WHO WANTS TO BE AN IN-CANOPY IRRIGATOR?

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INTRODUCTION AND GUIDELINES

In-canopy center pivot sprinkler irrigation is gaining popularity in much of the Great Plains region. Physical and institutional constraints have resulted in lower system capacities that have encouraged irrigators to get the maximum benefit from their water application. However, using center pivot sprinkler nozzles below the top of the corn crop canopy presents unique design and management considerations. Let's see if you really want to be an in-canopy irrigator!

The rules for the game are:

1. Use the provided answer sheet to choose your answer.
2. Author will provide rationale for correct answer.
3. Assume you are irrigating a western Kansas corn field.
4. There might be more than one answer, but choose the best .
5. Purpose of game is education and to encourage conceptual thinking.
6. Answers are author's opinion based on his scientific understanding.
7. Some questions are easier than others.
8. You can still be an in-canopy irrigator if you fail, but are hopefully wiser.

So, now that you know the rules,

WHO WANTS TO BE AN IN-CANOPY IRRIGATOR?

1 Any opinions, findings, conclusions, or recommendations expressed in this paper are those of the author and do not necessarily reflect the views of Kansas State University.

ANSWER SHEET FOR WHO WANTS TO BE AN IN-CANOPY IRRIGATOR?

Question	***My answer***	***Lamm's answer***
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

QUESTIONS FOR WHO WANTS TO BE AN IN-CANOPY IRRIGATOR?

Question 1. What do the letters LEPA stand for?

A. Lone Elm Protection Association

B. Low Energy Precision Application
C. Low Elevation Projected Aperture
D. Low Efficiency Puddled Application

Question 2. Which of the following is a traditional design criteria for sprinkler irrigation systems?

A. Always place sprinkler nozzles at a height below the corn ear height
B. When irrigating, use a timer setting not more than 7%
C. Apply water at a rate less than the soil intake rate
D. Use lower capacity sprinklers on sandier soils

Question 3. Which of the following is <u>not</u> an advantage of in-canopy sprinkler application?

A. Higher uniformity due to application closer to soil surface
B. Lower wind evaporation losses
C. Less canopy interception losses
D. Insecticides may be applied to crop canopy

Question 4. You are experiencing runoff on your typical Kansas farm when applying 1 inch with in-canopy irrigation. What solution should you try first?

A. Speed the system up by reducing cycle time
B. Slow the system down by increasing cycle time
C. Accept some runoff while reducing evaporation losses
D. Raise the outside span of nozzles above the canopy

Question 5. Which of the following is the most effective in-canopy management scheme?

A. Space nozzles 10 ft apart at a height of 4 ft.
B. Plant corn in circular rows and space nozzles at twice the row spacing
C. Replace nozzles annually
D. Use short duration cycles later in the crop season

Question 6. The father of LEPA is considered to be

A. Marvin Jensen
B. William Lyle
C. Alexander Senninger

D. Bill Kranz

Question 7. In deficit irrigation situations, a lower value of application uniformity is of more importance.

A. True
B. False

Question 8. K-State research has shown in-canopy irrigation can

A. Result in 50% water savings when compared to above-canopy irrigation
B. Help improve soil structure due to less crusting
C. Help reduce nitrogen costs
D. Reduce corn yields when nozzle spacing is 10 ft

Question 9. Which of the following is <u>not</u> a guiding principle of LEPA sprinkler irrigation?

A. Pressure at the end tower must be less than 20 psi
B. Be capable of conveying and discharging water into a single crop furrow
C. Each plant has equal opportunity for irrigation water
D. Result in zero runoff from irrigation water application point

Question 10. K-State research has found in-canopy sprinkler distortion to be affected by

A. Crop row orientation with respect to center pivot sprinkler travel
B. Time of the irrigation season
C. Height of the nozzles
D. All of the above

Question 11. Which of the following are true about stemflow, the amount of water reaching the soil by flowing down the stem?

A. Is a small portion of the total delivered water from the top of a corn canopy
B. Is the predominate flow path for a fully developed corn canopy
C. Increases with decreased plant spacing
D. Both B and C

Question 12. K-State promotes use of in-canopy sprinkler irrigation

A. For all corn production systems due to high corn water use
B. On all sandy soils but less frequently on silt loam soils
C. When properly designed and managed
D. Both B and C

CORRECT ANSWERS AND RATIONALE FOR WHO WANTS TO BE AN IN-CANOPY IRRIGATOR?

Question 1. What do the letters LEPA stand for?

The correct answer is **B. Low Energy Precision Application.** Low energy refers to a guiding principle that nozzle pressures should be in the low range. Precision application refers to guiding principles related to conveying water equally to the crop furrow, reducing evaporation losses, and eliminating runoff (Lyle, 1992).

Question 2. Which of the following is a traditional design criteria for sprinkler irrigation systems?

The correct answer is **C. Apply water at a rate less than the soil intake rate.** Traditionally, sprinkler irrigation systems have been designed to uniformly apply water to the soil at a rate less than the soil intake rate to prevent runoff from occurring (Heermann and Kohl, 1983). These design guidelines need to be either followed or intentionally circumvented with appropriate design criteria when designing and managing a center pivot irrigation system using LEPA and other in-canopy sprinklers. Answer A (Always place sprinkler nozzles at a height below the corn ear height) is incorrect because it ignores the fact that impact sprinklers might be the most appropriate selection in many cases. Answer B (When irrigating use a timer setting not more than 7%) is incorrect because timer settings are changed as needed to adjust irrigation amount. Answer D (Use lower capacity sprinklers on sandier soils) is incorrect because lower soil water holding capacities for sands generally increase the need for higher capacity sprinklers that can more closely match peak water needs.

Question 3. Which of the following is <u>not</u> an advantage of in-canopy sprinkler application?

The correct answer is **A. Higher uniformity due to application closer to soil surface** is <u>not</u> an advantage of in-canopy sprinkler application. Distortion

of the spray pattern by the crop canopy will lower the uniformity of broadcast applications (Lamm, 1997). In the case of LEPA applications in the bubble mode to alternate furrows, uniformity would still be lower than broadcast applications over a short distance, but are not considered to be a detriment. Answers B, C and D (Lower wind evaporation losses, less canopy interception losses and Insecticides may be applied to crop canopy) are all considered to be advantages. For further discussion of this topic, check out references Lamm (1997) or Yonts et al. (1997) or point your Internet browser to http://www.ianr.unl.edu/pubs/irrigation/g1337.htm

Question 4. You are experiencing runoff on your typical Kansas farm when applying 1 inch with in-canopy irrigation. What solution should you try first?

The best answer is **D. Raise the outside span of nozzles above the canopy** because a larger wetted radius occurs when sprinklers are raised above the corn canopy. A larger wetted radius reduces peak application rates that may be exceeding the soil infiltration rate. Both A and B (Speed the system up by reducing cycle time or slow the system down by increasing cycle time) are sometimes attempted by irrigators but are incorrect. Increasing or decreasing the center pivot sprinkler speed DOES NOT affect the peak application rate (Figure 1). It only changes the duration of the application period. Increasing the system speed may reduce the total amount of runoff, but will not eliminate runoff. Increasing the system speed will increase the ratio of evaporative losses to applied irrigation, thus lowering application efficiency. Long slow center pivot sprinkler cycles have been promoted by some consultants as a way to promote soil cracking which could be a positive influence on infiltration. However, this increases the duration and resulting total amount of runoff (Figure 1) Answer C (Accept some runoff while reducing evaporation losses) is accepting defeat. Runoff losses can easily be larger than the evaporation savings the irrigator is trying to gain. For further discussion of this topic, check out the reference Kranz et al. (1991) or point your Internet browser to http://www.ianr.unl.edu/pubs/irrigation/g1043.htm

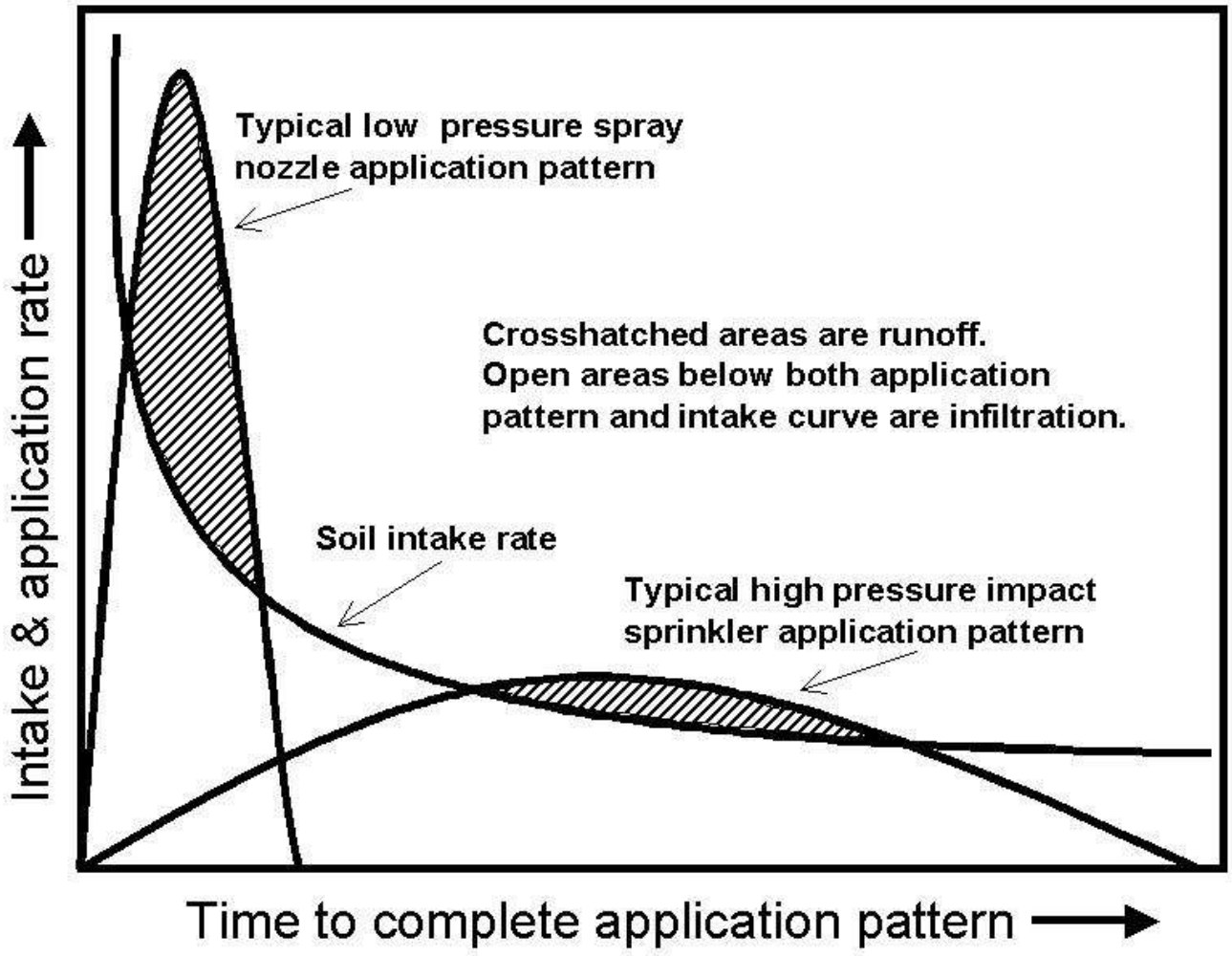

Figure 1. Typical soil intake and sprinkler application patterns as related to time to complete the whole application pattern. Note: Increasing or decreasing the center pivot sprinkler travel speed would not change the peak application rate for either sprinkler type. Thus runoff would likely still occur. Increasing or decreasing the travel speed would change the duration of the pattern and thus would decrease or increase the total amount of runoff.

Question 5. Which of the following is the most effective in-canopy management scheme?

The most effective scheme is **B (Plant corn in circular rows and space nozzles at twice the row spacing)** because it allows water to be applied relatively uniformly to the cropped area and reduces the potential for runoff. Straight planted corn rows will distort the pattern severely when corn rows are parallel to center pivot sprinkler travel. Nearly all the center pivot sprinkler capacity will be applied to a few irrigation furrows when the corn rows are perpendicular to sprinkler travel direction. (Lamm, 1998) Nozzles at twice the row spacing still allow plants equal opportunity for the irrigation water. Answer A (Space nozzles 10 ft apart at a height of 4 ft.) is incorrect because K-State research (Lamm, 1997) has shown 4 ft. to be the worst height because of the large ear and leaf mass at this location. Answer C (Replace nozzles annually) is generally not required every year. Nozzle wear is most often associated with heavy pumping of sand. Answer D (Use short duration cycles later in the crop season) is incorrect because earlier in the season is generally the time period shorter duration cycles are utilized to firm wheel tracks.

Question 6. The father of LEPA is considered to be

The correct answer is **B. William Lyle.** Bill Lyle, agricultural engineer from Texas A& M University is considered to be the Father of LEPA sprinkler irrigation. For a good discussion of the LEPA concept, check out the reference, New and Fipps (1990) or point your internet browser to http://agpublications.tamu.edu/pubs/eengine/b1691.pdf.

Question 7. In deficit irrigation situations, a lower value of application uniformity is of more importance.

The correct answer is **B. False.** In some cases, where irrigation is limited, a lower value of uniformity can be acceptable (von Bernuth, 1983). For example, if the maximum water application amount still falls upon the upward sloping line of the yield production function, a crop area deficient of water will be compensated for by an area receiving a larger amount of water (Figure 2). The example of nonuniform deficit irrigation has the same average application amount as the uniform irrigation amount. Overall, production under the two systems would be identical because the production function is linear over the range of water applications.

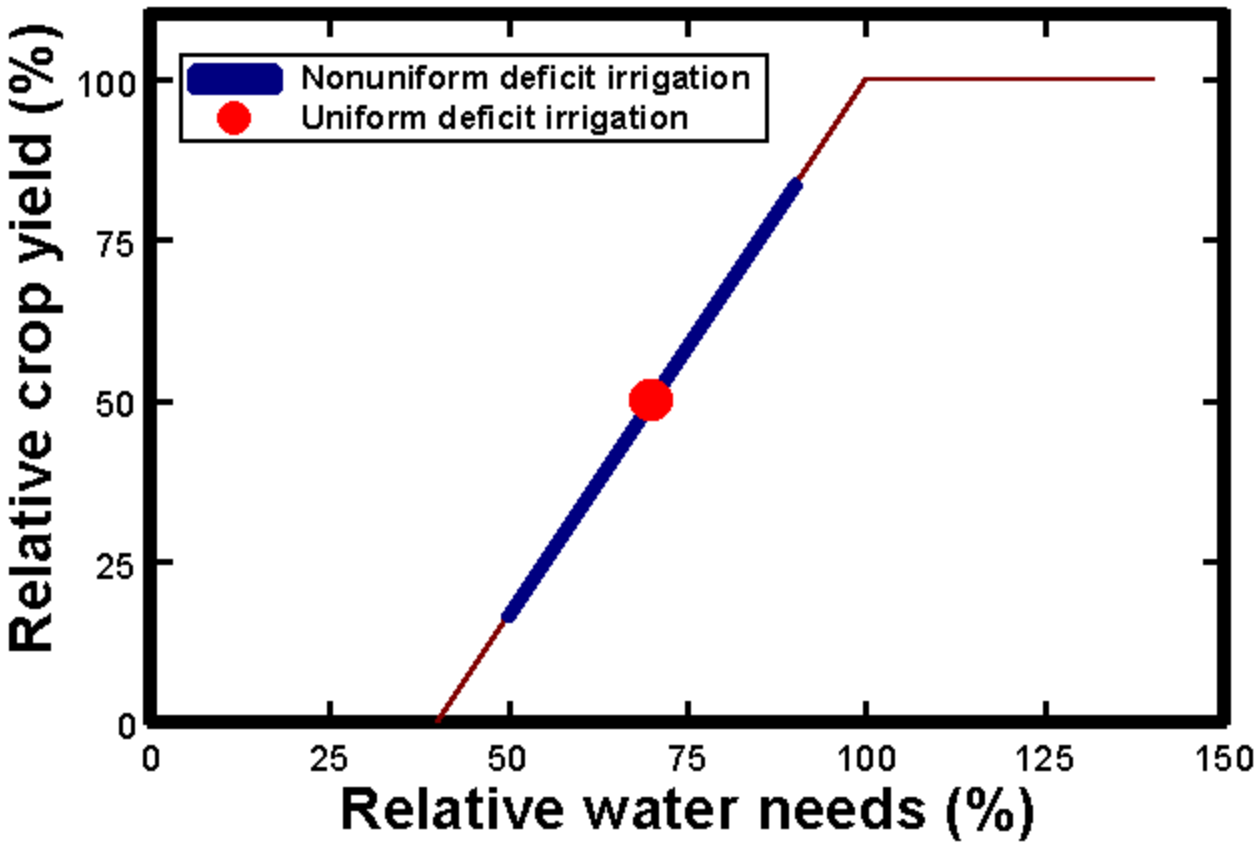

Figure 2. Hypothetical relationship of relative crop yield and relative water needs for nonuniform deficit irrigation (bold range bar) and for uniform deficit irrigation (large dot). Average relative water need is the same for both irrigation schemes, and, consequently, the average relative yield would also be the same.

Question 8. K-State research has shown in-canopy irrigation can

The correct answer is **D. Reduce corn yields when nozzle spacing is 10 ft.** In 1997, corn yields for rows halfway between 10-ft spaced nozzles were reduced as much as 40 bu./acre as compared to corn rows next to the nozzle (Figure 3).

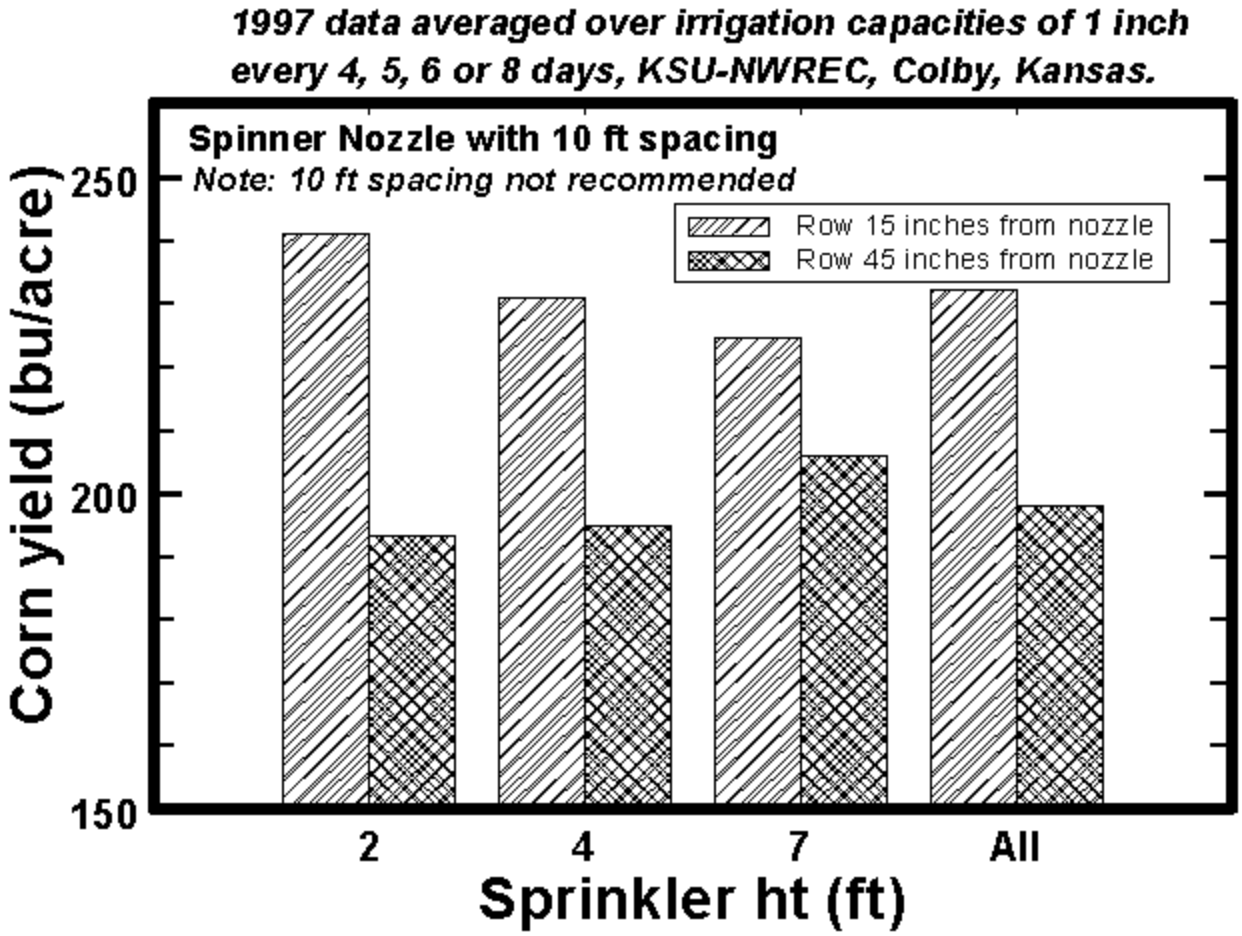

FIGURE 3. Row-to-row variation in corn yields as affected by sprinkler height when in-canopy sprinklers are too widely spaced at 10 ft. Note: Field average yield for a particular sprinkler height would be the average of the two side-by-side bars rather than the higher yield that could be obtained with properly spaced in-canopy sprinklers.

Answer A (Result in 50% water savings when compared to above-canopy irrigation) is incorrect. Savings in the 5-15% are more realistically possible. Answer B (Help improve soil structure due to less crusting) is incorrect because the typically higher peak application rates associated with in-canopy irrigation would tend to degrade the soil surface, leading to more soil crusting. Answer C (Help reduce nitrogen costs) is incorrect. Nitrogen fertigation has been successfully used with LEPA

fertigation in some K-State research, but there isn't evidence at the present time indicating it would be more efficient than traditional sprinkler irrigation methods.

Question 9. Which of the following is not a guiding principle of LEPA sprinkler irrigation?

The correct answer is **A. Pressure at the end tower must be less than 20 psi.** It is not a guiding principle, because the pressure should be less than 10 psi. Answers B, C, and D (Be capable of conveying and discharging water into a single crop furrow, each plant has equal opportunity for irrigation water, result in zero runoff from irrigation water application point) are all guiding principles (Lyle, 1992).

Question 10. K-State research has found in-canopy spray pattern distortion to be affected by

The correct answer is **D. All of the above which included crop row orientation with respect to center pivot sprinkler travel, time of the irrigation season and height of the nozzles.** Circular crop rows which result in sprinkler nozzles traveling parallel to corn rows will result in less distortion of the spray pattern. Spray patterns for widely spaced spray nozzles at a two ft. height are distorted for approximately 60 days, while spray nozzles just below the truss rod are distorted for only about 30 days. This difference in time periods for the different heights can ultimately reduce corn yields for rows furthest from the spray nozzle (Lamm, 1998). This is also noted in Figure 3 where the yield reduction effect for distant rows was greater for the lower heights.

Question 11. Which of the following are true about stemflow, the amount of water reaching the soil by flowing down the stem?

The correct answer is **D. Both B and C: Is the predominate flow path for a fully developed corn canopy and Increases with decreased plant spacing.** Although most people would think that water falling through the plant leaves would be the primary way water reaches the soil, the fully developed corn plant is actually a very good funnel and channels the water along the stem. Higher plant population results in more "funnels." At a typical irrigated corn plant spacing of 7.9 inches, stemflow accounts for 53% of the water reaching the soil after tasseling when being irrigated near the top or above the

corn canopy (Lamm, 1990). This flow mechanism conceivably could affect application of crop amendments when using the center pivot sprinkler.

Question 12. K-State promotes use of in-canopy sprinkler irrigation

The correct answer is **C. When properly designed and managed.** Answer A (For all corn production systems due to high corn water use) is incorrect because sometimes runoff on tight soils and/or sloping ground can easily exceed any possible evaporation savings. Answer B (On all sandy soils but less frequently on silt loam soils) is incorrect because system flowrates, which are higher on sandy soils to meet peak water needs, may exacerbate runoff problems.

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