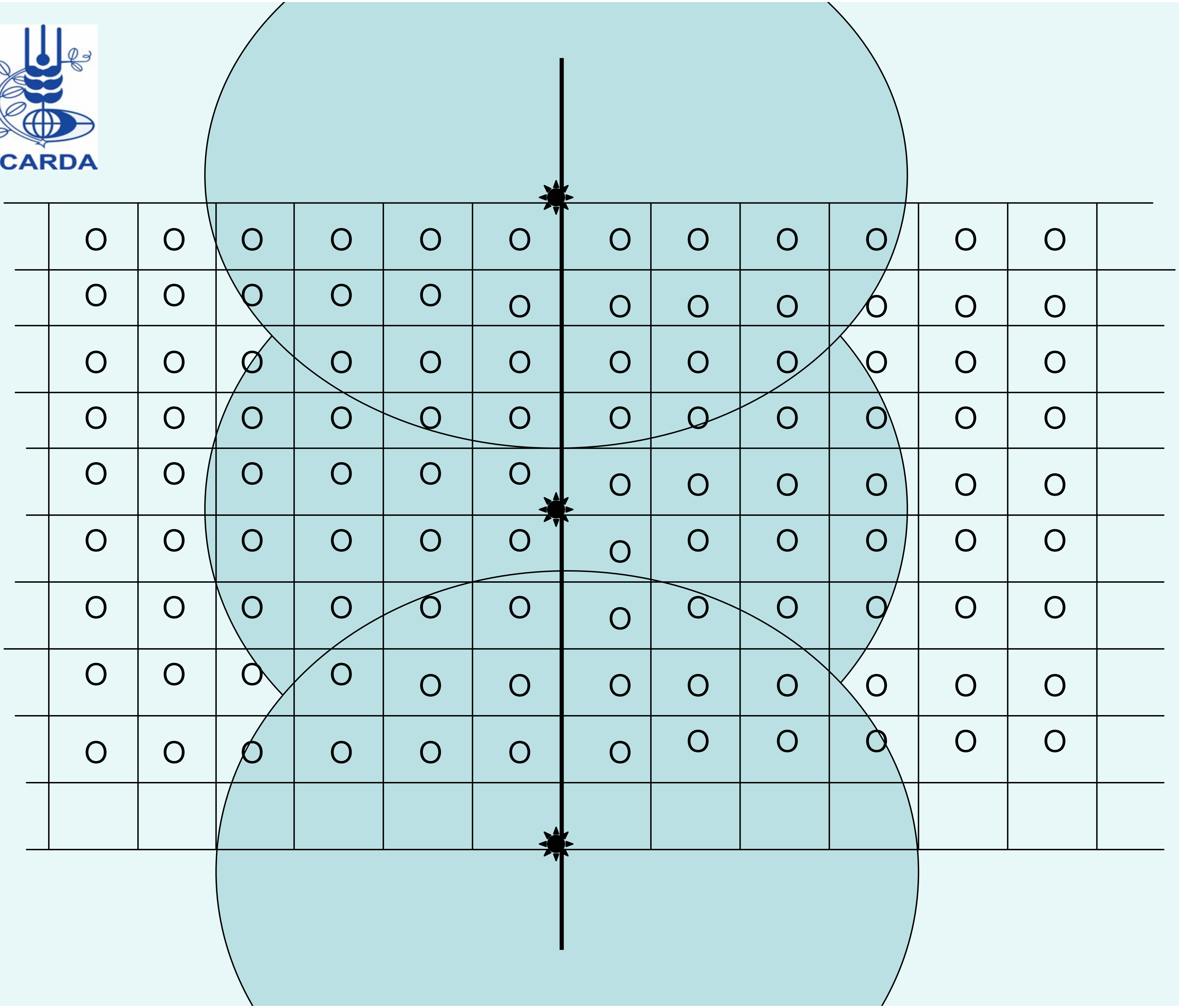
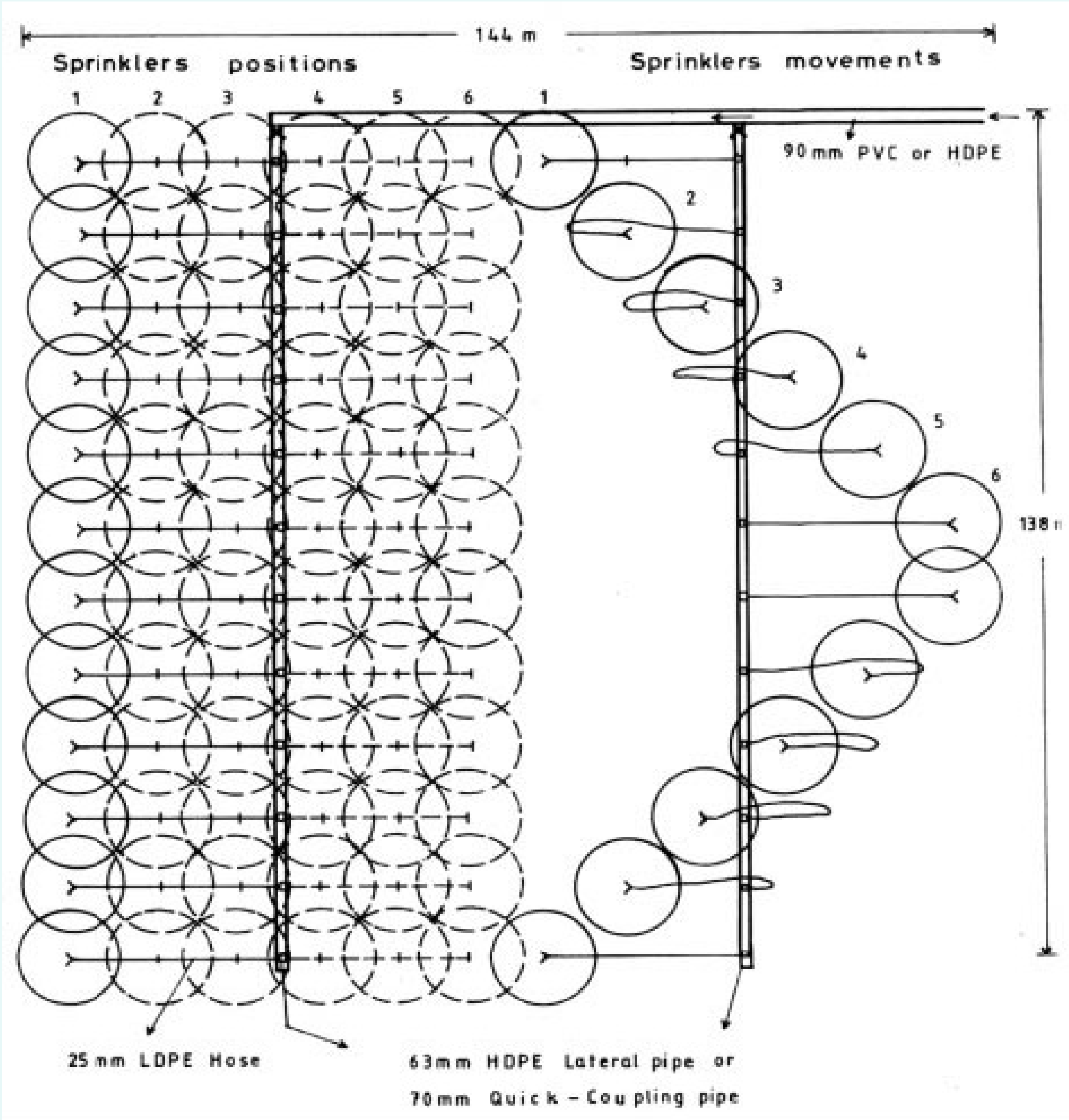


Table 1. Uniformity coefficient (%) for different laterals spacing and two pressure heads. Prevailing wind speed 2.6 m/sec. Sprinkler head: Full circle, impact type, 7 mm size single nozzle; Make: Bauer B90. Discharge= 3 m^3/hr. Riser height = 1.20 m.

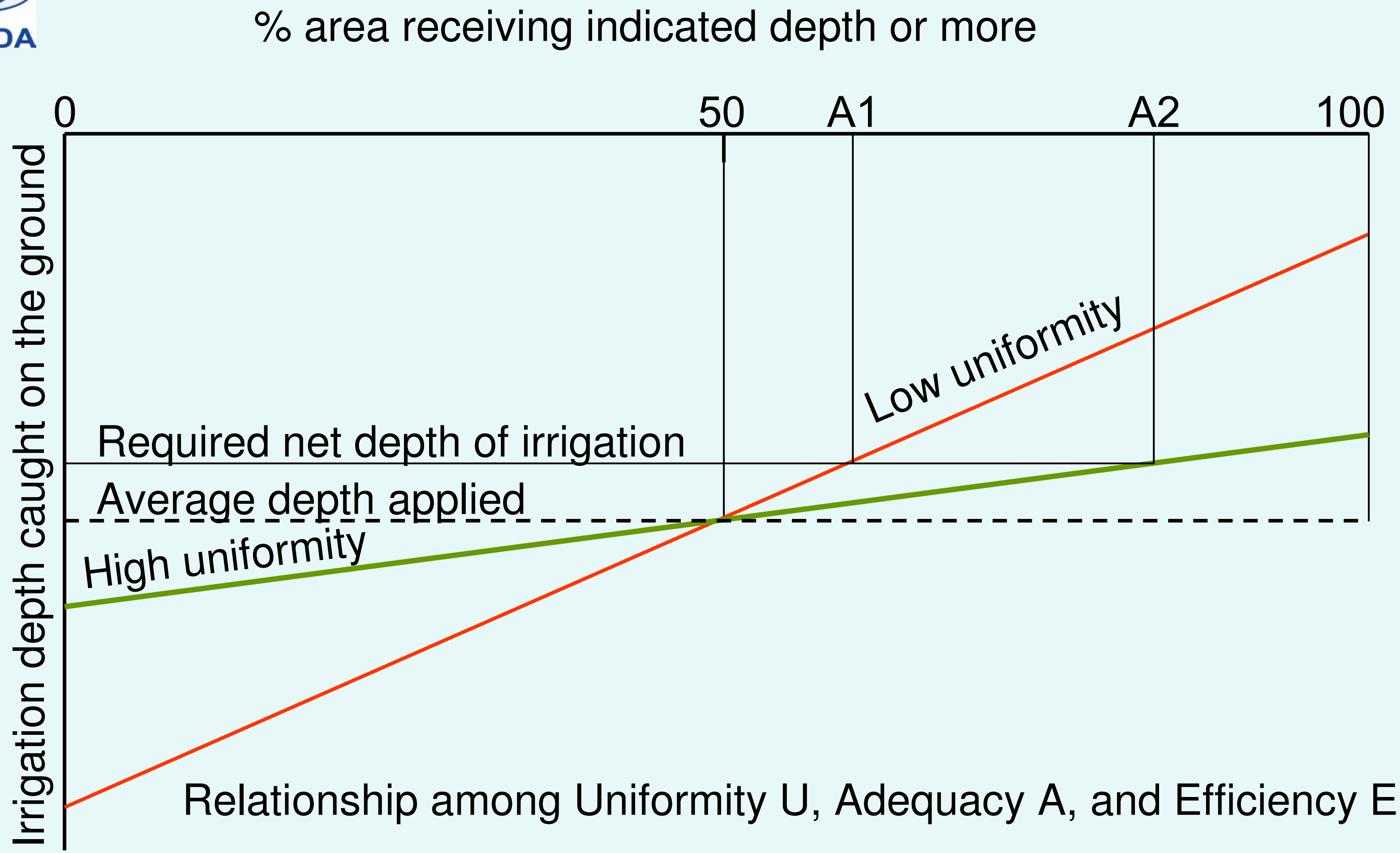
Sprinkler spacing	Pressure head = 25 m Mean coverage diameter = 32 m	Pressure head = 32 m Mean coverage diameter = 36 m
12 x 12	94	95
12 x 18	83	87
12 x 24	91	92
12 x 27	80	84



Typical layout of hose move sprinkler irrigation system (Source: FAO, 2000)

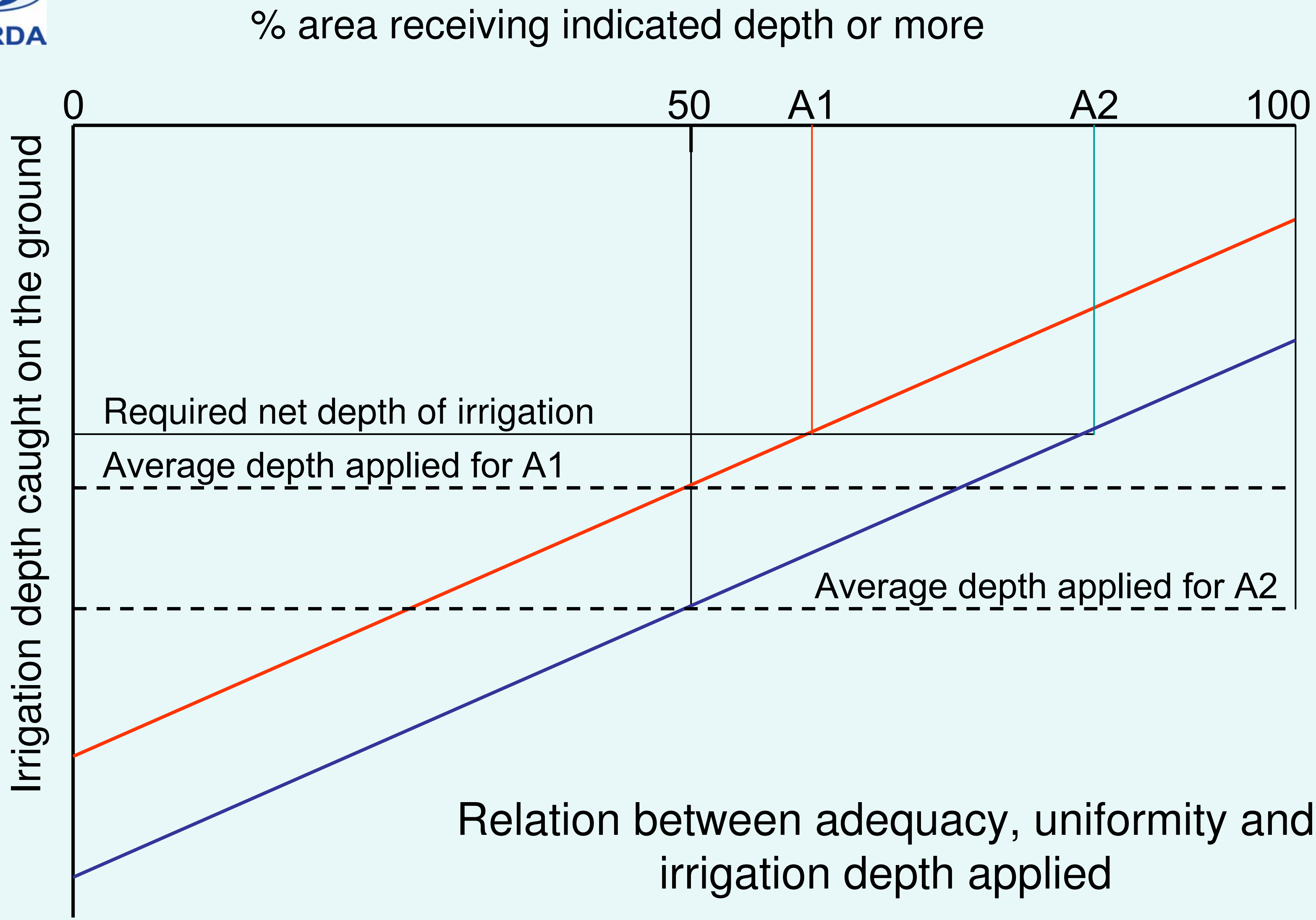
Percent field area receiving indicated depth or more

Can catch	Rank	P= 100 Rank/N
Largest value	1	100/N
	2	
	3	
Smallest value	N	100%

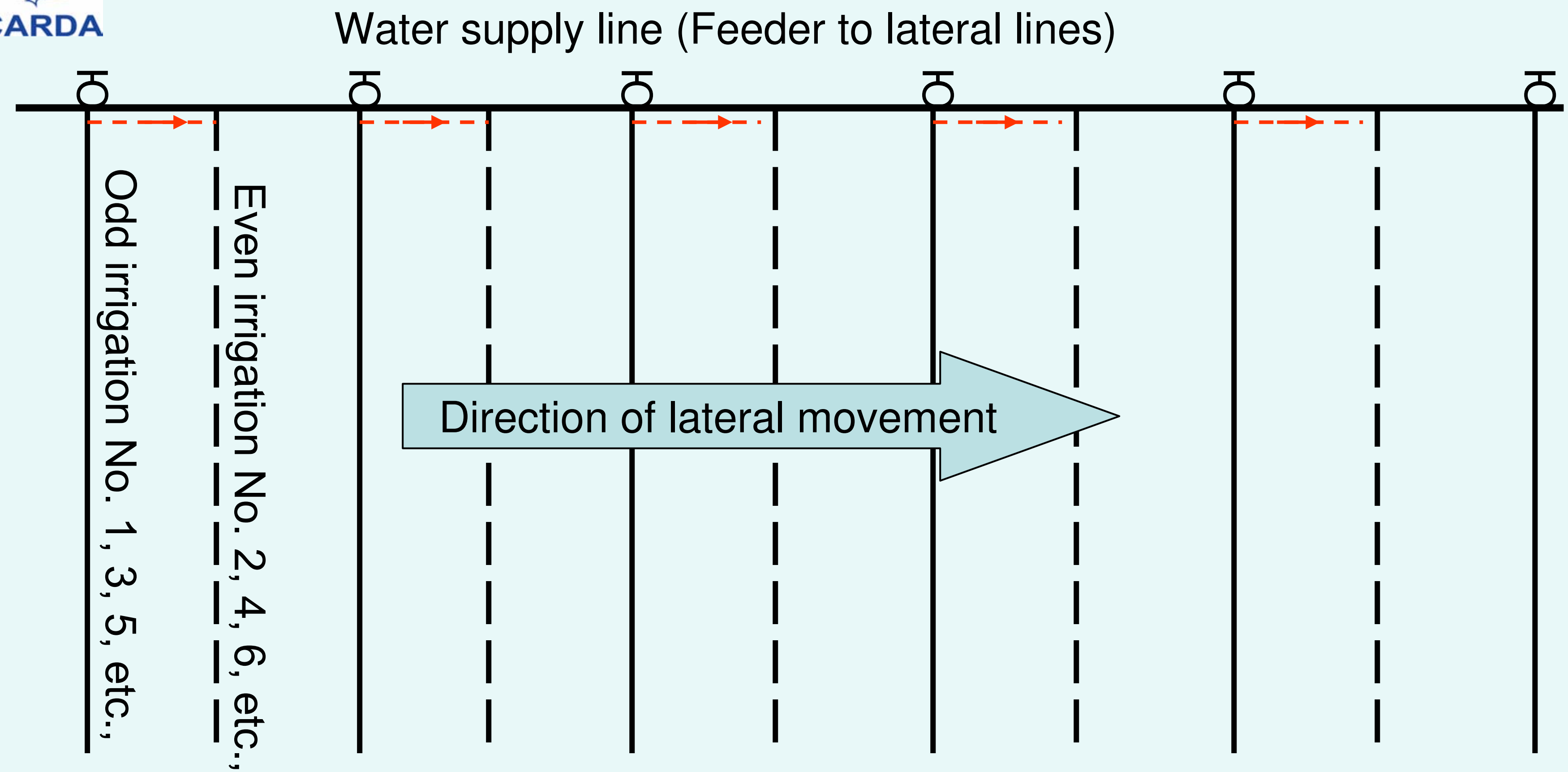


Relationship among Uniformity U, Adequacy A, and Efficiency E

$$E = 1 - 2\,(1 - U)\,A^2$$



Relation between adequacy, uniformity and irrigation depth applied



Alternate Setting for Portable Sprinkler Irrigation Lateral lines

$$\text{UC (with alternate setting)} = 10\sqrt{\text{UC (without alternate setting)}}$$

Uniformity coefficient, UC, can be increased by adapting the practice of alternate sets in which the lateral line is placed midway between the positions during the previous irrigation

$$UC_{as} = 10 \sqrt{UC}$$

$$UCas = 9.3\ UC^{0.517} \qquad (R^2 = 0.70)$$

IMPORTANT CONSIDERATIONS FOR PERFORMANCE EVALUATION

- ***Where and When to conduct the uniformity test?***

- Wind is the most important climatic factor affecting water distribution of sprinkler irrigation. Therefore, the wind condition (speed and direction) during the evaluation test will certainly affect the results. To be unbiased, evaluation tests should be carried out under climatic conditions close to that assumed in the design of the system. This may be difficult to ascertain, if we consider both speed and direction of the wind.

- It is interesting to note that wind direction has no effect on uniformity for square spks spacing (S=L), which is an advantage, however, the system may need more number of lateral lines (for solid set system) or more number of settings (moves) for portable spk systems.

- Representative SxL plots should be selected taken into consideration topography, location (distance from both ends of lateral line), wind direction, etc. All sprinkler heads should be operating during the test. For portable spk systems, all sprinklers along the line must be working.

- Necessary measures should be taken to avoid catch cans overturning under the action of sprinkler jet and/or water splash. For cropped fields, the cans should be supported with stakes to collect the spray above the crop's canopy.

Sprinkler spray losses SSL (Measured)

$$SSL = [(q \bullet T) - (D \bullet S \bullet L)] / (q \bullet T)\ 100$$

Sprinkler spray losses SSL (Estimated)

$$SSL = 8.5\ W^{0.46}\ P^{0.76}\ H^{-0.83}\ Z^{0.15}\ N^{-0.65}\ T^{0.56}$$

Irrigation Efficiency

$$E_f = E \bullet (1 - SSL)$$

Application Efficiency

$$E = 1 - 2\,(1 - UC)\,A^2$$

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Irrigation Efficiency, Ef, can be increased on the expense of decreasing Irrigation Adequacy and consequently reducing crop yield. Therefore, an optimal balance should be sought between cost of irrigation and crop yield in order to maximize net economical return.


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Thank you