Annual Assessment Report for 2020-2021 AY

Reports completed on assessment activities carried out during the 2020-2021 AY will be due September 30th 2021 and must be e-mailed to the Director of Assessment, Dr. Douglas Fraleigh (douglasf@csufresno.edu).

Provide detailed responses for each of the following questions within this word document. Please do NOT insert an index or add formatting. Furthermore, only report on two or three student learning outcomes even if your external accreditor requires you to evaluate four or more outcomes each year. Also be sure to explain or omit specialized or discipline-specific terms.

Department/Program: ___Plant Science_____ Degree ___B.S.__

Assessment Coordinator: _____Florence Cassel S. _____

UG Assessment Committee:____Florence Cassel S., Dave Goorahoo, Margaret Ellis_____

1. **Please list the learning outcomes you assessed this year.**

   - SLO 1.2 – Students will have the ability to define and assess the physical, chemical and biological environments for optimal agricultural productivity.
   - SLO 2.1 – Students will be able to make management decisions incorporating ethical and professional standards.
   - SLO 2.2 - Students will have the quantitative skills to perform calculations related to agronomic, pest management and cultural practices necessary for optimizing crop production.
   - SLO 2.3 – Students will have the ability to communicate in written and oral formats appropriate to agricultural professionals and the general public.

2. **What assignment or survey did you use to assess the outcomes and what method (criteria or rubric) did you use to evaluate the assignment? Please describe the assignment and the criteria or rubric used to evaluate the assignment in detail and, if possible, include copies of the assignment and criteria/rubric at the end of this report.**

The PLANT 174 (Soil and Water Management) Irrigation Scheduling Final Project was selected to assess the above mentioned SLOs. The complete guideline given to students to complete this final project is shown in Attachment 1. In summary, the primary purpose of the final project was to determine the students' ability and skills to develop an irrigation scheduling management plan for annual and perennial crops using data from publicly available sources, and to perform calculations of water requirements and irrigation applications. The final project was designed as if students were managers at a consulting firm and were providing their services to a grower.

Therefore, in addition to irrigation schedules, students were asked to make management decisions, formulate recommendations based on the data they generated, and communicate their work in a written report that could be provided to a grower.

The final project was designed as a three-step progression to ensure students were provided with the necessary resources to perform the assignment and were given timely feedback for improvement. The first step consisted of a series of lectures during which the instructor provided a list of resources (publications, softwares, online databases) that students could utilize to obtain their input data on crops, soils, and weather parameters. During that time, the instructor also trained students on the use of different softwares, databases, as well as Excel. As part of the second step, students were given two assignments towards the middle of the semester to perform irrigation calculations and develop a scheduling model (Attachment 2), as well as to research the crop, soil, and climatic input parameters that would serve as the basis for their final project (Attachment 3). The goal of these assignments were to ensure that students: a) could perform correct calculations, b) started working on the data collection for their final project early, and c) were provided with feedback from the instructor regarding reliability of information, accuracy, and decision-making process. After completion of this assignment (with revisions based on feedback), students initiated the second part of their final project which consisted in performing calculations of crop water requirements and irrigation schedules, and formulating recommendations for growers. Students were then required to compile an "Irrigation Scheduling Final Report" that included a detailed analysis of all their irrigation schedules and recommendations, along with excel spreadsheets, graphs, tables, and references.

Upon successful completion of the final project and report, the students would have developed the ability and skills to:

- Identify and collect appropriate data/information from published and online sources.
- Effectively consider and assess physical and biological constraints related to irrigation water management.
- Perform calculations to develop irrigation schedules for various crops, soils, and irrigation systems.
- Create graphs and tables, and interpret results obtained from the above calculations.
- Provide sound management recommendations for optimizing irrigation scheduling and crop production based on calculations and interpretation of results.
- Effectively communicate the project, results, and recommendations in a written format consistent with professional agricultural services.

The rubrics used to assess the four outcomes are presented in Attachment 4. For each outcome, we expected that **80% of the students achieve a score of 3 or higher on the rubric**, indicating their proficiency in the learning outcome being assessed. The final reports used in the evaluation were reviewed by the three members of the Plant Science Undergraduate Assessment Committee- Drs. Florence Cassel S, Dave Goorahoo and Margaret Ellis. In order to derive more meaningful and statistically sound interpretations, the committee reviewed the final reports of students enrolled in the PLANT 174 (Soil and Water Management) course over two semesters. As help with the

review, the two assignments given by the instructor during the semester to prepare students were also provided to the committee (Attachments 2 and 3).

3. **What did you learn from your analysis of the data? Please include sample size (how many students were evaluated) and indicate how many students (number or percentage instead of a median or mean) were designated as proficient.**

PLANT 174 is an upper division elective for students expected to be employed in the agricultural sector. Hence, the UG assessment coordinators strongly believe it is critical that at least **80% of the students perform at or above proficiency level (score of 3 or higher on rubrics)** for all four learning outcomes. The assessment was performed on the twenty-seven students enrolled in the course over two semesters who submitted a final report. One student was not included in our analyses as he was unable to complete the final report and received an incomplete in the course. The summary of all scores is provided in Table 1 below.

Table 1. Proficiency distribution scores for all learning outcomes[§]

SLO	% of students meeting the standards (at or above benchmark)	Unsatisfactory (1)	Partially proficient (Below benchmark) (2)	Proficient - Meets Standard (benchmark) (3)	Exceeds standards (Above benchmark) (4)
1.2	93%	0%	7% (2)	41% (11)	52% (14)
2.1	82%	0%	18% (5)	30% (8)	52% (14)
2.2[#]	77%	0%	23% (5)	41% (9)	36% (8)
2.3	81%	0%	19% (5)	33% (9)	48% (13)

[§]Numbers show percentages of students achieving a certain proficiency level along with number of students in parenthesis.
[#]In 2020, some students did not submit the portion of the final report that covers SLO 2.2; therefore assessment did not include those students.

SLO 1.2 – Students will have the ability to define and assess the physical, chemical and biological environments for optimal agricultural productivity.

Evaluation of the final reports indicated that almost all students (93%, i.e., twenty-five out of 27 students) met or exceeded the proficiency level for outcome 1.2. Only two students (7%) did not achieve the standard required to "*define and assess the physical, chemical and biological environments for optimal agricultural productivity"*. Therefore, the vast majority of students were able to identify and integrate the relevant information (soil, crop, climatic parameters) required to develop an irrigation scheduling management plan. They collected accurate and current data from reliable online sources and published documents. Students were also able to effectively consider and assess the physical and biological factors that affect efficient irrigation management. The students who exceeded the standards for this outcome (52%) provided a thorough description of their data collection strategies, taking into account the physical and biological factors affecting

their cropping systems. The only two students who performed below the benchmark omitted to consider important data or did not describe them in their final reports. None of the students used inaccurate data or unreliable sources. The high level of proficiency observed for this outcome was mostly the result of the lectures and the mid-term assignment (see Appendix 3 – Assignment 3) that prepared students for data identification, collection, database searches, and constraint integration. It also underlines the importance of instructor feedback.

SLO 2.1 – Students will be able to make management decisions incorporating ethical and professional standards.

Evaluation of student work revealed that twenty-two out of 27 students (82%) met or exceeded the proficiency level for outcome 2.1. Specifically, 30% (8 students) met the benchmark and 52% (14 students) exceeded it. Overall, students showed a high level of proficiency in making appropriate management decisions and in providing sound and professional recommendations regarding irrigation scheduling. More than half of the students made decisions and recommendations that integrated and synthesized most of the materials covered during the semester. None of the students made inaccurate decisions or recommendations. However, five students (18%) did not elaborate the reasoning behind their decision making or provided limited professional recommendations, resulting in a score of 2 on the rubric.

SLO 2.2 - Students will have the quantitative skills to perform calculations related to agronomic, pest management and cultural practices necessary for optimizing crop production.

This outcome assessment was conducted on twenty-three final reports as four students did not submit the quantitative component of their assignment in Canvas (spreadsheets with calculations). The four students were enrolled in Fall 2020 when all courses were virtual and all assignments had to be uploaded in Canvas. Given that the spreadsheets were missing for our review, it might be a misrepresentation to include an Unsatisfactory score in our analyses; our interpretation on this particular outcome could have been skewed.

The analysis conducted on this outcome showed that 77% of the students (17 out of 22) performed at or above the proficiency level expected for quantitative skills in our major. These students were able to follow the computation steps required to develop an industry-standard irrigation scheduling plan. They included all the crop, soil, and climatic variables necessary to perform irrigation calculations. They were also proficient in the use of spreadsheets, such as Excel, to create irrigation schedules for an entire growing season. The students who exceeded the proficiency benchmark for this outcome (36%) were able to enter complex formulas in Excel and develop an accurate scheduling model. They also provided relevant graphs and derived informed interpretation of their results. Students (41%) who received a 3 on the rubric scale made some minor errors with their calculations in Excel, and were not as thorough in their result interpretations.

The above-mentioned 77% percentage is slightly below our target of 80% proficiency among PLANT 174 students. However, it is worth noting that, over two semesters, only five students out of 23 had difficulties performing the quantitative component of the final project and scored below the benchmark (score of 2 on the rubric). Evaluation of the spreadsheets revealed that these students made a number of errors in their calculations; they either did not enter some of the formulas correctly or omitted to consider the temporal variability of some input data. In general, they also provided a basic or incomplete interpretation of their results.

SLO 2.3 – Students will have the ability to communicate in written and oral formats appropriate to agricultural professionals and the general public

Evaluation of the final reports revealed that twenty-two out of 27 students (81%) met or exceeded the proficiency level for outcome 2.3. Specifically, 33% (9 students) met the benchmark and 48% (13 students) exceeded it. Overall, students showed a good proficiency at communicating their irrigation management plan in a format that follows professional standards. Almost half of the students provided a thorough and well organized final report in which they described cropping systems selected, data collected, results of irrigation schedules, management decisions, and recommendations that integrated and synthesized the concepts covered during the semester. None of the students submitted a poor report with limited content. However, five students (19%) did not follow the recommended formatting and submitted a poorly organized or written report, resulting in a score of 2 on the rubric.

Overall, most PLANT 174 students performed at or above expected proficiency levels for the various SLOs assessed. The data analyses indicated that students in this upper-division course were able to:
1) Identify, collect and integrate physical and biological data related to soil water management, considering environmental and economic constraints (SLO 1.2),
2) Perform accurate irrigation scheduling calculations, create graphs and tables, and use Excel spreadsheets by the end of the semester (SLO 2.2),
3) Make informed management decisions and formulate recommendations based on results derived from calculations (SLO 2.1), and
4) Communicate their findings in an acceptable professional format (SLO 2.3).

In summary, our assessment revealed that most students had a good knowledge of irrigation scheduling and exhibited the problem solving, quantitative, management, and communication skills required of Plant Science graduates. The proficiency levels were also the results of a semester-long preparation during which students were guided through the various steps of the final project. The feedback provided by the instructor on the mid-term assignments seems to have been very beneficial to students and helped them reach a good level of proficiency in the learning outcomes assessed this academic year. Our findings reinforces the effectiveness of such approach for student improvement.

Finally, our assessment analysis also shows that a few students struggled with the more advanced irrigation scheduling calculations and had difficulties entering formulas in Excel. We also found that improvement could be made in written communication and in explaining management decisions and recommendations.

4. **What changes, if any, do you recommend based on the assessment data?**

Based on the data derived from our assessment analysis, we recommend the following:

SLO 1.2 - Provide more explicit guidelines on integration and reporting of data. In general, the students identified the correct data for their irrigation scheduling project and used reliable sources, but they sometimes failed to report and describe the interdependence of the physical and biological parameters affecting soil water management.

SLO 2.1 - Provide more explicit guidelines regarding the expectations on management decisions and recommendations. We advise adding a section or revising the instructions of the final report so students describe the decision making process they follow to develop their irrigation scheduling plan.

SLO 2.2 - Since students had most difficulties with the quantitative component of the final project, we suggest more lecture time be dedicated to review the complex calculations and the use of formulas in Excel.

SLO 2.3 - Overall, a wide variety of reports were submitted in terms of formatting, organization, writing skills, and content. Therefore, we recommend to revise the final report guidelines and add a section that better describes the expected formatting and required content. We also suggest the instructor provides students with a final report template and discusses appropriate reporting formats. Also it might help if students provide an outline of their report before submitting it.

5. **If you recommended any changes in your response to Question 4 in last year's assessment report, what progress have you made in implementing these changes? If you did not recommend making any changes in last year's report please write N/A as your answer to this question.**

N/A – A different learning outcome was assessed last year.

6. **What assessment activities will you be conducting during the next academic year?**

We are in the process of revising the SLOs listed in our SOAP and will determine the assessment activities for the next academic year after revisions are finalized.

7. **Identify and discuss any major issues identified during your last Program Review and in what ways these issues have or have not been addressed.**

Our undergraduate curriculum was revised two years ago. This revision was a direct response to the recommendations made in the department's most recent program review, considerable faculty input, survey of similar Plant Science undergraduate degrees nationwide, and industry needs for a trained and modernized workforce in Plant Science. The revised curriculum provides a better "...balance between science theory and practical experience" and a more direct path to degree completion.

Key changes to the curriculum include:

- Combining the Crop Production Management option and Plant Health Option into one Plant Science degree;
- Addition of a Crop Nutrition course in the major requirements;
- Reintroduction of Plant Propagation into the major requirements;
- Removal of the 2- prefix limit for electives;
- Unifying the course prefixes to either PLANT or MEAG;
- lntegrating the Chancellor's office mandates for General Education courses;
- Addition of MATH 11 for B4 GE and as a prerequisite for PLANT 99;
- Removal of BIOL 10 as a required prerequisite.

Attachment 1

PLANT 174 Soil and Water Management
Irrigation Scheduling Project
Final Report (100 points)

The final report of your scheduling project will be a major portion of your final grade and is due on December 10 (You are encouraged to finish and turn it in earlier).

A. Irrigation scheduling project goals

The irrigation scheduling project will consist of establishing a schedule of irrigation events for four crops of your choice grown on different soil types.

The final report should be written as though you were the executive water management specialist for Bulldog Agricultural Services and you had a new client in the area of your CIMIS station. That new client wants to grow four crops in different soils in fields of 100 acres each. You will have at least one permanent (tree/vine) crop and at least one annual crop. Different varieties can count as different crops as long as the dates and Kc's are different. At least two different soil types must be selected. Pick a soil that would be appropriate for each of the crops you choose. You should identify the fields by soil, and crop (e.g. peaches on the Hanford sandy loam field). You may select to grow any crop in the four fields however you wish, but some crops will be more suited to some soils than others. Prepare the proposal to the new client as though you and the client have decided on the crops and fields but he is depending upon you to determine the basic irrigation schedule and the factors needed to design the system. He owns 25,000 acres in the area and is looking for a consulting service to manage all his irrigated land. This 400 acre project is a try-out to see how well you perform. You need to impress him with your knowledge and enthusiasm for the project so that he will sign you to a contract.

As an option, your new client can be the CSUF University Agricultural Laboratory, in which case you would select crops grown on the CSUF farm. You will still need to select two different soil types and at least one permanent crop and one annual crop. If you are currently conducting research on the farm, are growing one or several crops, and have had to schedule or manage irrigation applications, you can use that experience for your final project.

For any questions on the goal of the project and selection of crops/soils, let me know as soon as possible.

You will need to use resources available online or posted on Canvas (under the folder named "Final project"). We will have one or two lectures dedicated to the final project, during which I will detail all the information you need for the project and where to find that information. In addition, I would encourage you to take advantage of my office hours (after our class) and get started early. If you have classes during my office hours, please contact me to set up a different time to meet.

B. <u>Content and organization of your final report.</u>

The report/proposal should be organized in the following two sections. Please ensure that you provide information asked in both sections.

1. An introduction and summary of the project.

A. An introduction explaining the project and summarizing the results.

B. The soils and crop information explaining why each crop and soil combination was chosen.

C. The irrigation system in each field and why it was chosen. You must use at least two of the three choices for irrigation systems (flood, sprinkler and drip).

2. A detailed analysis of each crop that will include:

A. A table (or graph or both) showing the average ET_o's for your CIMIS station. If you wish, the maximum ET_o's for your area can also be included. You should also add any relevant information about the CIMIS station in this section.

B. A section for each crop/soil combination that includes:

1. The basic soil and crop factors detailed on the pages provided below (attach these four pages as part of your final report). List the dates and Kc's from the reference handouts, and then the changes you made and why you changed or did not change each date or Kc. List the source of the water contents you use for each field and list any soils factors that would be important in selecting the specific crop or parameters like the root zone that you choose for it. Provide the references you used to obtain your soil and crop factors; for example, the USDA Web soil Survey or UC Publications for Kc values.
2. An irrigation scheduling spreadsheet that will follow the templates used in class exercises and assignments. You should develop one spreadsheet for each crop you selected. The spreadsheets should include the historical average ET_o values and precipitations for the locations you selected, soil and crop factors detailed above, MAD values, irrigation amounts and irrigation run times. Select an appropriate irrigation method and application rate; use these levels of precision (flood = whole inch, sprinkler = 0.1 inch, micro-irrigation = 0.05 inch).

C. Summarize the data for each crop/field with comments and recommendations including potential problems and possible improvements. You can find some information in the Soil Web survey for example.

<u>C. Final project grading</u>

The project will be graded using the following criteria:

40% - Proper calculations and appropriate decisions regarding ET and crop factors. This will include using the proper ET values, selecting and modifying the dates and Kc's and justifying each value used in your irrigation schedules.

30% - Proper calculations and appropriate decisions regarding irrigation and soil factors. This will include selecting the appropriate water contents and explaining how you determined them and any soil factors that influenced your selection of the root zone or other soil conditions.

20% - Originality, completeness and creativity with regard to the overall problem. The clarity, comprehensiveness and readability of the report are part of this evaluation. You are encouraged to be creative but remember, this is only 20 points of the total score.

10% - Organization and presentation of the proposal. The overall organization and appearance of the report will be the last 10 points of the total score.

Attachment 2

Assignment 2

50 points

Soil and Water Management (PLANT 174)

Name: _____

PART I – Wateright

Using the WATERIGHT Irrigation scheduling program (www.WATERIGHT.net), create a schedule for the following three situations and provide outputs of your schedules. Calculate total run time and total inches of water applied for each exercise.

Exercise 1 (8 pts)

Create a schedule for a pepper crop:

a. Set Time/Irrigation: Set with 20 hours.
b. Select an appropriate rooting depth.
c. Soil type - Clay loam.
d. Drip Tape - Uniformity of 90%, flow rate of 0.05 GPM/100 ft and spacing of 1 ft.
e. Choose any station in Central California; soil type should match location.

Exercise 2 (8 pts)

Create a schedule for an almond crop:

a. Using 35% Management Allowable Depletion between irrigations.
b. Select an appropriate rooting depth.
c. Soil type - Sandy loam.
d. Drip emitters: 8 emitters per tree, 1 gph per emitter, tree spacing of 20 ft x 22 ft; system uniformity of 85%.
e. Choose any station in Northern California.

Exercise 3 (10 pts)

Create a schedule of your choice using a sprinkler system and the Management Allowable Depletion as the scheduling basis.

PART II – Irrigation scheduling spreadsheet (24 pts)

Complete the irrigation schedule for cherry using the attached excel spreadsheet. Upload in Canvas using the link.

PLANT 174 - Assignment 2 - Part II - due Tuesday, Oct 1st

NAME _____

Soil:
F.C.= 3.2 in/ft
W.P.= 1.2 in/ft
TAW = in

Crop: Cherry
R.Z.= 2.5 ft
Kc = 0.85

Management & irrigation system
MAD = 25%
Sprinkler application rate = 0.16 in/hr

Date	ETo	Kc	ET crop	Available Water		Soil moisture Deficit		Irrigation	Run Time
	in/day		in/day	inches	%	inches	%	inches	Hours
1-Jul	0.32								
2-Jul	0.30								
3-Jul	0.28								
4-Jul	0.26								
5-Jul	0.29								
6-Jul	0.33								
7-Jul	0.35								
8-Jul	0.36								
9-Jul	0.34								
10-Jul	0.32								
11-Jul	0.31								
12-Jul	0.24								
13-Jul	0.26								
14-Jul	0.29								
15-Jul	0.33								
16-Jul	0.36								
17-Jul	0.32								
18-Jul	0.34								
19-Jul	0.35								
20-Jul	0.30								
21-Jul	0.25								
22-Jul	0.24								
23-Jul	0.27								
24-Jul	0.29								
25-Jul	0.31								
26-Jul	0.33								
27-Jul	0.34								
28-Jul	0.31								
29-Jul	0.30								
30-Jul	0.32								
31-Jul	0.30								

Total ETc (inches) =

Total Irrigation Applied (inches) =

Attachment 3

Assignment 3

40 points

Soil and Water Management (PLANT 174)

Name: _____

This assignment constitutes a part of your final Irrigation Scheduling Project. Refer to the handout that describes the components of that project.

For this assignment, please provide the following information that will be the basis of your project:

1. **Selection of parameters**
   - **a)** Select 4 crops (at least one permanent crop and one annual crop – different varieties can count as different crops as long as the dates and Kc's are different)
   - **b)** Select a soil type for each crop (each field should have a different soil type and have the appropriate properties to grow the crop. You should pick two light textured and two medium - heavy textured soils.
   - **c)** Select a location to grow each crop (location and soil type should be consistent) and choose the closest CIMIS station.
   - **d)** Select an irrigation method for each field (select at least two different irrigation methods).

2. **Data collection**
   - **a)** For each crop, determine the growing season and obtain the corresponding Kc values (see attached pages that you will need to complete as part of your final project). Graph the Kc values for each crop throughout the growing season. Also find the changes in the crop rooting depth during the growing season, and justify the MAD percentages you selected.
   - **b)** For each location, obtain the average ETo data from the closest CIMIS station (indicate how you obtain the average data for the corresponding crop growing seasons).
   - **c)** For each soil, obtain or calculate the available water from the Soil Surveys.

Assignment format:

You can fill out the following pages or provide the soil/crop/location information in a table format.

Annual Crop: _____ Soil: _____

CIMIS location: _____ Station number: _____

CROP Factors:

Date A:

Date from reference_____ K_c-1 from reference_____

Modified Date_____ Modified K_c-1 _____

Reasons for changing (or not changing) the date and Kc: _____

_____

Date B:

Date from reference_____ K_c-1 from reference_____

Modified Date_____ Modified K_c-1 _____

Reasons for changing (or not changing) the date and Kc: _____

_____

Date C:

Date from reference_____ K_c-2 from reference_____

Modified Date_____ Modified K_c-2 _____

Reasons for changing (or not changing) the date and Kc: _____

_____

Date E:

Date from reference_____ K_c-3 from reference_____

Modified Date_____ Modified K_c-3 _____

Reasons for changing (or not changing) the date and Kc: _____

_____

MAD_{A-C} _____ % Rationale: _____

MAD_{C-E} _____ % Rationale: _____

Root $Zone_{A-B}$ _____ feet Rationale: _____

Root $Zone_{C-E}$ _____ feet Rationale: _____

Available Water: $\Theta_{vol.}$ = _____%, $\Theta_{vol.}$ = _____ inches/foot. Source of water content data: _____

_____

COMMENTS: (additional information regarding the crop or soil and recommendations regarding irrigation practices)

_____

_____

_____

_____

Permanent Crop: _____Soil: _____

CIMIS location: _____ Station number: _____

CROP Factors:

Date B:

Date from reference_____ K_c-1 from reference_____

Modified Date_____ Modified K_c-1 _____

Reasons for changing (or not changing) the date and Kc: _____

_____

Date C:

Date from reference_____ K_c-2 from reference_____

Modified Date_____ Modified K_c-2 _____

Reasons for changing (or not changing) the date and Kc: _____

_____

Date E:

Date from reference_____ K_c-3 from reference_____

Modified Date_____ Modified K_c-3 _____

Reasons for changing (or not changing) the date and Kc: _____

_____

MAD_{B-C} _____ % Rationale: _____

MAD_{C-E} _____ % Rationale: _____

Root $Zone_{A-B}$ _____ feet Rationale: _____

Root $Zone_{C-E}$ _____ feet Rationale: _____

Available Water: $\Theta_{vol.}$ = _____%, $\Theta_{vol.}$ = _____ inches/foot. Source of water content data: _____

_____

COMMENTS: (additional information regarding the crop or soil and recommendations regarding irrigation practices)

_____

_____

_____

_____

_____

_____

_____

Attachment 4

Rubrics used for the assessment

Outcome 1.2: Students will have the ability to define and assess the physical, chemical and biological environments for optimal agricultural productivity.

	1	2	3	4
	Unsatisfactory	**Partially proficient (Below benchmark)**	**Proficient - Meets Standard (benchmark)**	**Exceeds standards (Above benchmark)**
Identify and collect physical and biological data related to soil water management	Inaccurate data identification; collection from unreliable or outdated sources	Incomplete data identification and collection	Most data were correctly identified and collected from reliable sources	All data were correctly identified and collected from reliable sources
Integration of all relevant data (synthesis)	No integration of data	Little integration	Main data integrated	Complete integration of all data
Consideration of environmental and economic constraints associated with efficient soil water management	Failure to evaluate the potential environmental impact or economic feasibility of the management practice	Consideration of only one of the constraints	Consideration of both constraints	Explicit consideration of both constraints

Outcome 2.1: Students will be able to make management decisions incorporating ethical and professional standards.

	1	2	3	4
	Unsatisfactory	**Partially proficient (Below benchmark)**	**Proficient - Meets Standard (benchmark)**	**Exceeds standards (Above benchmark)**
Ability to make decisions on irrigation management strategies and provide recommendations to professionals	No reasonable decisions or recommendations were made.	Demonstrated ability to make some decisions and recommendations, but some are incorrect or incomplete	Good decisions and management recommendations for irrigation scheduling using professional standards but could be more explicit in describing decision making process.	Excellent decision making process and management recommendations using professional standards.

Outcome 2.2: Students will have the quantitative skills to perform calculations related to agronomic, pest management and cultural practices necessary for optimizing crop production.

	1	2	3	4
	Unsatisfactory	**Partially proficient (Below benchmark)**	**Proficient - Meets Standard (benchmark)**	**Exceeds standards (Above benchmark)**
Ability to perform and interpret calculations & graphs related to irrigation scheduling	Major errors in basic calculations and units conversion; Misinterpretation or lack of results and graphs.	Several errors with calculations, unit conversions and graphs; incomplete interpretation of results.	Minor errors with calculations, unit conversions and graphs; average interpretation of results.	Correctly completed calculations, unit conversions, and graphs; excellent interpretation of results.

Outcome 2.3: Students will have the ability to communicate in written and oral formats appropriate to agricultural professionals and the general public.

	1	2	3	4
	Unsatisfactory	**Partially proficient (Below benchmark)**	**Proficient - Meets Standard (benchmark)**	**Exceeds standards (Above benchmark)**
Ability to communicate irrigation management plan in written format appropriate to agricultural professionals	Report is poorly organized and written, and does not follow professional standards. Report is missing major components of the irrigation management plan.	Report is poorly organized or written, very brief, and does not follow professional standards. At least one important component of the irrigation management plan is missing from the report.	Report follows professional standards, but is not well organized or written. All components of the irrigation management plan are included.	Thorough, clear, well organized and written report that follows professional standards. All components of the irrigation management plan are included.