LEPA, CONCEPT AND SYSTEM

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This presentation is intended to provide an understanding of Low Energy Precision Application (LEPA) both as a water and energy conserving concept and as an irrigation/tillage/ management system.

Concept

The overall goal of LEPA is to maximize use of the total water resource, which for the Great Plains includes both irrigation water and rainfall. LEPA minimizes non-transpiration losses associated with irrigation distribution and application. Non-transpiration irrigation losses are primarily (1) evaporation (spray evaporation in the air and from the wetted soil surface), (2) deep percolation past the effective root zone and (3) runoff. The total LEPA management system, which can include deficit irrigation, enhances the use of rainfall for crop production by increasing both soil profile and soil surface water storage capacities to minimize rainfall runoff and deep percolation.

Evaporation. LEPA minimizes spray and crop foliage evaporation by moving the water discharge point close to or at the soil surface. Although not an option for some crops, LEPA has the capability to confine water application to alternate crop furrows which eliminates 50% or more of the wetted soil surface evaporation and has increased yields by 10 percent or more for many field crops.

Runoff. The LEPA concept normally includes soil manipulation and/or surface stubble and residue management to increase surface storage capacity so that the high intensity water application to a small area does not create runoff. Surface rainfall storage is enhanced by the same soil surface manipulation. Subsurface rainfall storage capacity can also increase during a growing season as a result of deficit LEPA irrigation.

Deep Percolation. Unlike surface application methods, control of irrigation application depth is accomplished with speed control of a LEPA system as with other moving systems and should be managed to prevent irrigation deep percolation.

Design Concept. LEPA was designed to be independent of soil intake rate. Sprinkler system design and management attempts to match application rate of the system to the intake rate of the soil. LEPA is designed and managed such that the **application volume** per irrigation does not exceed the **surface storage volume** of the soil. Since the LEPA concept is based on storaging rainfall and irrigation water in the furrow until it infiltrates, it is very important that a surface management system be implemented. It is of equal importance that the resulting soil surface storage volume not be diminished or destroyed in the process of applying irrigation water. **This is a primary consideration in choosing an application device for LEPA systems.**

System

It is my observation that some systems are being labeled LEPA which are neither installed nor operated as the system was originally intended. This is not to say that the installations are not correct or good, but that perhaps they should be called something other than LEPA. To clarify this, the following definition is offered for the LEPA mechanical irrigation/tillage/management system as it was originally intended and developed. To qualify for LEPA the mechanical system should:

(1) be an overhead tower supported pipe system capable of either linear or pivotal movement,
(2) be capable of conveying and discharging water into a single crop furrow,
(3) discharge water very near to the soil surface to negate evaporation in the air,
(4) operate with mainline end pressure no greater than 10 psi when the end tower is at the highest field elevation, and
(5) locate the conveyance and discharge devices so that each plant within a field has equal opportunity for irrigation water delivery; the only deviation being non-uniformity caused by nozzle sizing and topographic changes.

Additionally to qualify as LEPA irrigation, the combined soil surface management and mechanical system operation should:

(1) result in zero runoff from the irrigation water application point and
(2) result in rainfall retention which is demonstratably greater than conventionally tilled and managed systems.

CHEMIGATION POTENTIAL WITH LEPA

Considerable research is currently underway to improve in-canopy chemigation application techniques with LEPA-type nozzles. Precise targeting of chemicals with minimal plant wash-off has been the research objective.

Excellent results with the moving nozzles on an earlier multifunction irrigation system (MFIS) prompted development of manually adjustable and stationary in-canopy nozzle packages. They are being designed for basically the same type of complete plant coverage by spraying in an upward pattern to the underside of plant leaves. The stationary in-canopy systems are nozzled to apply approximately one-fourth the water volume of the LEPA irrigation nozzles and operate at higher pressure of approximately 30 to 40 psi. Figure 1 gives a conceptual diagram of the in-canopy type nozzles.

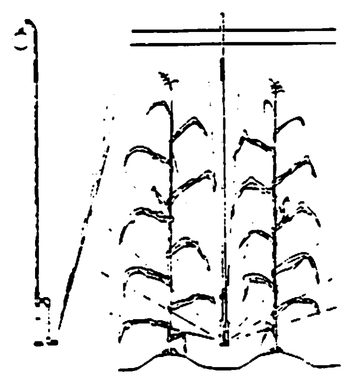

Figure 1

Another phase of research to accomplish uniform low-volume applications is development and evaluation of high speed continuous moving electrically propelled center pivots. An experimental conversion package has been developed with which to convert a conventional percent timer controlled pivot to a high speed continuously moving pivot with speed regulation form variable frequency control. An eight tower prototype system has been undergoing field testing for the last two years. Nozzeling and continuous high speed operation will combine to lower application water volumes to approximately 5 percent of that possible with conventional nozzles and conventional speed control. Uniform continuous movement at slow speeds will also contribute to the overall utility of the system to meet numerous application needs.

Research is also expanding to develop and evaluate multi-purpose, multi-flow, multi-directional nozzles which can cover a wide variety of chemigation situations ranging from high volume soil directed herbigation to low volume foliar applied insectigation, fungigation and herbigation. This research is aided by the recent construction of a 5-row chemigation simulator which has greatly facilitated replicated and randomized experimental design for testing various experiment nozzle packages along with chemicals and chemical rates. Each application with an experimental nozzle and continuous movement is being compared to commercially available nozzles operating with traditional start-stop movement. Also the application of many environmentally safe chemicals such as oils, insecticidal soaps, insect diseases and growth regulators are being tested with the simulator.

The most recent tests compared commercial in-canopy LEPA application, commercial overhead application and application with an experimental multidirectional nozzle utilizing a fluorescent pigment as a tracer. The nozzles tested, located in alternate 40-inch rows, were Senninger Quad-Spray LEPA nozzles, Senninger 360° multi-angle corn pad operated from a LEPA position, a 360° spray nozzle above the crops and an experimental TAES multidirectional LEPA nozzle. The experimental TAES nozzle applied the chemical in one-fourth the water volume as was applied with the commercial nozzles. The pigment coverage, expressed as ng per cm^2 of leaf area recovered from the bottom, middle and top of corn plants, is given in Table 1. Cotton coverage separated into bottom and top coverage of leaves, squares and bolls is shown in Table 2.

The concentrations obtained with low volume TAES experimental nozzles were approximately double that obtained with the commercial nozzles whether in-canopy or overhead. There were no significant differences in the average concentration obtained with the commercial nozzles.

Table 1. Comparison of spray deposition to corn when a chemical marker is applied through different chemigation nozzles.

	ηg of fluorescent pigment/cm^2 of leaf area			
Nozzle	Bottom	Middle	Top	Avg.
Quad	10.9 C [1/]	9.4 B	10.4 AB	10.2 B
IC 360°	13.9 B	9.4 B	7.5 C	10.3 B
OH 360°	8.4 C	7.1 B	12.8 A	9.5 B
TAES Exp.	30.8 A	14.5 A	9.7 BC	18.4 A

Table 2. Comparison of spray deposition on cotton when a chemical marker is applied through different chemigation nozzles.

	ηg of fluorescent pigment/cm^2 of plant area					
	Leaves		Squares			
Nozzle	Bottom	Top	Bottom	Top	Bolls	Avg.
Quad	16.1 B[1/]	14.9 B	32.4 B	19.6 B	41.8 B	24.9 B
IC 360°	18.0 B	19.3 B	33.8 B	26.8 AB	47.3 B	29.1 B
OH 360°	13.1 B	16.4 B	36.4 B	36.6 A	43.1 B	29.1 B
TAES Exp.	54.1 A	36.1 A	72.7 A	21.7 B	64.7 A	49.9 A

1/ Means in each column followed by the same letter are not significantly different ($P = 0.05$).