University of Nebraska Lincoln EXTENSION

Know how. Know now.

EC718

# Agricultural Sprayer Automatic Section Control (ASC) Systems

**Joe Luck, Extension Precision Agriculture Engineer**

## Introduction

Agricultural sprayer automatic section control systems are one type of map-based precision agriculture technology. The main goal of these systems is to reduce overapplication by turning boom sections off as they pass over previously sprayed areas. Another benefit includes reduced application to environmentally sensitive areas by turning boom sections off in mapped zones (e.g., grassed waterways or buffer strips) as chosen by the operator. These systems can provide substantial savings in fields with irregular boundaries that create point-rows or in fields containing obstacles such as grassed waterways.

## Map-Based Method of Operation

Automatic section control (ASC) systems for sprayers can reduce overapplication (e.g., of pesticides or fertilizer) by turning off application equipment sections as they pass over previously treated areas. Some systems have the capability to only spray within pre-loaded field boundaries or boundaries recorded by the operator during an initial pass around the field. This "map-based" function ensures that boom sections are always off when passing over areas outside cropped regions of the field. An added benefit of this boundary mapping feature is that some systems allow the operator to map interior field areas to prevent application within grassed waterways or buffer strips.

ASC systems operate by mapping treated areas in real-time as the sprayer crosses the field. The sprayed areas, also referred to as "as-applied polygons," are stored using coordinates from the GPS receiver and the active control sections (*Figure 1*). As the sprayer continues

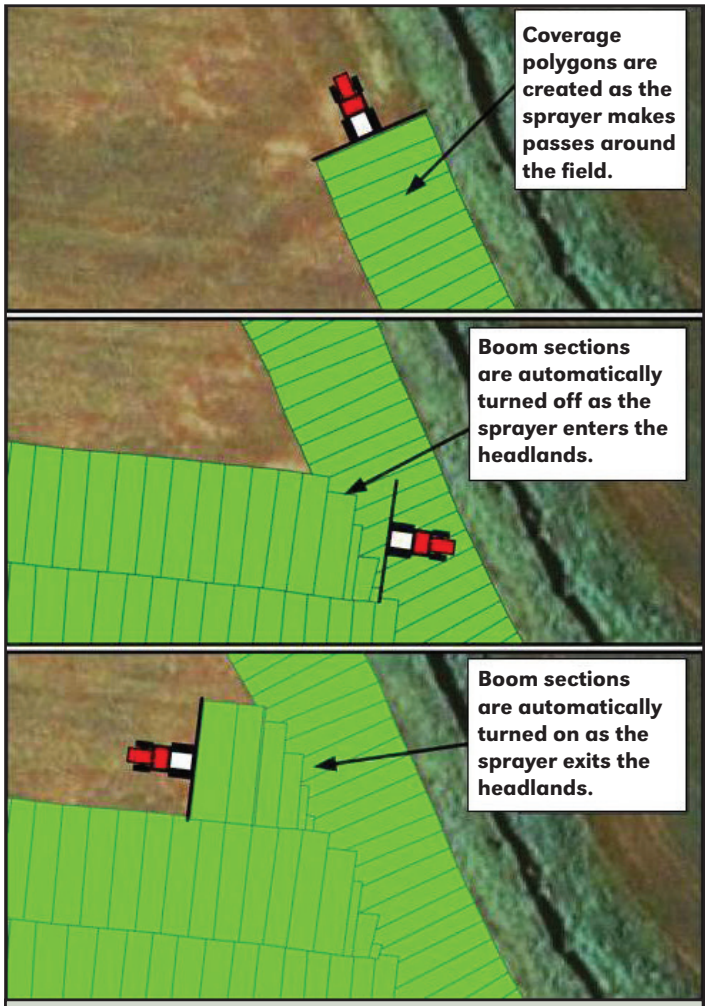


**Figure 1. Field coverage polygons generated in real-time as the sprayer makes initial headland pass (top), enters headland area (center), and exits headland area (bottom).**

to cover the field, the controller continually checks to determine if any boom sections will pass over previously mapped polygons or beyond a mapped field boundary. When a boom section passes into these areas, that section is turned off; it is turned on when it passes back over unsprayed regions. Most systems also allow the operator to choose the on/off coverage percentage for the boom sections. For a 100 percent setting, full coverage is ensured (with some overlap) in point-rows, whereas a 50 percent setting would result in the boom section turning off (or on) when half of that section has entered a previously sprayed zone.

ASC systems must also maintain application rates by regulating boom flow when sections are turned on or off. Spray rate controllers compensate for ground speed changes by controlling flow to the boom based on feedback from a flow meter and speed sensor. Similarly, section control systems require an integrated spray rate controller to adjust total flow for boom sections as they are switched on or off.

**Figure 2. Typical boom section valves used for boom section actuation.**

## System Control Elements

There are several components required for an ASC system:

- The control console contains software for generating coverage maps, actuating boom sections, and controlling application rate. Some ASC systems (e.g., SmartBoom™ from Raven Industries or Swath Manager from TeeJet Technologies), do not require a control console for ASC operation.
- A spray control module may be required for control section actuation. The module is connected between the spray rate controller and system control valves.
- A GPS receiver is required to provide geographic positioning data to the controller. Some spray controllers also may use GPS data to determine sprayer speed, so there is no need for an external speed sensor.
- A flow meter is required to provide feedback to the spray rate controller. The flow meter must be calibrated correctly for ideal system performance.
- A flow control valve (proportional or motorized) is necessary for throttling flow to the boom based on output from the spray rate controller.
- Boom section valves or individual nozzle valves are required for section actuation.

ASC systems are generally offered as an option on new equipment. When adding such a system to an existing sprayer, it is important to work with the equipment provider to ensure that existing components are compatible with the system you intend to purchase and install. Most existing sprayers utilize some form of rate controller and boom valves that can be upgraded for use with ASC systems.

## Selecting and Configuring Boom/Nozzle Valves

When it comes to hardware, there are two important issues with setting up the boom: the type of section valves used and how to group nozzles to form the most effective control sections. Two types of valves are currently available. Boom section valves (*Figure 2*) are typically found on existing sprayers and are placed ahead of multiple nozzles; individual nozzle valves (*Figure 3*) attach directly to each nozzle body and can be grouped together (by wire) to control sections of nozzles.

*Figure 4* shows how one might go about grouping nozzles for an ASC system with 30 control sections. This examples illustrates a 100-foot boom with 60 nozzles on a 20-inch spacing. While the individual nozzle valves may be simply grouped by wire, the existing boom configuration must be considered during setup. The example wet boom plumbing system in *Figure 4* consisted of 11

**Figure 3. Individual nozzle valves used for boom section actuation.**

subsections. Boom subsections 5 and 7 had three nozzles each; all other subsections provided flow for six nozzles. As shown in *Figure 4*, six nozzles at either end of the boom were controlled individually (control sections 1 to 6 and 25 to 30). Moving toward the boom center, the next three control sections (7 to 9 and 22 to 24) were used to manage paired nozzles. Finally, the remaining control sections (10 to 21) were utilized to control nozzles in groups of three. The example configuration in *Figure 4* illustrates one setup; several variations could be possible for a system using individual nozzle valves.

In general, for most systems with 10 or fewer available control sections, boom section valves may be most cost effective given the existing spray boom plumbing. However, for systems with more than 10 sections, consider using individual nozzle valves. When grouping spray nozzles into sections, it is important to consider the two forms of overlap during application: headland overlap (e.g., point rows) and pass-to-pass overlap. The best strategy for reducing headland overlap is to distribute control sections evenly to eliminate any large (wide) control sections. This is the best case scenario for reducing total overlap if you are using a guidance system, which already helps to minimize pass-to-pass overlap. If pass-to-pass overlap is a concern and no guidance system is used, consider having one or two small controls sections at either end of the boom. However, any guidance aid (lightbar or automated guidance) lessens the need for smaller sections at boom ends.

## Reducing Overapplication

Potential savings estimates for adopting ASC systems are shown in *Table I*. Overapplication (percentage of field area) was analyzed for four different boom control systems (each operated with automated guidance). Data were collected from a wide variety of field shapes and sizes for all four systems. These studies indicated that the addition of ASC can substantially reduce overapplication. Similarly, savings typically increase as the number of control sections increase.

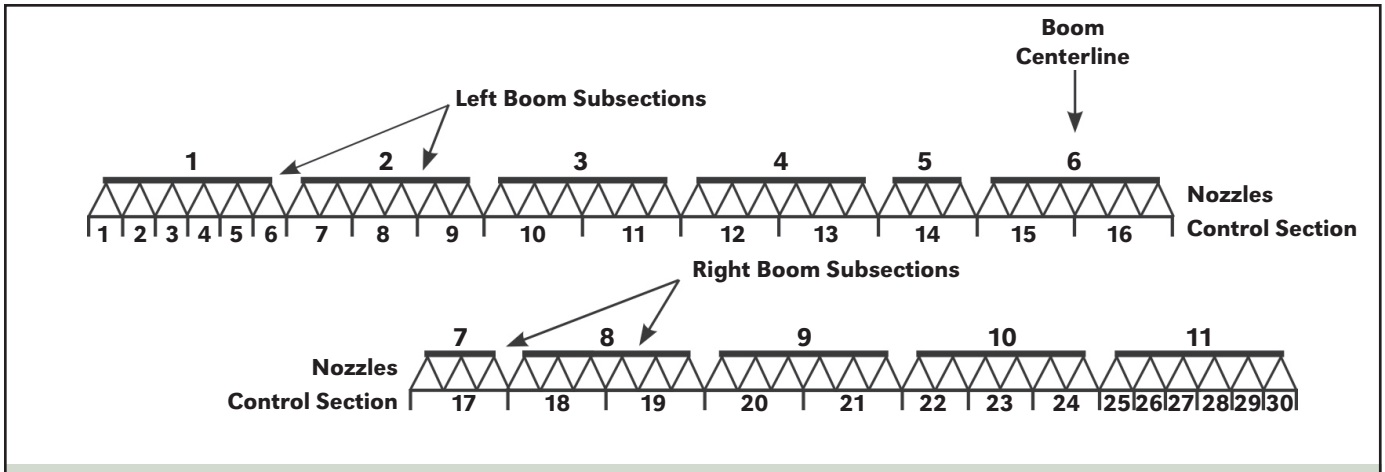


**Figure 4. Potential nozzle groupings for a 100-foot boom with 20-inch nozzle spacing using 30 control sections with individual nozzle control valves.**

**Table I. Summary of overapplication from four sprayer control systems.**

| Sprayer control system | Boom width (ft) | Overapplication (% of field area) |
|---|---|---|
| Manual-5 section | 80 | 14.5 |
| ASC-7 section† | 80 | 5.7 |
| ASC-9 section† | 80 | 4.7 |
| ASC-30 section†† | 100 | 2.3 |

†AccuBoom™ with Envisio Pro controller from Raven Industries, Inc.
††Zynx X20 controller from Topcon Positioning Systems, Inc. (Luck et al., 2010; Luck et al., 2011)

*Figure 5* illustrates one field that was sprayed with the manual 5-section control system (left) and the automatic 7-section system (right). Areas of overapplication are shown in blue, and areas where application may have been skipped are shown in red. In both cases, addition of the ASC improved application to this field, especially in point-row locations.

One important point to consider is that field shape significantly impacts potential savings from section control. Savings are generally greatest for irregularly shaped field boundaries, or if the fields contain obstacles such as grassed waterways or wooded areas. As fields become more regular (square) in shape, savings are less, and increasing the number of control sections reduces the benefit of ASC. A common measure of field "irregularity" is the perimeter-to-area (P/A) ratio. The field perimeter (including any interior obstructions, measured in feet) is divided by the field area (measured in acres). As the P/A ratio increases, the field becomes more irregular. *Figure 6* shows that as the P/A ratio increased for all four control systems (from *Table I*), overapplication also increased in those fields. In general, more savings are realized as the number of sprayer passes ending in point rows increases.

Also shown in *Figure 6* are two of the fields used in the study comparing manual 5-section control to automatic 7-section control. A relatively square rectangular 100-acre field is shown on the left (P/A ratio of 100 ft/ac) with a small, irregularly shaped 9-acre field (P/A of 650 ft/ac). Overapplication for the 100-acre field was reduced from 4 to 2 percent while the smaller 9-acre field saw overapplication reduction from 35 to 10 percent.

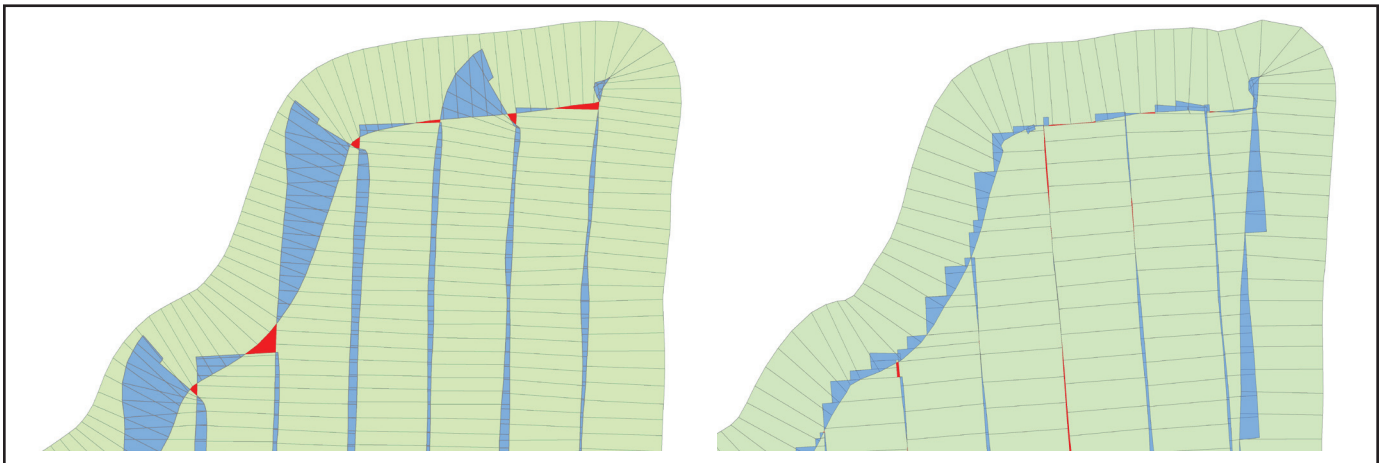

**Figure 5. Overapplication for the same field using manual 5-section control (left) and a 7-section ASC system (right). Blue areas indicate overlap and red areas indicate skipped application.**

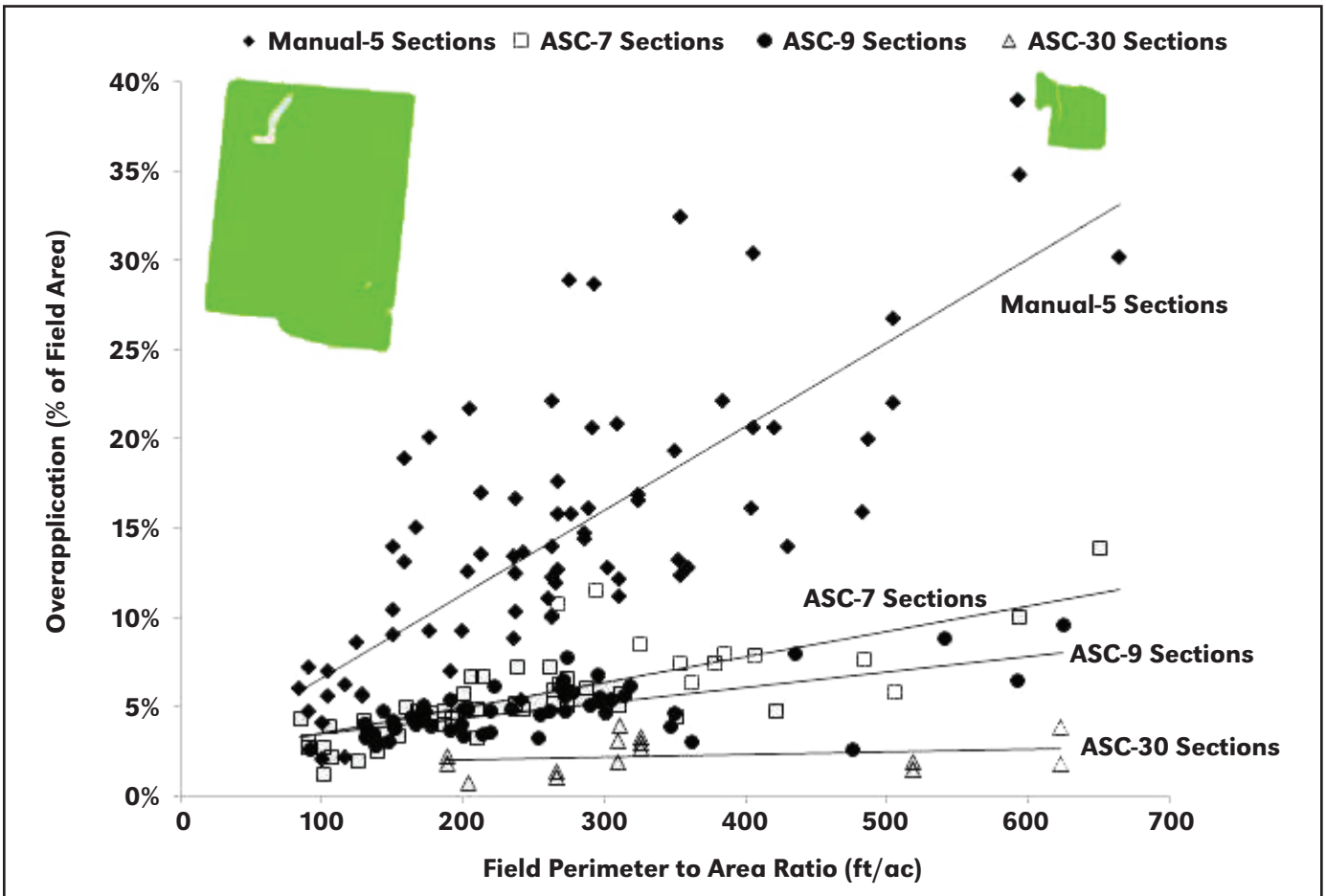


**Figure 6. Overapplication versus field P/A ratio for four different boom control systems. Two example fields are shown with a P/A of 100 (left) and P/A of 600 (right).**

## Manufacturer Information

Several manufacturers provide ASC systems ranging from 5 to 48 control sections. Visit the following websites for additional information on ASC systems:

AgLeader: *www.agleader.com*
Dickey John: *www.dickey-john.com*
Farmscan: *www.farmscan.net*
John Deere: *www.deere.com*
Leica: *www.leica-geosystems.com*
Raven: *www.ravenprecision.com*
TeeJet: *www.teejet.com*
Topcon: *www.topconpositioning.com*
Trimble: *www.trimble.com*

Boom section valves are available from many spray equipment manufacturers, but individual nozzle valves are less widely available. At the time of publication individual nozzle valves were available from:

Capstan: *www.capstan.com*
Harrison Ag Technologies: *www.H-AgTec.com*
TeeJet: *www.teejet.com*

It will be helpful to contact manufacturers or dealers for suggestions on what to purchase and install. In addition to price, availability, and compatibility with existing equipment, consider the following questions:

- How many control sections are available and how can they be grouped to maximize the performance of my system?
- Can the unit be expanded in the future to add control sections?
- Is map-based control available and how does the system manage field boundary files and no-spray zone areas?
- Are "as-applied" files produced after spraying for verification of system performance?
- Will dealer service be readily available after the ASC system is installed, and is system training available from the dealer?

## Resources

Luck, J.D., R.S. Zandonadi, and S.A. Shearer. 2011. A case study to evaluate field shape factors for estimating overlap errors with manual and automatic section control. *Trans. ASABE* 54(4): 1237-1243.

Luck, J.D., R.S. Zandonadi, B.D. Luck, and S.A. Shearer. 2010. Reducing pesticide overapplication with map-based automatic boom section control on agricultural sprayers. *Trans. ASABE* 53(3): 685-690.

## Disclaimer

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by University of Nebraska–Lincoln Extension is implied for those mentioned.

**This publication has been peer reviewed.**

UNL Extension publications are available online at *http://extension.unl.edu/publications*.