KS652.0505 State Supplement–Selecting an Irrigation Method

(a) General information

This section contains additional technical information that is necessary for informed planning decisions when trying to decide on the appropriate type of irrigation system. The user's irrigation management objectives need to be incorporated into this decision. A methodology was developed by the Natural Resources Conservation Service (NRCS) to help compare different types of irrigation systems as well as using different management practices. The Farm Irrigation Rating Index (FIRI) provides a uniform and objective evaluation method for planning irrigation water conservation. It also provides good documentation of the effects of improvements in irrigation management practices and system changes. It is important to understand that FIRI analyzes **seasonal** irrigation efficiencies. These are not the same as potential efficiency for a particular system for a single irrigation. Seasonal efficiencies take into account scheduling, water measurement, irrigator skill, and other factors that will impact irrigation water use efficiency over an entire irrigation season. FIRI was the result of a western United States water conservation emphasis program during the 1980s. The development of that program was documented in the publication entitled "Farm Irrigation Rating Index (FIRI), A Method for Planning, Evaluating, and Improving Irrigation Management" (USDA, Soil Conservation Service, West National Technical Service Center, Portland Oregon, June 1991).

A DOS computer program was written to assist with the use of FIRI. That was replaced with a Windows-based program (FIRI Version 1.2, September 28, 2006). These programs have been used by NRCS and others for a number of years. A spreadsheet version of the program (FIRI 2014.1) has also been developed by NRCS to improve portability and simplify operation of the program. Kansas NRCS has modified the spreadsheet for use by conservation planners in Kansas. See the Field Office Technical Guide (FOTG), 449, Irrigation Water Management, Work Sheet—FIRI Spreadsheet.

This link is to an example in the FIRI Spreadsheet that compares a current irrigation system (present or benchmark condition) to either a proposed new irrigation system or an upgrade to the current system or management style (planned condition). The type of irrigation system is picked from a drop-down list which sets the base FIRI rating. Selections are then made from the Operation Management Factors and the Irrigation System Factors categories to reflect the operation and hardware of the irrigation system. These factors contribute to a rating given to each irrigation system scenario, and these ratings can be compared to see the effects of changes to one or more categories.

Each type of irrigation system was given a rating value based on the efficiency in the distribution and application of irrigation water. These initial rating values along with the irrigation systems are shown in Table KS5-1.

With this information, a rating can be obtained to show relative changes from one irrigation system type to another, as well as changes that are made to each of the management concerns. Some combinations of management alternatives are not possible because not every management alternative is appropriate for a given irrigation system type.

To complete the FIRI Spreadsheet, enter the information at the top of the sheet. In the System/Field description box, describe the current irrigation system and describe the proposed changes to the current system or the planned new irrigation system. For the net irrigation requirement (NIR), use the 80% chance NIR for the typical crop grown in the field (Table KS4-1). In a deficit irrigation situation where there is less water available than needed for full irrigation, the average amount applied during the year should be used.

Table KS5-1 Irrigation system type

Irrigation System Type	Initial Rating
Border–border ditch	60
Border–contour level, field ditch	70
Border–contour level, rice	80
Border–contour level, rice with side inlets	85
Border–graded border	80
Border–guide	70
Border–level or basin	90
Furrow–contour furrow	75
Furrow–corrugations	75
Furrow–graded furrow	75
Furrow–level or basin	90
Furrow–surge	80
Flood–contour ditch	60
Flood–controlled	60
Flood–uncontrolled	50
Subirrigation–subirrigated	75
Sprinkler–big gun or boom	60
Sprinkler–hand line or wheel line	70
Sprinkler–solid set (above canopy)	75
Sprinkler–solid set (below canopy)	80
Center Pivot	80
Center Pivot–Low Elevation Spray Application (LESA)	89
Center Pivot–Low Energy Precision Application (LEPA)	92
Center Pivot–low pressure improved	83
Center Pivot–Low Pressure In Canopy (LPIC)	87
Center Pivot–Mid Elevation Spray Application (MESA)	85
Center Pivot–Variable Rate Irrigation (VRI)	87
Lateral Move	82
Lateral Move–improved using LEPA, LESA, LPIC, MESA, or VRI	87
Microirrigation–continuous tape	90
Microirrigation–point source	90
Microirrigation–sprays	85
Microirrigation–Subsurface Drip Irrigation (SDI)	92

Clicking on the highlighted cells under either the Present Condition or the Planned Condition will reveal a drop-down box. Click on the down arrow to show the list of choices for that cell location. Selecting one of the choices from the list will place a Rating Factor into the adjoining cell.

To access the Present Condition FIRI rating, start by selecting the current irrigation system or method being used to irrigate the crop.

Proceed to the Operation Management Factors section and, by using the drop-down box, select the appropriate description from the list of choices. Do this for each category. More information on these factors is presented below. Client interviews and on-site investigations should be adequate to determine which factor to select.

Proceed to the Irrigation System Factors section and, by using the drop-down box, select the appropriate description from the list of choices. Do this for each category. More information on these factors is presented below. Review the water source, delivery system, field slope, climate information, and irrigation system on-site to arrive at the best description for each item. The Improved Conveyance System category also requires that the length of the ditch be known, as well as the soil type along the location of the ditch.

The overall rating for the Present Condition will be displayed at the bottom of the column.

To obtain the Planned Condition overall rating, follow the same procedure as was used in the Present Condition to determine a rating for the new or improved irrigation system. Several possibilities for different alternatives can be analyzed and compared to the existing system.

The rating for the Planned Condition(s) will be displayed at the bottom of the column.

The Operation Management and Irrigation System Factors will usually be better for the Planned Condition, but in some rare cases, they could be worse. Any factor that scores lower in a planned alternative compared to the existing condition should be examined. A mitigating practice may be warranted to counteract any negative effects from a planned alternative.

The difference in the FIRI rating going from the Present Condition to the Planned Condition is shown at the bottom of the sheet.

Also, the amount of potentially conserved water is shown at the bottom of the sheet. This is the difference in the gross irrigation amount between the Present Condition and the Planned Condition with the percentage of Water Conserved based on the Present Condition.

(1) Operation management factors

Each of the Operation Management Factors is discussed below. Additional information is shown on the Factors tab of the FIRI spreadsheet. Many of the cells showing the choices for the various categories display comments when the cursor is hovered over the cell with the red arrow.

(i) Improved water measurement—Water measurement is a critical component of any well planned and managed irrigation system. Knowing how much water is delivered to a farm, field, or irrigation set is critical for efficient use of water. There are a variety of methods to measure water. Weirs, orifices, flumes, and propeller meters are just a few of these methods. Check to see where and how the water is measured. Having a single measured water source providing water to 1 field is the best scenario. Water measured at the delivery point to the farm scores lower as it could make it difficult to track the amount of water delivered to an individual field. Check to see if there is a way to record the total volume of water delivered to the field automatically (for example, propeller meter totalizer), or is the water flow measured manually and the total volume estimated using hours of flow? Pick the option that best fits the water measurement efforts

currently taking place or in one of the planned alternatives.

(ii) Improved soil moisture monitoring and irrigation scheduling—Knowing when to irrigate and how much water to apply is very important in managing an irrigation system. The selections available under this category range from no scheduling of any kind to continuous monitoring of soil moisture, water applied, and evapotranspiration (ET) amounts via electronic sensors. Most irrigators are usually between these two endpoints. Pick the method that best describes the irrigator's moisture monitoring and irrigation scheduling.

(iii) Irrigation skill and action—Having the necessary information does not mean the irrigator follows the recommendations for the irrigation timing and amount. The factor selected in this category is the planner's best professional judgment after talking with the irrigator and reviewing management records.

(iv) Maintenance factor—Similar to the Irrigation Skill and Action category described above, the Maintenance factor should be selected using the planner's best professional judgment after talking with the irrigator and reviewing management records.

(v) Water delivery—The availability of water timing and quantity is very important in managing the irrigation system. If water is delivered by an irrigation district using canals and pipelines, the water may be available on a rotational basis, and the crop may get water on a fixed interval which limits management practices. Other irrigation entities may provide water available at any time, but the amount may be restricted. The irrigator may have an on-site supply—whether it is a well or a reservoir—and these other supplies could be available on demand with a limited or unrestricted amount of water.

(vi) Improved soil condition index (SCI)—SCI predicts the consequences of cropping management systems on soil organic matter. Although the SCI is used as an input directly from the Revised Universal Soil Loss Equation (RUSLE) 2, it can be estimated for use here. There are three parts of the SCI: site information (location and soils), management information (cropping systems and tillage operations), and organic matter (annual residue or manure). It is reasonable to expect that a higher SCI will result in conserving soil moisture, increasing infiltration, and reducing runoff. Soil with higher organic matter and good soil tilth will have a higher SCI. No-till fields will have higher indexes than fields tilled many times. In some instances, a high SCI is not possible because of the tillage needs for efficient water application—especially in furrow irrigation systems.

(2) Irrigation system factors

Each of the irrigation system factors is discussed below. Additional information is available in the comments on the Factors tab in the FIRI Spreadsheet.

(i) Improved distribution system—This category recognizes the ability of the irrigator to manage, direct, and control the water flow stream onto the farm, across the farm to one or more fields, and to multiple irrigation sets across the farm or field. The better the control, the higher the irrigation rating factor. For example, using a center pivot sprinkler (which is 1 set per field) and water from a local well via pipeline will have the highest factor.

(ii) Improved conveyance system—Fewer losses during the conveyance of irrigation water provide for higher system efficiency. This category recognizes the condition of the conveyance system which conveys the water from the source—whether off-farm or on-farm—to the field. In Kansas, most irrigation water is conveyed using a closed conduit pipeline—although there are a few irrigation districts that use earthen canals and ditches. Concrete or clay-lined ditches will have less

seepage than ditches constructed in sandy soils with no lining.

(iii) Improved land leveling—Most surface-irrigated fields in Kansas have been leveled to a uniform slope. Uniform slope provides for more efficient application of water—mostly due to consistent advance and recede times between furrows or borders. Proper length of runs for slope and soil type also can increase efficiencies. Precision-leveled fields have higher efficiency potential and are easier to manage then less controlled grades and slopes. Laser- or Global Positioning System (GPS)-controlled leveling equipment is used to construct precision-leveled fields.

Some tillage operations, when carried out year-after-year, can move enough soil to decrease the uniformity of slope in a field. Evaluate the impact of operation and maintenance on precision leveling while conducting interviews with the irrigator and by visual inspection or survey of the field. In some instances, reconstruction of the precision leveling may be warranted.

(iv) Adding tailwater recovery with and without irrigation storage reservoirs—Runoff from irrigated fields may be captured and reused, and its impact is evaluated under this factor. If tailwater is not captured, select zero. If tailwater is collected, estimate the percentage of the gross irrigation volume captured as tailwater following an irrigation event. Use professional judgment and irrigator interviews to estimate the percentage of tailwater captured. This factor does not include capture of rainfall runoff—only irrigation amounts. The factors on the list are for water that is reused at 50% application efficiency. Higher application efficiencies will have higher factors. Sprinkler and microirrigation systems should have zero runoff if properly designed. However, if they have runoff that is reused, recalculate the reuse at the appropriate application efficiency percentage.

(v) Climatic factor—This factor accounts for climate impacts on overall irrigation efficiency, particularly evaporation. ET from the crop is an input variable to this factor. Peak ET can be estimated as 0.30 inch per day in eastern Kansas and 0.45 inch per day in western Kansas. Alternately, ET can be calculated using an NRCS-approved program that estimates the peak average ET for a particular crop and location. The climate affects the evaporation from the ground and the plants being grown. In Kansas, evaluate this factor only on sprinkler and spray microirrigation systems (center pivot LEPA excluded).

(vi) Wind factor—The wind speed and sprinkler water droplet size have an effect on the amount of evaporation and the movement of water off the target area. The higher the average wind speed and the smaller the droplet size, the lower the factor is. Evaluate this factor using the average wind speed for the growing season. Because the stage of crop growth impacts evaporation rates, consider the dominant vegetative condition for the year when evaluating this factor. In Kansas, evaluate this factor on sprinkler and spray microirrigation systems (center pivot LEPA excluded).

(vii) Sprinkler factor—This factor evaluates the impact on uniformity caused by pressure variation across the sprinkler system, the impact this pressure variation has on uniformity of the flow from the sprinklers, and the sprinkler application rate versus the intake rate of the soil. The more uniform the sprinkler output, the better is the chance of not under-irrigating or over-irrigating the crop. Keeping the application rate less than the intake rate minimizes surface runoff. In Kansas, evaluate this factor only for sprinkler irrigation systems.

(viii) Emitter clogging factor—This factor evaluates the susceptibility of the microirrigation outlets to clogging. Since measuring clogged emitters is difficult, outlet size and filtration effort are used as a substitute. The larger the outlet and the greater the amount of filtering, the lesser the chances are of clogging. Other items

to keep in mind are the temperature of the water and the flushing frequency. The different scenarios describing various factors in emitter clogging have subtle differences. Use careful judgment to select the scenario that fits best the microirrigation system under investigation.

***(ix) Trickle design factor*—**This factor evaluates the impact of the relationship between pressure, flow, type of emitter, and the variability in emitter manufacturing (coefficient of variability [CV]). The CV depends on the manufacturing process and should be provided by the manufacturer. Sloping fields can cause differences in pressure and thus differences in flow unless the emitters are made to compensate for those pressure differences. Point source emitters usually have less variation than lateral line emitters. For Kansas, consider pressure-compensating emitters as being **low** in flow variability; non-compensating, point-source emitters as **average**; and non-compensating, long-path emitters as **high**.

FIRI will evaluate many possible combinations of irrigation systems, management factors, and irrigation system factors. The FIRI spreadsheet can compare these different combinations very quickly. The example in the FIRI Spreadsheet shows just one of the many possible combinations for both the present and planned condition.