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Table of contents

Summary

The Dutch government's policy has set goals for the reduction of the emission of pesticides into the environment. To support decision making on the authorization of the use of agrochemical data are needed on actual spray drift and on drift reducing measures when spraying an agrochemical in a crop. Only limited data are available for evaluating the effect of techniques that reduce spray drift next to the field to meet the thresholds of these chemicals for ecotoxicological risk in the off-field zone (non-target arthropods and plants).

The present study describes the evaluation of the effect of low drift nozzles belonging to drift reduction classes 50%, 75%, and 90% on spray drift deposition next to the treated crop. The effects on spray deposits by replacing the last and last-but-one nozzle by an end nozzle is evaluated as well. Downwind spray deposits were calculated with the IDEFICS spray drift model. Four crop types were distinguished: a cereal, potato, sugar beet, or maize crop, primarily by defining the position of the last nozzle with respect to the edge of crop canopy. In each case, the drift evaluation zone was located 0.5-1.5 m downwind from the last nozzle. Crop height, sprayer boom height and average wind speed were varied in the simulations.

Global effects (after averaging over various situations) of using end nozzles show that a single end nozzle can give drift reductions up to about 70%, though in some cases it is only about 30%, mainly depending on crop type and nozzle type used. Typically, using a second end nozzle may enhance drift reduction by about 10%, at most. Usually the effect of end nozzles is limited to a few meters next to the crop, whereas the largest effects are observed at about 0.5-1.0 m off the crop edge. For low-drift nozzle types such as ID12002 and XLTD04-110, using end nozzles has only minor effects, since end nozzles cannot reduce drift if it (almost) is not there after all.

With respect to a reference situation (XR11004 nozzles, sprayer boom height 0.5 m, crop height 0.5 m, wind speed 3 m/s), the use of coarse nozzles and lowering the sprayer boom can result in drift reduction well above 95% when spraying potato crop. For a maize crop such high reductions are much more restricted, due to a difference in nozzle positions with respect to the edge of the crop.

Typically, the use of a second end nozzle appears to be useful only when it replaces a wide-angled nozzle like XR11004 or DG11004. When used with ID12002 or XLTD04-110, having smaller top angles, a second end nozzle doe not affect drift deposits significantly.

A surfactant may affect drop size distribution; however, in many cases, the effects on spray drift due to changes in drop size distribution are relatively small compared to other factors such as wind velocity, crop height and boom height.

1. Introduction

The Dutch government's policy (Water Pollution Act, VW/VROM/LNV, 2000; Sustainable Crop Protection, LNV, 2004) has set goals for the reduction of the emission of pesticides into the environment. To support decision making on the authorization of the use of agrochemical (by the Dutch Board for the Authorisation of Plant Protection Products and Biocides, CTGB), data are needed on actual spray drift and on drift reducing measures when spraying an agro-chemical in a crop. Only limited data are available for evaluating the effect of techniques that reduce spray drift next to the field to meet the thresholds of these chemicals for ecotoxicological risk in the off-field zone (non-target arthro-pods and plants).

At this moment, the drift deposition at 1 m distance from the centre of the last crop row is used to estimate the exposure to terrestrial ecosystems (non-target arthropods, non-target plants) next to a sprayed plot (LNV, 2006). In the authorization procedure a standard drift deposition of 10% is used as exposure value in the off-crop evaluation (CTGB, 2008). This is based on the amount of the deposition of spray drift on a 1 m wide strip, 0.5-1.5 m from the last crop row or last nozzle when crop protection products are applied with a standard conventional spraying technique (derived from Zande *et al.*, 2000). This standard technique involves the use of flat fan nozzles XR11004, a sprayer boom height of 0.50 m above the crop canopy (being potatoes, 0.50 m high) in a 3 m/s cross wind.

Nowadays, drift reducing techniques are used at the border of a field and calculations for the aquatic environment are based on the use of such techniques. Their potential for drift reduction was evaluated on an off-field evaluation zone next to the field (Zande, *et al.*, 2007) which showed that the effect of drift reducing nozzles, end nozzles and boom height above crop canopy were important parameters for downwind off-target spray deposition. Especially the use of end nozzles could reduce spraying directly over the edge of the crop, resulting in a reduction of spray deposi-tion by 30% (Michielsen, *et al.*, 2001).

The present study describes the evaluation of the effect of several low drift nozzles belonging to drift reduction classes 50%, 75%, and 90% (Porskamp, *et al.*, 1999; TCT, 2009) on spray drift deposition next to the treated crop. The effects on spray deposits by replacing the last and last-but-one nozzle by an end nozzle is evaluated as well. The end nozzle itself can be standard or drift reducing. Downwind spray deposits were calculated with the IDEFICS spray drift model (Holterman, *et al.*, 1997). In the simulations, various situations involving a cereal, potato, sugar beet, or maize crop were defined by adjusting the position of the last nozzle with respect to the edge of crop canopy and selecting an appropriate downwind strip where drift deposits were investigated. Parameters varied in the simulations were average crop height (0.25 and 0.50 m), sprayer boom height (0.30 and 0.50 m above crop canopy), average wind speed (1, 3 and 5 m/s, perpendicular to the driving direction of the sprayer). Results of these calculations are presented and evaluated for main effects of crop type, spray technique, and single or double end nozzle use.

A comparison can then be made with earlier results from field measurements (Zande, *et al.*, 2007) based on estimated drift reduction at the evaluation zone relative to the reference field situation.

2. Materials and methods

2.1 Introduction

The project consisted of two parts: (1) measurement of drop size spectra for a set of selected nozzle types; and (2) using these spectra in the IDEFICS spray drift model to compute downwind spray deposits. Four flat fan nozzle types were selected: one standard type and three drift-reducing types. See Table 1 for details. With each nozzle type, an appropriate end nozzle type was associated according to the following rules: an 04 flat fan nozzle type was associated with an 04 end nozzle, and similarly for 02 nozzles. Drift-reducing nozzles were associated with the appropriate drift reducing end nozzles types.

Table 1. Set of selected nozzle types in this project.

Nozzle type	Description	Associated end nozzle type
TeeJet XR11004	Standard flat fan (reference)	TeeJet UB8504
TeeJet DG11004	Pre-orifice flat fan, 50% drift reducing	Lechler IS8004
Lechler ID12002	Venturi flat fan, 75% drift reducing	Lechler IS8002
Agrotop XLTD04-110	Venturi flat fan, 90% drift reducing	Lechler IS8004

2.2 Measurements

Nozzle types XR11004 and DG11004 were sorted and pre-selected according to their flow rates by The Arable Group (Silsoe, UK). Flow rates of the other nozzle types were determined at PRI (Wageningen; The Netherlands. For each of these nozzle types, 20 new nozzles were selected. Flow rates of each nozzle was determined at a liquid pressure of 300 kPa, using tap water as spray liquid. Flow rate was determined by collecting the spray for a fixed time (3 minutes) weighing the collected liquid afterwards. The 20 nozzles were sorted by increasing flow rate. The 6 nozzles with flow rates closest to the median flow rate were selected for further use. After sorting, the even numbered nozzles were sent to The Arable Group (Silsoe, UK) for comparative wind tunnel work. In this way both research groups ('Silsoe' and 'Wageningen') had a similar set of 10 nozzles per type, with 3 nozzles selected for further use.

Drop size measurements were carried out using a Phase Doppler Particle Analyzer (PDPA, TSI, USA). To minimize contamination of the spraying chamber with various spray liquids (see below), an aluminium container was placed below the nozzle to collect the spray during drop size measurements. Nozzle height was 0.25 m above the plane of measurement. Typically, the spray cone below the nozzle was scanned in 11 parallel paths, each 1.10 m long. The distance between neighbouring paths was 0.01 m, and travel speed of the nozzle along the paths was 0.04 m/s. Slight modifications of this setup were applied if required by the circumstances. End nozzles were measured in the same setup but these nozzles were rotated to have the central axis of the spray cone directed vertically downward, like normal flat fan nozzles. The angle of rotation was measured.

Four spray liquids were selected: tap water, tap water with fluorescent dye (Brilliant Sulphoflavin, BSF, 3.0 g/l), tap water with surfactant (Agral, 1.0 g/l), and tap water with both BSF and Agral (3.0 g/l and 1.0 g/l, respectively). In a limited set of measurements using these four liquids, their effects on drop size distribution for several nozzle types was investigated. The results show that the addition of BSF to tap water and tap water + Agral did not alter drop size distributions significantly (see Section 3.1). Therefore, the full set of measurements was carried out with two liquids only: tap water and tap water + Agral (1.0 g/l).

The spray chamber climate was controlled at a temperature of 20°C and a relative humidity of 70%. Spray liquid temperature was maintained at 20°C as well.

In order to estimate the flow structure of entrained air in the spray cone, stationary measurements with the PDPA were done at the central axis of the spray cone, but at different distances below the nozzle (4, 6, 9, 12, 15, 20, 25 and 30 cm). From these measurements the average droplet velocity was computed as a function of drop size, from which an empirical model of entrained air velocities was derived. Initial velocities of drops at the outlet of the nozzle could be derived as well from these measurements. These measurements are required for modelling purposes.

The PDPA system was configured as follows:

- Total laser power: 700 mW
- Focus of front lens of transmitter: 1000 mm
- Focus of front lens of detector: 1000 mm
- Transmitter supplied with a contractor (to enhance droplet diameter range)
- Detection mode: forward refractive scattering
- Angle of detection: 40°
- Voltage of detector photomultiplier: 450 V
- Burst signal threshold: 75 mV
- Diameter range: 5 – 1250 μm)
- Probe Volume Correction: yes

For each of the 3 selected nozzles per nozzle type, drop size measurements were carried out three times, returning 9 drop size distributions per nozzle type and per spray liquid. The average of these 9 distributions was used as input for the IDEFICS simulations. Drop size distributions were characterized by D_{V50} (volume median diameter) and V_{100} (volume fraction consisting of droplets having diameter <100 μm).

2.3 Simulations

Spray drift simulations were carried out using the IDEFICS spray drift model (version 3.5). The following parameters were varied in the simulations: crop height, sprayer boom height above the crop, average wind speed, position of first (outmost) nozzle with respect to edge of the crop (see Table 2). These variations yielded 36 combinations per nozzle type and per spray liquid type. A 'single simulation' of a full-field spray application consisted of calculating the paths of $3 \cdot 10^4$ drops for each of 14 nozzles located at selected positions along the sprayer boom. By interpolation and extrapolation for nozzles not in this selection, a full-field application could be simulated. Simulations for end nozzles were carried out only for the first and second position (i.e. nearest to the crop edge).

Table 2. Parameters varied in the simulations.

Parameter	Values
Crop height	0.25, 0.50 m
Sprayer boom height (above crop canopy)	0.30, 0.50 m
Average wind speed (at 2 m height above cut grass)	1.0, 3.0, 5.0 m/s
Position of first nozzle (from crop edge, in upwind direction)	0.25, 0.50, -0.125 m
Nozzle type	See Table 1
Spray liquid	tap water; tap water + Agral

The three possible positions for the first nozzle corresponded to crop types (1) cereals, (2) sugar beet or potato, (3) maize, respectively. The assumed concentration of formulated material was 3 g/l for tap water (to mimic BSF) and 4 g/l for tap water + Agral (to mimic BSF+Agral).

Other settings that remained constant throughout the simulations: wind direction perpendicular to the field edge, driving speed of the sprayer 1.67 m/s (6.0 km/h), air temperature 20°C, relative humidity 70%, atmospheric stability: neutral, distance between nozzles along the sprayer boom: 0.50 m. Downwind deposits were recorded up to 21 m down wind from the crop edge.

3. Results

3.1 Measurements

3.1.1 Flow rates

The results of the flow rate measurements are summarized in Table 3.

Table 3. Summary of flow rate measurements, using tap water at pressure 300 kPa.

Nozzle type	Median flow rate [l/min]	Coefficient of variation [%]
XR11004	1.57	0.9
DG11004	1.56	2.3
ID12002	0.78	1.9
XLTD04-110	1.62	0.7
UB8504	1.59	2.2
IS8002	0.60	2.6
IS8004	1.35	0.4

3.1.2 Effect of spray liquid on drop sizes

Four spray liquids were tested: (1) tap water, (2) tap water + 3g/l BSF, (3) tap water + 0.1% Agral, (4) tap water + 3g/l BSF + 0.1% Agral. Two important physical properties that may affect drop sizing are surface tension and viscosity. Surface tension of these liquids was measured using a Krüss tensiometer at room temperature in a few replications. Results are shown in Table 4. Clearly BSF does not affect surface tension, whereas the surfactant Agral strongly affects surface tension, as expected. Viscosity was not measured in this study, but from previous experience it was not expected that viscosity would differ significantly among these liquids.

Table 4. Spray liquids and their surface tension.

Liquid		Surface tension [mN/m]
Water		73
Water	+ 0.3% BSF	71
Water	+ 0.1% Agral	33
Water + 0.3% BSF	+ 0.1% Agral	33

According to these findings, one would expect that the solutions containing Agral might show different drop size distributions, whereas one would not expect the addition of BSF to give rise to changes in drop sizes.

PDPA measurements were carried out with these four liquids, for the BCPC threshold nozzles F/M [1] and C/VC, and for nozzles from this study XR1004, DG11004 and XLTD04-110 (one nozzle of each type). The latter three were chosen as representatives of normal flat fan, pre-orifice and venturi types. Results of the PDPA measurements revealed some unexpected phenomena. For instance, Figure 1 shows the ratio of V_{100} to that for tap water, for the BCPC threshold nozzles. While the addition of Agral slightly decreases V_{100}, the presence of BSF appears to increase V_{100}, especially for the C/VC nozzle. Similarly, Figure 2 shows ratios of D_{V50} for these measurements, relative to D_{V50} of tap water. While Agral hardly affects D_{V50}, the presence of BSF clearly decreases D_{V50}. Further investigations of the raw results of the PDPA measurements showed that the intensity of light scattered by the drops was decreased for the liquids containing BSF. All liquids were clear solutions without scattering inside the drops. Apparently, BSF being a fluorescent dye, absorbs some light from the laser beams which results in reduced intensities at the detector. Two effects that relate to drop size can be distinguished. Firstly, the path of light beams through large drops is longer than through smaller drops, therefore laser attenuation for larger drops would be larger than for smaller drops. Secondly, reduced intensities cause some weak signals to become undetectable when these intensities do not rise above the detection threshold. This may affect smaller drops more than larger drops as signal intensities are proportional to the droplet diameter squared. Correcting the PDPA measurements for light absorption by BSF might be possible in theory but there is currently no practical solution. Therefore, the liquids containing BSF were discarded from the rest of the project, leaving only water and water + Agral as spray liquids to be investigated. However, the first measurements with XR11004, DG11004 and XLTD04-110 showed that the effect of Agral on drop size distribution is not straightforward either (see Figure 3).

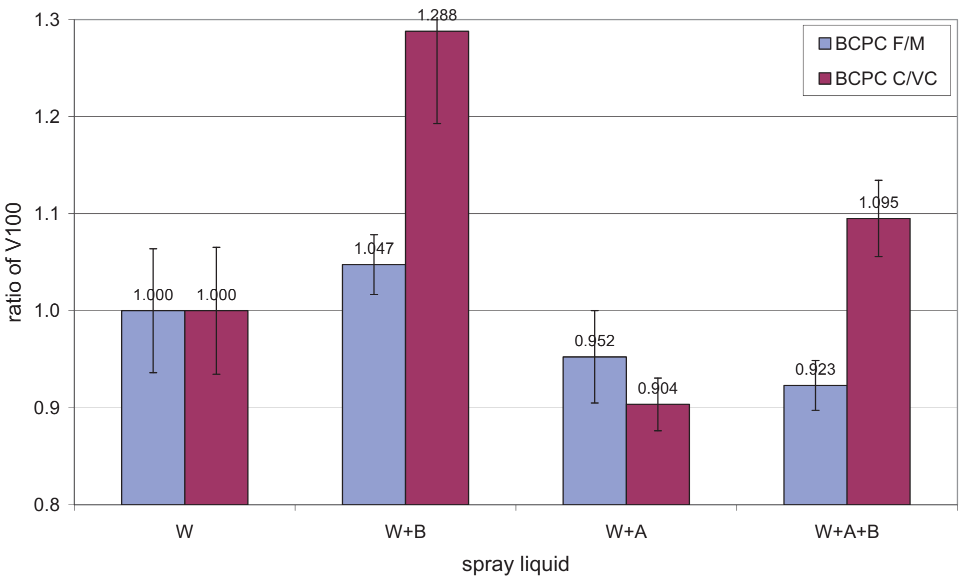

Figure 1. *Ratio of V_{100} relative to that for water, for all spray liquids (W: water; A: Agral; B: BSF), for drop size distributions with BCPC threshold nozzles F/M and C/VC.*

[1] F/M, C/VC: BCPC classification fine/medium and coarse/very coarse, respectively.

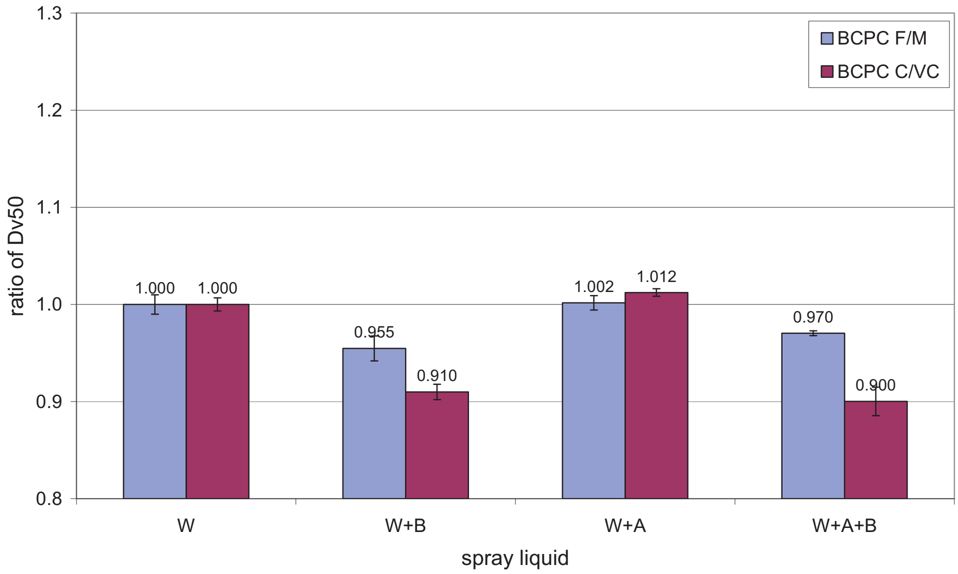

Figure 2. *Ratio of D_{V50} relative to that for water, for all spray liquids (W: water; A: Agral; B: BSF), for drop size distributions with BCPC threshold nozzles F/M and C/VC.*

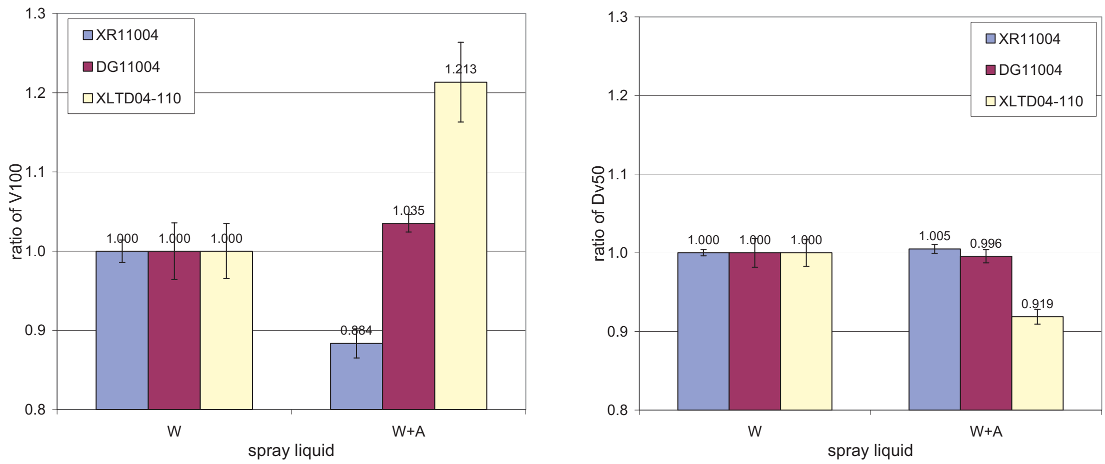

Figure 3. *Ratio of V_{100} (left) and D_{V50} (right) relative to that for water, for all spray liquids water (W) and water+Agral (W+A), for drop size distributions with nozzles XR11004, DG11004 and XLTD04-110.*

3.1.3 Drop size distributions

A summary of results for drop size measurements is given in Table 5. Values of D_{V50} and V_{100} are averages of 9 measurements (3 nozzles per type, each measured three times). Top angles were measured for tap water only and averaged for all three nozzles per type. Occasional checks of top angles during measurements with tap water+Agral showed no change in top angles. Since end nozzles have a flat fan spray cone which is tilted towards one side, these nozzles were rotated during the drop size measurements so that the central axis of the spray cone was vertical. The required angle of rotation is referred to as tilt angle in the tables below. The initial velocity of drops at the outlet of the nozzle is given by v_0.

Table 5. Summary of drop size measurements at liquid pressure of 300 kPa.

Nozzle type	Spray liquid	D_{V50} [µm]	V_{100} [%]	Top angle [°]	Tilt angle [°] [1]	v_0 [m/s]
XR11004	tap water	272	3.82	122	0	20.1
	tap water + Agral	267	4.02	122	0	20.1
DG11004	tap water	307	2.53	122	0	17.1
	tap water + Agral	306	2.45	122	0	17.1
ID12002	tap water	433	0.91	97	0	11.1
	tap water + Agral	405	0.90	97	0	11.1
XLTD04-110	tap water	482	0.57	100	0	11.7
	tap water + Agral	442	0.68	100	0	11.7
UB8504	tap water	298	2.99	87	35	20.7
	tap water + Agral	297	2.94	87	35	20.7
IS8002	tap water	470	0.65	79	10	11.2
	tap water + Agral	434	0.93	79	10	11.2
IS8004	tap water	615	0.28	83	10	10.9
	tap water + Agral	482	0.67	83	10	10.9

[1] *tilt angle: angle between central axis of spray cone and a vertical line; for normal flat fan nozzles it is 0° by definition.*

3.2 Simulations

3.2.1 Drift curves

In the simulations, the drop size distributions for tap water and tap water + Agral were used with an addition of a hypothetical non-volatile formulation (3 g/l) that was assumed not to affect drop size distribution. For tap water + Agral the total concentration of non-volatile materials was 4 g/l, to account for the presence of 0.1% Agral.

Three possible placements of nozzles along the boom (uniquely identified by the placement of the first nozzle) corresponded to the four crops of interest. While sugar beet and potato have the same nozzle placement with respect to the edge of the crop, the range where deposits are to be computed differed due to the fact that this range is defined with respect to centre of the last row of plants rather than with respect to the crop edge or nozzle location. Thus four drift ranges should be investigated, as shown in Table 6. Since in IDEFICS the edge of the crop represents a natural boundary between crop and downwind area, all distances are given with respect to the crop edge. Figure 4 gives a schematic view of the layout for the four crops.

Table 6. Relation between crop type, position of first nozzle and assessment range for downwind spray deposits.

Crop type	Position of outmost nozzle with respect to crop edge [m]	Drift assessment range from crop edge [m]
Cereal	0.25	0.50 – 1.50
Potato	0.50	0.00 – 1.00
Sugar beet	0.50	0.25 – 1.25
Maize	-0.125	0.50 – 1.50

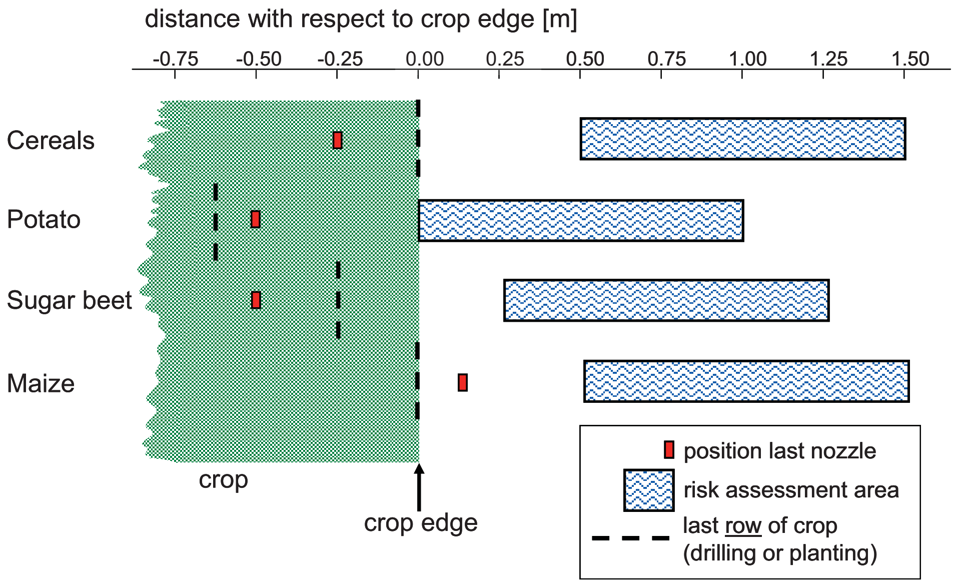

Figure 4. *Schematic view of the relation between the position of the last nozzle, the risk assessment area and the last row of crop for the four crops in this study. The risk assessment area is 0.5-1.5 m from the last row of crop, except for the potato crop where the risk assessment area was adjusted to be kept outside the crop area.*

Figure 5 shows spray deposits as a function of distance downwind from a cereal crop, with crop height 0.50 m, sprayer boom height 0.50 m above the crop, average wind velocity 3 m/s and spraying 'tap water' (i.e., 3 g/l formulated product in tap water). The curves for XR11004 and DG11004 are similar and show relatively high deposits the first few meters next to the crop. The curves for ID12002 and XLTD04-110 are similar as well. Apparently this is due to the relative large top angle for XR11004 and DG11004 (both about 120°), in comparison to top angles for ID12002 and XLTD04-110 (both about 100°). The decrease in deposition observed directly next to the crop (0-0.25 m) is caused by the shadowing effect of the crop. Replacing the outer XR11004 nozzle by an end nozzle (UB8504) significantly reduces spray deposits. Due to the relatively large tilt angle of the UB8504, most of the spray produced by that nozzle is directed upwind (and downward), i.e., towards the crop rather than spraying out over the edge of the crop. The effect of end nozzles IS8002 and IS8004 in the outer position is much more limited, as these end nozzles have only a small tilt angle and part of their spray is still directed out over the crop edge into the off-crop area.

Figure 6 shows the same situation, but for spraying tap water + Agral (i.e., total product concentration is 4 g/l). This Figure is almost identical to Figure 5, indicating that the (albeit relatively small) differences in drop size distributions have limited effects on the amount of downwind spray deposits.

Similarly, Figure 7 and Figure 8 show the deposition curves for potato or sugar beet, for water and water + Agral, respectively, where the last nozzle is 0.50 m upwind from the crop edge. Again, the deposition curves for XR11004 and DG11004 show higher deposits than for ID12002 and XLTD04-110. However, since the last nozzle is placed farther upwind than with the cereal crop, the effects of end nozzles IS8002 and IS8004 now reduce spray deposits considerably, similar to the effect of the UB8504 end nozzle.

Finally, Figure 9 and Figure 10 show the deposition curves for maize where the last nozzle is located 0.125 m outside the crop edge. Obviously no shadowing effect is observed as the last nozzle is located outside the crop. Similarly, using an end nozzle in the last position hardly affects spray deposits. In fact, the use of IS8002 or IS8004 may even enhance deposits at 0 – 1 m due to the more condensed spray pattern of these end nozzles in comparison with normal flat fan nozzles.

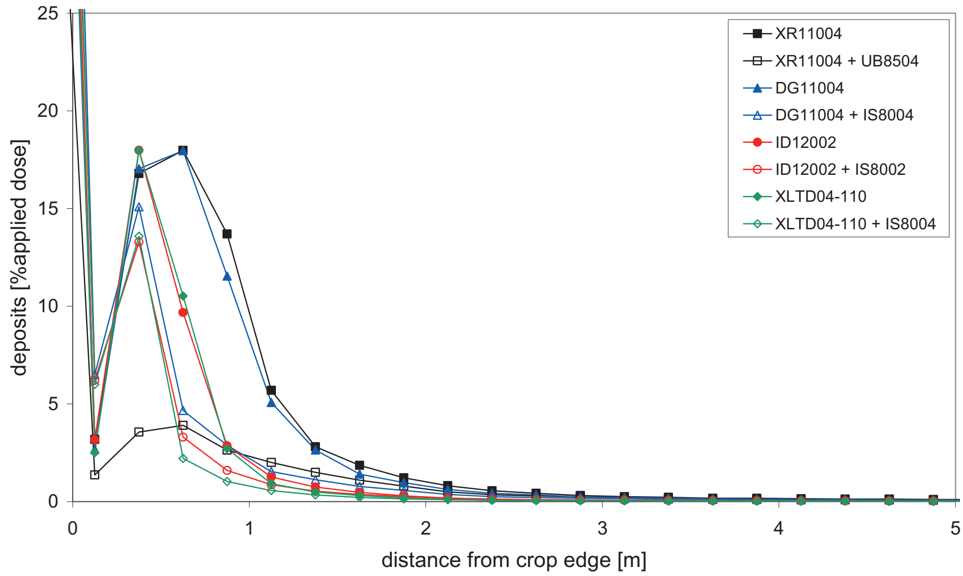

Figure 5. *Downwind drift for boom sprayers without end nozzle (closed symbols), and with one end nozzle (open symbols); first nozzle located 0.25m upwind from crop edge (cereals); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water; average wind velocity 3 m/s.*

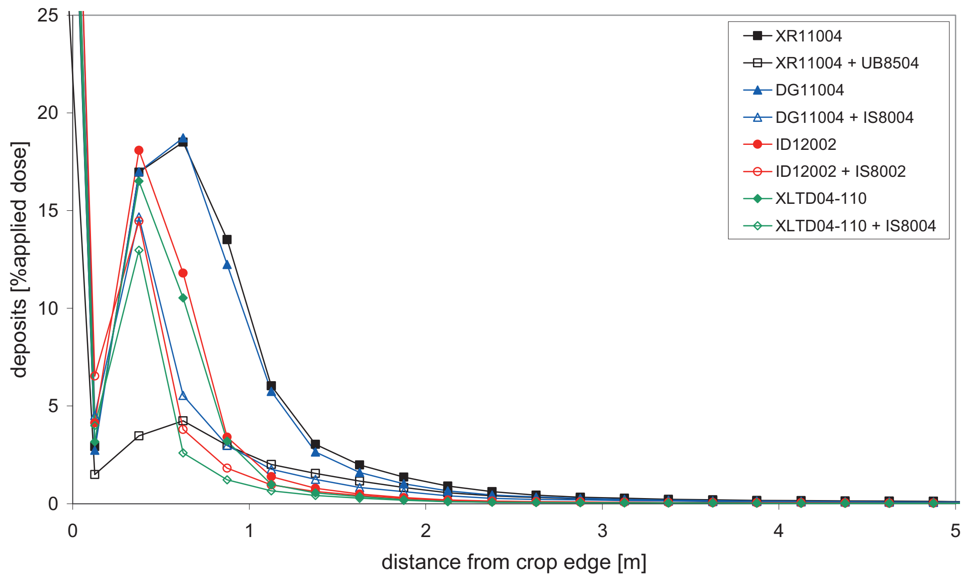

Figure 6. *Downwind drift for boom sprayers without end nozzle (closed symbols), and with one end nozzle (open symbols); first nozzle located 0.25m upwind from crop edge (cereals); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water+0.1% Agral; average wind velocity 3 m/s.*

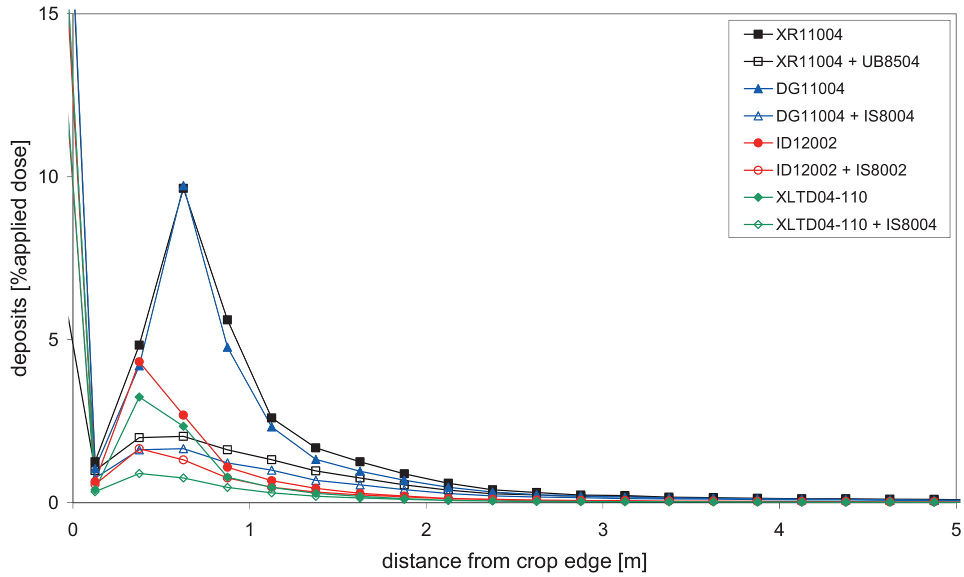

Figure 7. *Downwind drift for boom sprayers without end nozzle (closed symbols), and with one end nozzle (open symbols); first nozzle located 0.50m upwind from crop edge (potato/sugar beet); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water; average wind velocity 3 m/s.*

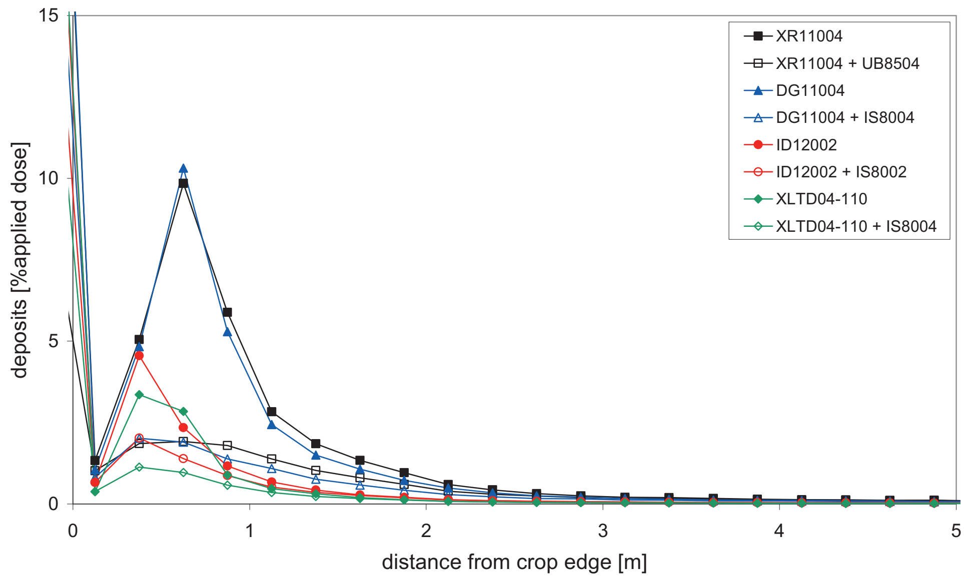

Figure 8. *Downwind drift for boom sprayers without end nozzle (closed symbols), and with one end nozzle (open symbols); first nozzle located 0.50m upwind from crop edge (potato/sugar beet); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water+0.1% Agral; average wind velocity 3 m/s.*

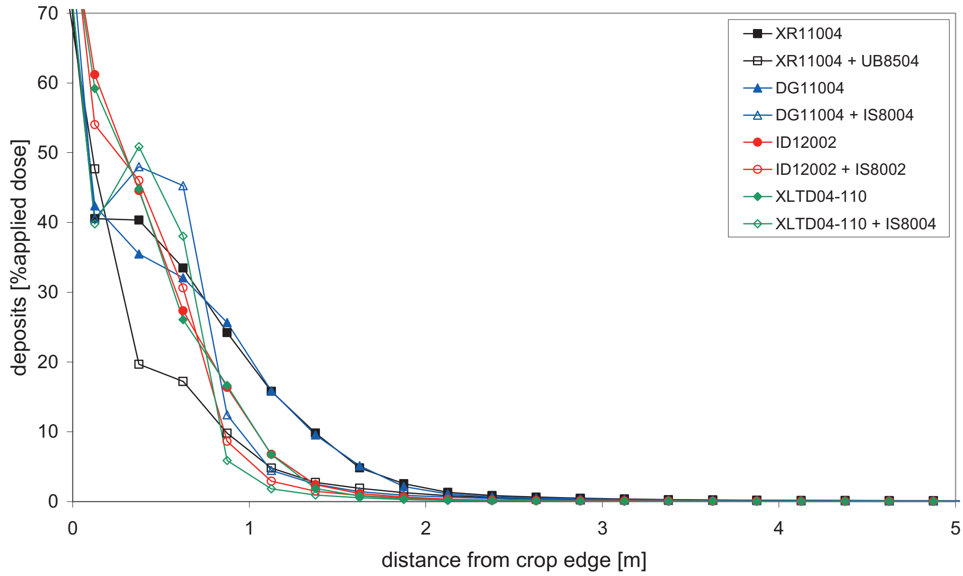

Figure 9. *Downwind drift for boom sprayers without end nozzle (closed symbols), and with one end nozzle (open symbols); first nozzle located 0.125m downwind from crop edge (maize); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water; average wind velocity 3 m/s.*

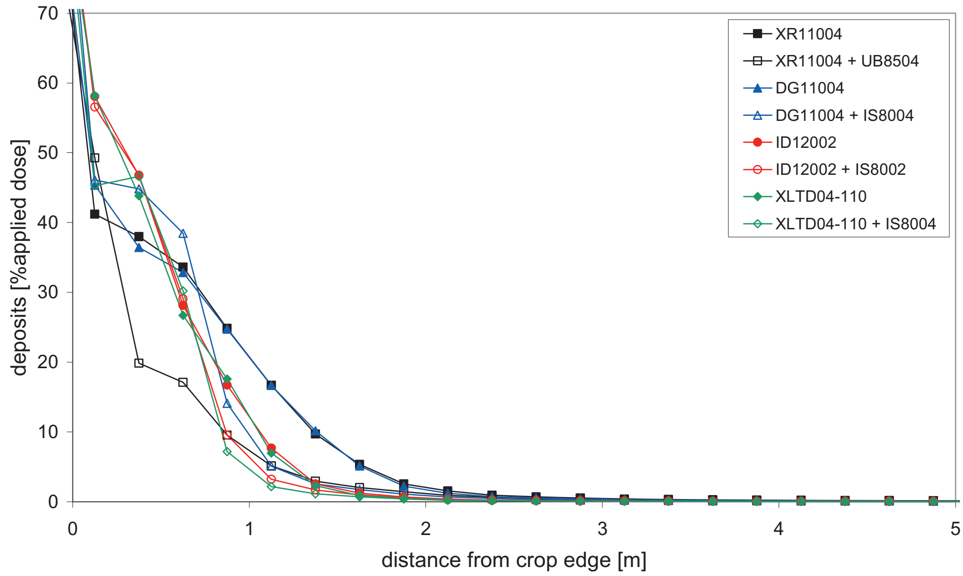

Figure 10. *Downwind drift for boom sprayers without end nozzle (closed symbols), and with one end nozzle (open symbols); first nozzle located 0.125m downwind from crop edge (maize); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water+0.1% Agral; average wind velocity 3 m/s.*

The effect of a second end nozzle in the last-but-one position is shown for a cereal crop and the XR11004 and DG11004 nozzles in Figure 11 (other settings are similar to those of Figure 5). A second UB8504 end nozzle (with the XR11004) significantly reduces deposits further. However, a second IS8004 (with DG11004) hardly affects the high deposit at 0.25-0.50 m (which is caused almost completely by the first end nozzle still present), but farther downwind deposits are reduced with respect to one end nozzle. For the ID12002 and XLTD04-110 nozzles, results similar to the DG11004 case would be obtained.

In the case of a potato or sugar beet crop where the last nozzle is farther upwind from the crop edge, the effect of a second end nozzle is more limited than for a cereal crop. Figure 12 shows only the curves with one and two end nozzles, and one should note the reduced scale of the vertical axis. For the XR11004 and DG11004 nozzles, a second end nozzle has a significant drift reducing effect, while for the ID12002 and XLTD04-110 nozzles, there is hardly any visible effect. It is likely that, due to the larger top angle of the XR11004 and DG11004 nozzles, these nozzles in the last-but-one position still cause some deposition directly over the crop edge and having end nozzles in the penultimate nozzle positions will reduce such deposits. For the ID12002 and XLTD04-110 nozzles with smaller top angles, this effect is hardly present.

Finally, Figure 13 shows deposition curves for maize with one and two end nozzles. The effect of a second end nozzle is limited in the range 0 – 1 m as most of the deposits in that range are caused by the direct spray load from the last nozzle.

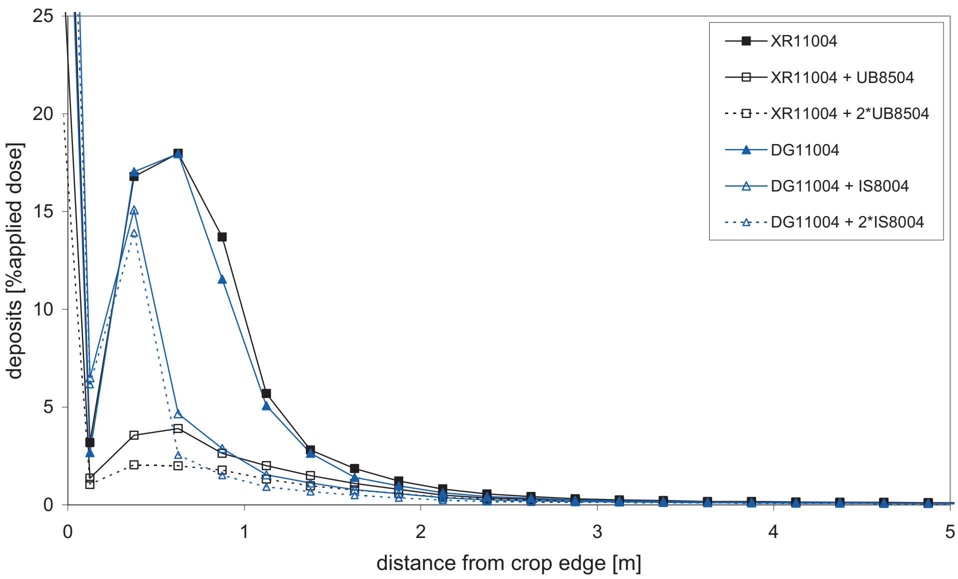

Figure 11. *Downwind drift for boom sprayers without end nozzle, and with one or two end nozzles; for XR11004 and DG11004 only; first nozzle located 0.25m upwind from crop edge (cereals); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water; average wind velocity 3 m/s.*

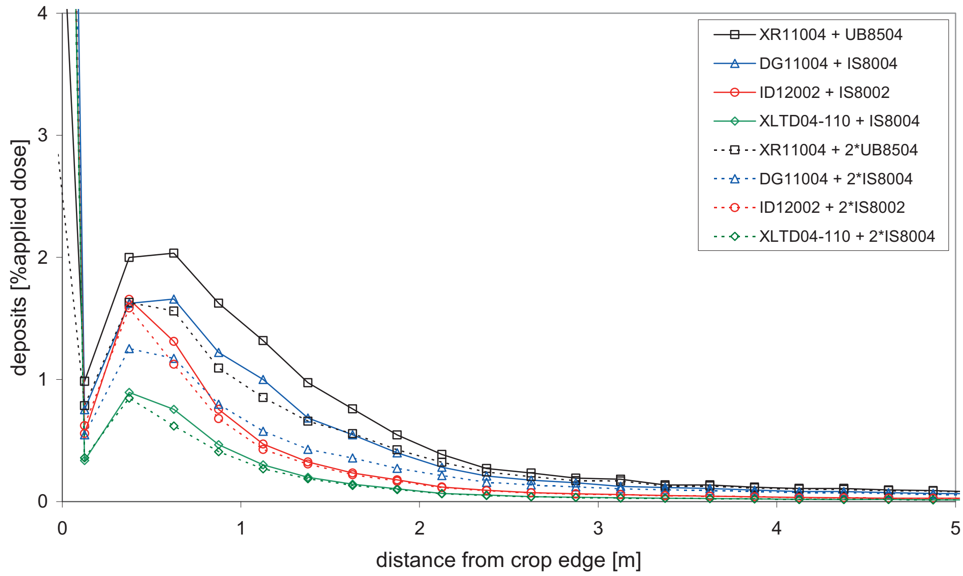

Figure 12. *Downwind drift for boom sprayers with one or two end nozzles; first nozzle located 0.50m upwind from crop edge (potato/sugar beet); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water; average wind velocity 3 m/s.*

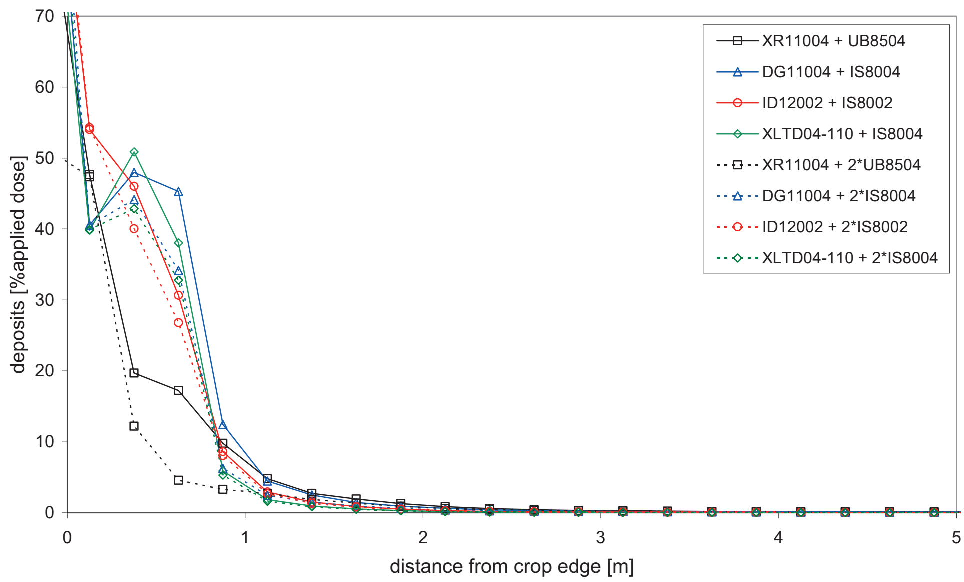

Figure 13. *Downwind drift for boom sprayers with one or two end nozzles; first nozzle located 0.125m downwind from crop edge (maize); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water; average wind velocity 3 m/s.*

To give an impression of drift reduction as a function of distance, in Figure 14 drift deposits are shown relative to a boom with all XR11004 nozzles for a potato/sugar beet crop. Exchanging all XR11004 nozzles with other flat fan nozzle types can reduce drift deposits, especially when using ID12002 or XLTD04-110 nozzles. The curves also show that the use of one or two end nozzles can reduce drift considerably in case of XR1004 or DG11004 nozzles, but the reduction declines farther downwind. With ID12002 or XLTD04-110 nozzles, a single end nozzle significantly reduces drift from 0 – 2 m but farther downwind, an end nozzle has little effect. Using a second end nozzle in those cases has little effect at any distances. Clearly, if drift is low already, there is little room for drift reduction! The low deposits in these cases are caused mainly by settling of small drift-prone drops. Such drops are produced by all nozzles (though in different amounts) and initial velocity or direction of those drops is not an important aspect since these drops are entrained rapidly by any wind and will drift downwind anyway.

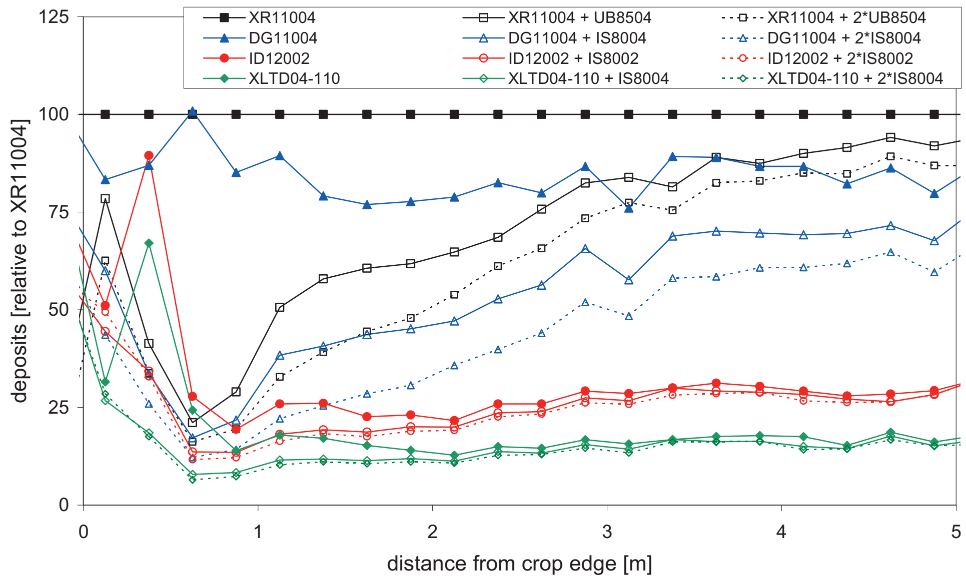

Figure 14. *Downwind drift for boom sprayers relative to the case with XR11004 nozzles; without end nozzles, and with one or two end nozzles; first nozzle located 0.50m upwind from crop edge (potato/sugar beet); crop height 0.50 m; boom height 0.50 m above crop; spray liquid water; average wind velocity 3 m/s.*

3.2.2 Trends in drift reductions on reference distance

Table 6 gives the reference distances where spray deposits are computed and compared. The tables in Appendix I show spray deposits in these ranges for all individual simulations. For global trends in drift reduction, various situations can be taken together and averaged. Of particular interest are the effects of one or two end nozzles and in which situations these can be an effective drift reducing strategy.

Figure 15 shows averaged drift reductions by using end nozzles, as estimated using the reference distances for various crops and both spray liquids used. A further distinction was made for boom height, averaging over different crop heights, wind velocities, and nozzle types. On average, using a second end nozzle in the last-but-one position does have a positive effect, though in some cases it is only limited. For cereals, average drift reduction is high in all cases. Except for maize, the average reduction due to end nozzles is better for the higher sprayer boom (0.5 m). With maize and high sprayer boom, the spray from the end nozzles can easily reach the reference range resulting in a relatively low drift reduction. For potato or sugar beet combined with a low sprayer boom, end nozzles are less effective (roughly only 30-40% reduction), probably due to the fact that the last nozzle is 0.50 m upwind from the crop edge, and with a boom height of only 0.3 m, even a normal flat fan nozzle will not spray directly over the crop edge, thus limiting the effect of an end nozzle. In most cases, using Agral as a surfactant in the spray liquid appears to decrease drift reduction slightly, except for potato/sugar beet and lower boom in which cases such decrease is considerable.

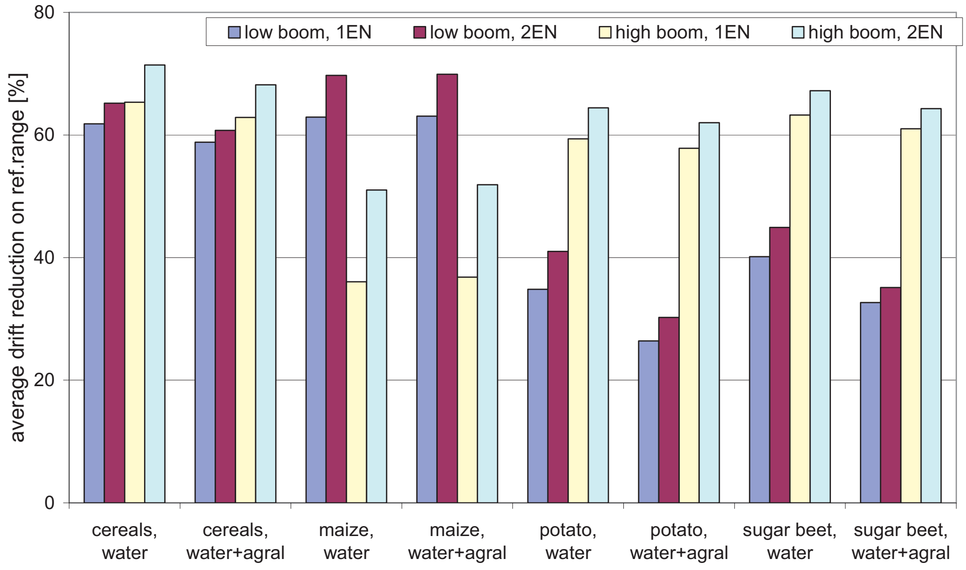

Figure 15. *Averaged drift reduction on reference range by the use of one or two end nozzles, per crop type and per spray liquid. Low boom: 0.3 m above the crop; high boom: 0.5 m above crop. 1EN: one end nozzle; 2EN: two end nozzles. Averaged over different crop heights, wind speeds, and nozzle types.*

Making a distinction regarding crop height rather than boom height, Figure 16 shows averaged drift reductions. Again, average drift reductions are high for a cereal crop, especially for a higher crop. For other crop types, with higher crops the use of end nozzles appears to be (slightly) less effective. For maize the same explanation as for a higher sprayer boom is valid. For potato and sugar beet, an effect of crop height is present but only limited. Other effects are similar to those observed in Figure 15, such as the slight decrease in drift reduction in most cases due to the presence of Agral in the spray liquid.

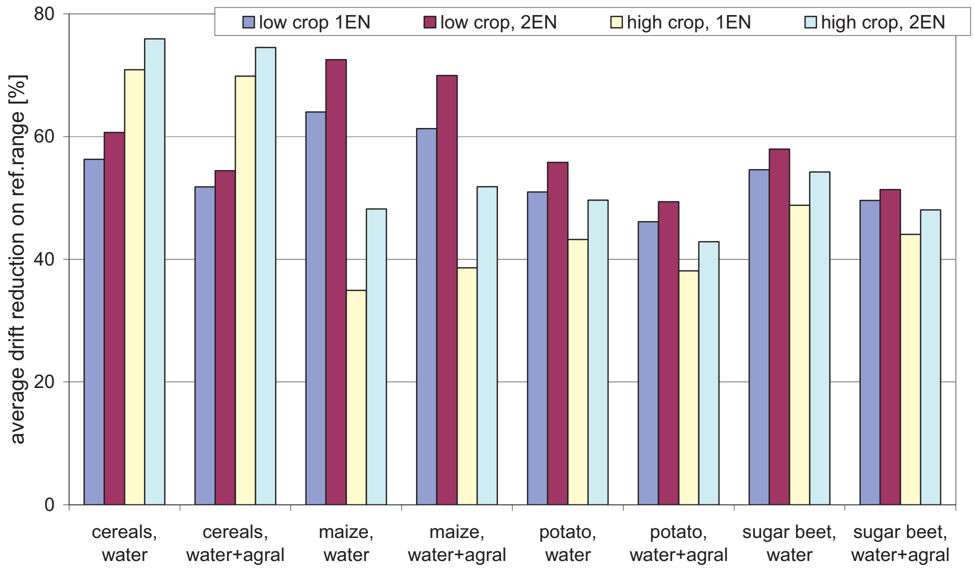

Figure 16. *Averaged drift reduction on reference range by the use of one or two end nozzles, per crop type and per spray liquid. Low crop: 0.25 m; high crop: 0.50 m. 1EN: one end nozzle; 2EN: two end nozzles. Averaged over different boom heights, wind speeds, and nozzle types.*

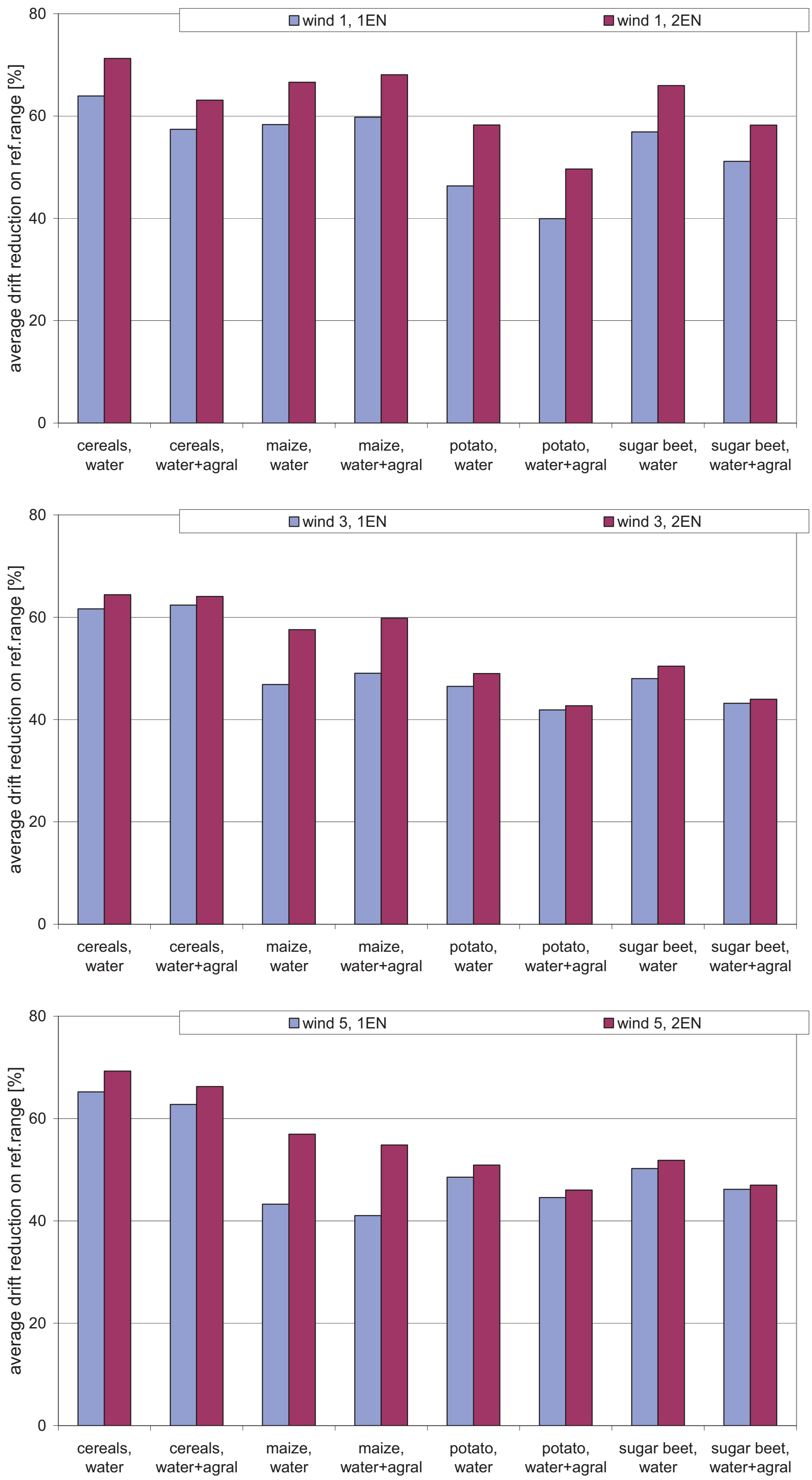

Figure 17. *Averaged drift reduction on reference range by the use of one or two end nozzles, per crop type and per spray liquid. Top: wind 1 m/s; middle: wind 3 m/s; bottom: wind 5 m/s. 1EN: one end nozzle; 2EN: two end nozzles. Averaged over different crop heights, boom heights, and nozzle types.*

Figure 17 shows drift reductions when using end nozzles with respect to wind velocity. For maize, increasing wind velocity leads to lower drift reductions. For the other crops such an effect is absent to unclear. Using a second end nozzle appears to be most effective with the lowest wind velocity, in which cases more drops tend to follow their initial direction. With higher wind velocities, drops are more easily blown downwind and this limits the effectiveness of a second end nozzle. This effect is observed clearly for potato and sugar beet but is also present for a cereal crop. However, for maize and a sprayer with only one end nozzle, the decrease in drift reduction with increasing wind velocity is so large that the use of a second end nozzle still has a strong positive effect on drift reduction.

3.2.3 Drift reductions with respect to a reference situation

In another approach, one may calculate drift reductions with respect to a fixed reference situation. Such a reference would be the situation using a sprayer supplied with all XR11004 nozzles, with boom height of 0.5 m above the crop, crop height of 0.5 m, and an average wind velocity of 3 m/s (i.e., a reference situation also used in Van de Zande *et al.*, 2000, 2007). For maize, the results are summarized in Table 7 and Table 8, for potatoes in Table 9 and Table 10. Drift reductions are computed at the distance range as given before (see Table 6). For convenience, reduction larger than 90% are marked with a single bullet (•), and reductions larger than 95% are marked with two bullets (••).

In all cases, reducing boom height enhances drift reduction. For maize, spraying at an earlier stage (i.e., over a lower crop) gives a greater drift reduction than when spraying over a higher crop. For potatoes, there is no such clear correlation with crop height. In fact, in most cases drift reduction appears rather insensitive to changes in crop height although there is a slight trend to lower drift reduction with increasing wind speed. Remarkably, with XR11004 and DG11004 nozzles, several cases show a significant decrease in drift reduction with decreasing crop height, particularly when no end nozzles were used. Apparently, the higher crop has a stronger shadowing effect than the lower crop, thus resulting in better drift reduction with the higher crop. When end nozzles are used, the shadowing effect is less important and effects related to crop height are much smaller. For maize, such a shadowing effect is completely absent, since the outer nozzle is located off the crop edge.

Regarding drift reductions above 90%, for maize such reductions only occur with at least one end nozzle and sprayer boom lowered to 0.3 m above the crop. In most cases, a reduced crop height is required as well.
For a potato crop, reductions above 90% typically require the coarser nozzle types (ID12002 and XLTD04-110) and at least one end nozzle, though there are some important exceptions. For instance, with these coarser nozzle types, a low sprayer boom provides reductions well above 95%, regardless of crop height, wind speed or the use of end nozzles. When using XR11004 or DG11004 with one or two end nozzles, some occasions with low sprayer boom appear to give reductions above 90% as well.

The use of a second end nozzle does not always give rise to greater drift reduction. Typically, a second end nozzle appears to be useful only in case of XR11004 or DG11004 nozzles (i.e., the standard and 50% drift reducing nozzles used in this work). Since those nozzle types have a relatively wide top angle, in the last-but-one position these may still spray directly over the edge of the crop. Consequently, having an end nozzle in that position will reduce drift deposits next to the field. It should be noted that in some cases a second end nozzle appears to result in slightly higher deposits (i.e., lower reductions) compared to the equivalent situations with only one end nozzle (see Table 9, Table 10), though the observed differences may be statistically insignificant.

Table 7. Drift reduction with respect to reference situation, for maize, spraying water, wind velocity 3m/s.

Nozzle type	End nozzle	Crop height [m]	Boom height [m]	Drift reduction with respect to reference [%] [1,2]								
				0 EN [3]			1 EN [3]			2 EN [3]		
				W1	W3	W5	W1	W3	W5	W1	W3	W5
XR11004	UB8504	0.25	0.30	62	51	50	•94	88	87	••98	•94	•93
			0.50	32	14	8	80	64	59	•90	82	81
		0.50	0.30	41	28	24	86	79	77	••95	•90	89
			0.50	15	0 [1]	-15	65	48	37	85	74	73
DG11004	IS8004	0.25	0.30	62	54	52	••95	•90	88	••97	•94	•94
			0.50	36	20	7	71	52	40	81	70	62
		0.50	0.30	42	33	25	70	58	54	78	69	66
			0.50	18	2	-7	40	15	2	57	41	39
ID12002	IS8002	0.25	0.30	86	81	79	••98	•94	•92	••98	•94	•92
			0.50	69	57	48	85	77	64	85	77	69
		0.50	0.30	72	63	56	84	75	69	84	75	69
			0.50	59	42	28	71	50	34	72	56	45
XLTD04-110	IS8004	0.25	0.30	83	79	82	••99	••98	••98	••99	••98	••98
			0.50	67	60	54	87	78	67	87	78	71
		0.50	0.30	65	63	60	81	74	71	81	74	71
			0.50	56	43	31	65	45	41	66	53	50

[1] *reference situation: XR11004, crop height 0.50 m, boom height 0.50 m, no end nozzle*

[2] *reductions ≥90% are marked with a single bullet (•), reductions ≥95% are marked with a double bullet (••).*

[3] *0 EN, 1 EN, 2 EN: no end nozzle, one or two end nozzles, respectively; W1, W3, W5: wind speed 1, 3 and 5 m/s.*

Table 8. Drift reduction with respect to reference situation, for maize, spraying water+Agral, wind velocity 3m/s.

Nozzle type	End nozzle	Crop height [m]	Boom height [m]	Drift reduction with respect to reference [%] [1,2]								
				0 EN [3]			1 EN [3]			2 EN [3]		
				W1	W3	W5	W1	W3	W5	W1	W3	W5
XR11004	UB8504	0.25	0.30	59	54	47	•94	88	86	••98	•94	•93
			0.50	33	16	5	79	64	55	•90	82	81
		0.50	0.30	41	27	22	85	78	77	••96	•90	•90
			0.50	20	0 [1]	-14	66	49	40	85	75	75
DG11004	IS8004	0.25	0.30	61	54	54	•94	89	84	••96	•93	•90
			0.50	36	17	10	71	52	39	80	70	61
		0.50	0.30	43	31	26	74	63	56	82	73	68
			0.50	17	2	-9	41	20	4	60	47	39
ID12002	IS8002	0.25	0.30	85	82	79	••98	•93	•91	••98	•93	•91
			0.50	67	58	46	84	76	60	84	76	64
		0.50	0.30	71	63	55	85	76	68	85	76	68
			0.50	59	40	24	70	51	33	71	56	42
XLTD04-110	IS8004	0.25	0.30	84	81	78	••98	••97	•94	••99	••98	•94
			0.50	67	59	54	86	78	66	87	79	70
		0.50	0.30	68	63	60	86	79	74	86	79	74
			0.50	56	41	32	68	52	39	70	59	51

[1] *reference situation: XR11004, crop height 0.50 m, boom height 0.50 m, no end nozzle*

[2] *reductions ≥90% are marked with a single bullet (•), reductions ≥95% are marked with a double bullet (••).*

[3] *0 EN, 1 EN, 2 EN: no end nozzle, one or two end nozzles, respectively; W1, W3, W5: wind speed 1, 3 and 5 m/s.*

Table 9. Drift reduction with respect to reference situation, for potatoes, spraying water, wind velocity 3m/s.

Nozzle type	End nozzle	Crop height [m]	Boom height [m]	Drift reduction with respect to reference [%] [1,2]								
				0 EN [3]			1 EN [3]			2 EN [3]		
				W1	W3	W5	W1	W3	W5	W1	W3	W5
XR11004	UB8504	0.25	0.30	56	64	72	•91	85	85	••97	88	87
			0.50	13	-19	-36	67	53	55	77	60	62
		0.50	0.30	54	66	76	84	82	85	••95	85	87
			0.50	5	0 [1]	4	51	53	62	68	55	64
DG11004	IS8004	0.25	0.30	71	76	81	•92	•90	•90	••96	•91	•92
			0.50	20	0	-23	76	68	71	82	75	77
		0.50	0.30	69	77	83	87	88	•91	•94	89	•92
			0.50	11	13	6	65	71	76	76	73	80
ID12002	IS8002	0.25	0.30	••98	••96	••97	••98	••96	••97	••98	••96	••97
			0.50	•91	77	70	•93	•90	•91	•94	•90	•91
		0.50	0.30	••97	••96	••97	••97	••96	••97	••97	••96	••97
			0.50	89	78	71	•91	•91	•93	•93	•90	•93
XLTD04-110	IS8004	0.25	0.30	••97	••97	••97	••99	••98	••98	••99	••98	••98
			0.50	•90	77	76	••95	•93	•93	••96	•92	•93
		0.50	0.30	••97	••97	••98	••98	••97	••98	••98	••97	••98
			0.50	89	83	80	•93	•93	•94	••95	•93	•94

[1] *reference situation: XR11004, crop height 0.50 m, boom height 0.50 m, no end nozzle*

[2] *reductions ≥90% are marked with a single bullet (•), reductions ≥95% are marked with a double bullet (••).*

[3] *0 EN, 1 EN, 2 EN: no end nozzle, one or two end nozzles, respectively; W1, W3, W5: wind speed 1, 3 and 5 m/s.*

Table 10. Drift reduction with respect to reference situation, for potatoes, spraying water+Agral, wind velocity 3m/s.

Nozzle type	End nozzle	Crop height [m]	Boom height [m]	Drift reduction with respect to reference [%] [1,2]								
				0 EN [3]			1 EN [3]			2 EN [3]		
				W1	W3	W5	W1	W3	W5	W1	W3	W5
XR11004	UB8504	0.25	0.30	56	64	72	•91	86	85	••97	88	88
			0.50	7	-12	-37	67	54	48	77	61	62
		0.50	0.30	53	64	76	84	82	84	••95	85	86
			0.50	6	0 [1]	3	52	55	63	68	56	66
DG11004	IS8004	0.25	0.30	71	75	80	•91	88	89	•94	•90	•91
			0.50	24	-7	-28	73	65	68	79	71	74
		0.50	0.30	68	78	84	85	87	•90	•91	88	•91
			0.50	15	8	12	63	68	75	73	70	78
ID12002	IS8002	0.25	0.30	••98	••96	••97	••98	••96	••97	••98	••96	••97
			0.50	•90	77	70	•92	•90	•91	•93	89	•91
		0.50	0.30	••97	••96	••97	••96	••96	••97	••96	••96	••97
			0.50	•90	78	67	•91	•90	•93	•92	89	•92
XLTD04-110	IS8004	0.25	0.30	••97	••97	••97	••98	••97	••97	••98	••97	••97
			0.50	89	74	72	•94	•91	•93	•94	•91	•92
		0.50	0.30	••96	••97	••98	••97	••97	••98	••97	••96	••97
			0.50	83	82	82	•92	•92	•94	•93	•91	•93

[1] *reference situation: XR11004, crop height 0.50 m, boom height 0.50 m, no end nozzle*

[2] *reductions ≥90% are marked with a single bullet (•), reductions ≥95% are marked with a double bullet (••).*

[3] *0 EN, 1 EN, 2 EN: no end nozzle, one or two end nozzles, respectively; W1, W3, W5: wind speed 1, 3 and 5 m/s.*

4. Conclusion

With IDEFICS, the effect of using end nozzles on drift reduction can be estimated. The various drift curves show that the results may not be straightforward nor intuitive and need to be looked at thoroughly. In most cases, a single end nozzle at the position of the last nozzle of the boom sprayer can give large drift reductions of up to 60-70%, though in some cases it is as little as 30%. This strongly depends on both the position of the last nozzle and the location of the reference range with respect to the edge of the crop. Typically, using a second end nozzle can enhance drift reduction by as much as about 10%, though in several cases its will be only a few percent. So far, only averaged trends are described. In specific situations, the use of end nozzles can reduce drift by up to 95%, but also as low as -20% (in fact enhancing drift). Usually, the effect of end nozzles is limited to a few meters next to the crop, whereas the largest effects are observed at about 0.5-1.0 m off the crop edge.

For low-drift nozzle types such as ID12002 and XLTD04-110, using end nozzles has only minor effects since end nozzles cannot reduce drift if there is (almost) no drift at all.

A surfactant may affect drop size distribution; however, in many cases, the effects on spray drift due to changes in drop size distribution are relatively small compared to other factors such as wind velocity, crop height and boom height. Nevertheless, such changes can still be significant and need to be borne in mind.

With respect to a reference situation (XR11004 nozzles, sprayer boom height 0.5 m, crop height 0.5 m, wind speed 3 m/s), the use of coarse nozzles and lowering the sprayer boom can result in drift reduction well above 95% when spraying a potato crop. For a maize crop such high reductions are much more restricted, due to the difference in nozzle positions with respect to the edge of the crop.

Typically, the use of a second end nozzle appears to be useful only when it replaces a wide-angled nozzle like XR11004 or DG11004. When used with ID12002 or XLTD04-110, these having smaller top angles, a second end nozzle doe not affect drift deposits significantly.

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Appendix I.
Drift deposits results

Key to tables I-1 through I-8:
Endnoz: type of end nozzle.
Boomhgt: height of sprayer boom above the crop.
Crophgt: average height of the crop above ground level.
Windspd: average wind velocity at a height of 2 m above cut grass.
Drift0: drift deposits (% applied dose) on assessment range (corresponding to the selected crop type), with all flat fan nozzles (column 1).
Drift1: drift deposits on assessment range, with outmost nozzle replaced with an end nozzle (type given in column 2)
Drift2: as Drift1, but with 2nd nozzle from boom end also replaced with an end nozzle.
Reduc1: drift reduction percentage of Drift1 with respect to Drift0.
Reduc2: drift reduction percentage of Drift2 with respect to Drift0.

Table I - 1. Drift onto reference range for cereals, for a sprayer with 0, 1 or 2 end nozzles; spray liquid water.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	2.21	0.57	0.20	74.1	90.9
XR11004	UB8504	0.3	0.25	3	3.53	0.98	0.82	72.2	76.7
XR11004	UB8504	0.3	0.25	5	3.79	1.15	1.00	69.7	73.7
XR11004	UB8504	0.5	0.25	1	6.17	2.02	1.07	67.3	82.7
XR11004	UB8504	0.5	0.25	3	9.50	3.43	2.87	63.9	69.8
XR11004	UB8504	0.5	0.25	5	11.51	4.31	2.96	62.6	74.2
XR11004	UB8504	0.3	0.5	1	5.51	1.13	0.37	79.4	93.4
XR11004	UB8504	0.3	0.5	3	7.03	1.81	1.34	74.3	80.9
XR11004	UB8504	0.3	0.5	5	7.75	1.70	1.40	78.1	81.9
XR11004	UB8504	0.5	0.5	1	10.16	3.27	1.61	67.8	84.1
XR11004	UB8504	0.5	0.5	3	13.49	5.03	4.01	62.7	70.2
XR11004	UB8504	0.5	0.5	5	16.12	6.00	3.86	62.8	76.0
DG11004	IS8004	0.3	0.25	1	1.72	0.39	0.16	77.6	90.7
DG11004	IS8004	0.3	0.25	3	2.76	0.69	0.56	75.2	79.7
DG11004	IS8004	0.3	0.25	5	3.13	0.74	0.60	76.4	80.7
DG11004	IS8004	0.5	0.25	1	5.44	1.34	0.76	75.3	86.0
DG11004	IS8004	0.5	0.25	3	8.08	2.29	1.76	71.7	78.2
DG11004	IS8004	0.5	0.25	5	10.42	3.35	1.81	67.8	82.7
DG11004	IS8004	0.3	0.5	1	4.73	0.69	0.31	85.3	93.4
DG11004	IS8004	0.3	0.5	3	6.49	1.23	0.98	81.1	84.9
DG11004	IS8004	0.3	0.5	5	7.01	1.17	0.95	83.4	86.4
DG11004	IS8004	0.5	0.5	1	8.87	2.19	1.10	75.3	87.6
DG11004	IS8004	0.5	0.5	3	11.98	3.99	2.71	66.7	77.4
DG11004	IS8004	0.5	0.5	5	15.10	5.87	3.60	61.1	76.1
ID12002	IS8002	0.3	0.25	1	0.14	0.08	0.08	42.2	38.8
ID12002	IS8002	0.3	0.25	3	0.22	0.21	0.22	4.4	-0.8
ID12002	IS8002	0.3	0.25	5	0.26	0.22	0.23	14.6	11.0
ID12002	IS8002	0.5	0.25	1	0.35	0.31	0.31	12.5	12.1
ID12002	IS8002	0.5	0.25	3	1.72	0.61	0.64	64.3	62.8
ID12002	IS8002	0.5	0.25	5	2.78	0.65	0.66	76.4	76.2
ID12002	IS8002	0.3	0.5	1	0.27	0.14	0.14	46.7	47.9
ID12002	IS8002	0.3	0.5	3	0.51	0.36	0.36	29.9	30.0
ID12002	IS8002	0.3	0.5	5	1.48	0.34	0.35	77.1	76.5
ID12002	IS8002	0.5	0.5	1	1.54	0.41	0.41	73.4	73.4
ID12002	IS8002	0.5	0.5	3	3.46	0.93	0.95	73.1	72.7
ID12002	IS8002	0.5	0.5	5	6.14	2.67	2.67	56.5	56.4
XLTD04	IS8004	0.3	0.25	1	0.10	0.05	0.04	51.9	55.5
XLTD04	IS8004	0.3	0.25	3	0.20	0.15	0.15	24.9	24.8
XLTD04	IS8004	0.3	0.25	5	0.23	0.16	0.16	31.0	29.8
XLTD04	IS8004	0.5	0.25	1	0.33	0.22	0.21	32.3	38.0
XLTD04	IS8004	0.5	0.25	3	1.46	0.48	0.48	67.2	66.8
XLTD04	IS8004	0.5	0.25	5	2.10	0.52	0.52	75.2	75.4
XLTD04	IS8004	0.3	0.5	1	0.37	0.09	0.08	74.6	77.5
XLTD04	IS8004	0.3	0.5	3	1.11	0.28	0.27	75.0	76.1
XLTD04	IS8004	0.3	0.5	5	1.71	0.27	0.27	84.2	84.3
XLTD04	IS8004	0.5	0.5	1	2.34	0.31	0.28	86.7	88.0
XLTD04	IS8004	0.5	0.5	3	3.75	0.78	0.76	79.3	79.8
XLTD04	IS8004	0.5	0.5	5	5.72	1.91	1.89	66.7	67.0

Table I - 2. Drift onto reference range for cereals, for sprayer with 0, 1 or 2 end nozzles; spray liquid water+Agral.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	2.40	0.59	0.21	75.3	91.1
XR11004	UB8504	0.3	0.25	3	3.80	1.02	0.86	73.3	77.5
XR11004	UB8504	0.3	0.25	5	3.92	1.18	0.99	70.0	74.9
XR11004	UB8504	0.5	0.25	1	6.27	2.06	1.11	67.1	82.4
XR11004	UB8504	0.5	0.25	3	9.67	3.43	2.86	64.6	70.4
XR11004	UB8504	0.5	0.25	5	11.67	4.63	3.07	60.3	73.7
XR11004	UB8504	0.3	0.5	1	5.67	1.16	0.36	79.6	93.7
XR11004	UB8504	0.3	0.5	3	7.19	1.83	1.32	74.6	81.6
XR11004	UB8504	0.3	0.5	5	7.85	1.77	1.42	77.4	81.9
XR11004	UB8504	0.5	0.5	1	10.08	3.45	1.61	65.8	84.0
XR11004	UB8504	0.5	0.5	3	13.85	5.26	4.13	62.0	70.2
XR11004	UB8504	0.5	0.5	5	15.89	6.09	3.94	61.7	75.2
DG11004	IS8004	0.3	0.25	1	1.73	0.43	0.23	75.4	86.7
DG11004	IS8004	0.3	0.25	3	2.87	0.74	0.65	74.2	77.3
DG11004	IS8004	0.3	0.25	5	3.20	0.81	0.71	74.6	77.9
DG11004	IS8004	0.5	0.25	1	5.44	1.50	0.96	72.3	82.4
DG11004	IS8004	0.5	0.25	3	8.54	2.44	1.98	71.4	76.8
DG11004	IS8004	0.5	0.25	5	10.94	3.57	2.09	67.3	80.9
DG11004	IS8004	0.3	0.5	1	4.73	0.77	0.41	83.7	91.4
DG11004	IS8004	0.3	0.5	3	6.39	1.38	1.14	78.5	82.1
DG11004	IS8004	0.3	0.5	5	6.94	1.26	1.06	81.8	84.7
DG11004	IS8004	0.5	0.5	1	9.22	2.45	1.31	73.5	85.7
DG11004	IS8004	0.5	0.5	3	12.64	4.42	3.07	65.1	75.7
DG11004	IS8004	0.5	0.5	5	15.05	6.34	4.09	57.9	72.8
ID12002	IS8002	0.3	0.25	1	0.13	0.09	0.10	29.0	23.0
ID12002	IS8002	0.3	0.25	3	0.22	0.23	0.25	-5.3	-13.9
ID12002	IS8002	0.3	0.25	5	0.26	0.24	0.26	7.4	1.3
ID12002	IS8002	0.5	0.25	1	0.36	0.36	0.38	-0.7	-5.6
ID12002	IS8002	0.5	0.25	3	1.77	0.67	0.71	61.9	59.7
ID12002	IS8002	0.5	0.25	5	2.78	0.72	0.75	74.1	73.1
ID12002	IS8002	0.3	0.5	1	0.27	0.17	0.17	38.4	37.4
ID12002	IS8002	0.3	0.5	3	1.08	0.40	0.41	63.3	62.1
ID12002	IS8002	0.3	0.5	5	1.50	0.37	0.39	75.2	74.1
ID12002	IS8002	0.5	0.5	1	1.33	0.46	0.48	65.2	63.8
ID12002	IS8002	0.5	0.5	3	4.76	1.03	1.07	78.4	77.6
ID12002	IS8002	0.5	0.5	5	6.48	2.83	2.87	56.3	55.7
XLTD04	IS8004	0.3	0.25	1	0.11	0.07	0.07	31.8	30.2
XLTD04	IS8004	0.3	0.25	3	0.21	0.18	0.20	15.2	9.1
XLTD04	IS8004	0.3	0.25	5	0.25	0.20	0.21	20.4	15.6
XLTD04	IS8004	0.5	0.25	1	0.36	0.30	0.30	18.3	18.7
XLTD04	IS8004	0.5	0.25	3	1.71	0.54	0.58	68.5	66.4
XLTD04	IS8004	0.5	0.25	5	2.65	0.60	0.62	77.3	76.8
XLTD04	IS8004	0.3	0.5	1	0.37	0.13	0.13	64.4	65.3
XLTD04	IS8004	0.3	0.5	3	1.20	0.33	0.33	72.5	72.7
XLTD04	IS8004	0.3	0.5	5	1.57	0.30	0.31	80.7	80.1
XLTD04	IS8004	0.5	0.5	1	1.86	0.39	0.38	78.8	79.6
XLTD04	IS8004	0.5	0.5	3	4.33	0.87	0.89	79.9	79.5
XLTD04	IS8004	0.5	0.5	5	5.66	2.16	2.18	61.8	61.5

Table I - 3. Drift onto reference range for maize, for sprayer with 0, 1 or 2 end nozzles; spray liquid water.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	9.50	1.46	0.45	84.6	95.3
XR11004	UB8504	0.3	0.25	3	12.28	2.89	1.43	76.5	88.4
XR11004	UB8504	0.3	0.25	5	12.59	3.36	1.67	73.3	86.7
XR11004	UB8504	0.5	0.25	1	16.89	5.06	2.54	70.0	85.0
XR11004	UB8504	0.5	0.25	3	21.47	8.98	4.40	58.2	79.5
XR11004	UB8504	0.5	0.25	5	23.11	10.21	4.74	55.8	79.5
XR11004	UB8504	0.3	0.5	1	14.77	3.44	1.13	76.7	92.3
XR11004	UB8504	0.3	0.5	3	18.04	5.19	2.49	71.2	86.2
XR11004	UB8504	0.3	0.5	5	18.92	5.85	2.64	69.1	86.0
XR11004	UB8504	0.5	0.5	1	21.34	8.68	3.72	59.3	82.6
XR11004	UB8504	0.5	0.5	3	25.01	12.94	6.45	48.3	74.2
XR11004	UB8504	0.5	0.5	5	28.82	15.74	6.79	45.4	76.4
DG11004	IS8004	0.3	0.25	1	9.59	1.25	0.75	87.0	92.2
DG11004	IS8004	0.3	0.25	3	11.50	2.47	1.56	78.5	86.4
DG11004	IS8004	0.3	0.25	5	11.97	2.99	1.53	75.0	87.2
DG11004	IS8004	0.5	0.25	1	16.04	7.19	4.78	55.2	70.2
DG11004	IS8004	0.5	0.25	3	20.10	12.02	7.62	40.2	62.1
DG11004	IS8004	0.5	0.25	5	23.18	15.08	9.62	35.0	58.5
DG11004	IS8004	0.3	0.5	1	14.39	7.59	5.50	47.3	61.8
DG11004	IS8004	0.3	0.5	3	16.84	10.49	7.88	37.7	53.2
DG11004	IS8004	0.3	0.5	5	18.88	11.59	8.53	38.6	54.8
DG11004	IS8004	0.5	0.5	1	20.49	15.13	10.69	26.2	47.8
DG11004	IS8004	0.5	0.5	3	24.56	21.17	14.69	13.8	40.2
DG11004	IS8004	0.5	0.5	5	26.74	24.42	15.20	8.7	43.1
ID12002	IS8002	0.3	0.25	1	3.40	0.44	0.41	86.9	88.1
ID12002	IS8002	0.3	0.25	3	4.76	1.57	1.57	66.9	67.0
ID12002	IS8002	0.3	0.25	5	5.37	1.94	1.93	63.9	64.1
ID12002	IS8002	0.5	0.25	1	7.67	3.85	3.78	49.8	50.8
ID12002	IS8002	0.5	0.25	3	10.70	5.81	5.77	45.7	46.0
ID12002	IS8002	0.5	0.25	5	13.10	8.91	7.78	32.0	40.6
ID12002	IS8002	0.3	0.5	1	7.13	4.12	4.04	42.2	43.3
ID12002	IS8002	0.3	0.5	3	9.20	6.33	6.29	31.1	31.6
ID12002	IS8002	0.3	0.5	5	10.93	7.77	7.74	28.9	29.2
ID12002	IS8002	0.5	0.5	1	10.33	7.28	7.10	29.5	31.3
ID12002	IS8002	0.5	0.5	3	14.53	12.59	11.09	13.3	23.7
ID12002	IS8002	0.5	0.5	5	18.03	16.55	13.68	8.2	24.1
XLTD04	IS8004	0.3	0.25	1	4.25	0.30	0.25	93.1	94.2
XLTD04	IS8004	0.3	0.25	3	5.18	0.54	0.52	89.6	90.0
XLTD04	IS8004	0.3	0.25	5	4.57	0.53	0.51	88.4	88.9
XLTD04	IS8004	0.5	0.25	1	8.30	3.37	3.29	59.4	60.4
XLTD04	IS8004	0.5	0.25	3	9.93	5.60	5.50	43.6	44.6
XLTD04	IS8004	0.5	0.25	5	11.40	8.25	7.38	27.6	35.3
XLTD04	IS8004	0.3	0.5	1	8.83	4.78	4.67	45.8	47.1
XLTD04	IS8004	0.3	0.5	3	9.33	6.56	6.50	29.7	30.3
XLTD04	IS8004	0.3	0.5	5	10.03	7.23	7.18	27.9	28.4
XLTD04	IS8004	0.5	0.5	1	11.01	8.77	8.44	20.4	23.3
XLTD04	IS8004	0.5	0.5	3	14.38	13.64	11.84	5.1	17.7
XLTD04	IS8004	0.5	0.5	5	17.22	14.78	12.38	14.2	28.1

Table I - 4. Drift onto reference range for maize, for sprayer with 0, 1 or 2 end nozzles; spray liquid water+Agral.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	10.50	1.52	0.47	85.5	95.6
XR11004	UB8504	0.3	0.25	3	11.57	3.09	1.44	73.3	87.5
XR11004	UB8504	0.3	0.25	5	13.58	3.50	1.69	74.2	87.5
XR11004	UB8504	0.5	0.25	1	17.13	5.23	2.57	69.5	85.0
XR11004	UB8504	0.5	0.25	3	21.46	9.20	4.46	57.1	79.2
XR11004	UB8504	0.5	0.25	5	24.17	11.36	4.71	53.0	80.5
XR11004	UB8504	0.3	0.5	1	14.88	3.78	1.10	74.6	92.6
XR11004	UB8504	0.3	0.5	3	18.65	5.61	2.56	69.9	86.3
XR11004	UB8504	0.3	0.5	5	19.80	5.89	2.61	70.3	86.8
XR11004	UB8504	0.5	0.5	1	20.27	8.65	3.78	57.3	81.3
XR11004	UB8504	0.5	0.5	3	25.40	12.97	6.46	48.9	74.6
XR11004	UB8504	0.5	0.5	5	28.90	15.33	6.32	46.9	78.1
DG11004	IS8004	0.3	0.25	1	9.92	1.51	1.01	84.8	89.8
DG11004	IS8004	0.3	0.25	3	11.64	2.73	1.83	76.6	84.3
DG11004	IS8004	0.3	0.25	5	11.75	4.02	2.56	65.8	78.2
DG11004	IS8004	0.5	0.25	1	16.20	7.31	5.08	54.9	68.6
DG11004	IS8004	0.5	0.25	3	21.10	12.26	7.72	41.9	63.4
DG11004	IS8004	0.5	0.25	5	22.96	15.59	10.03	32.1	56.3
DG11004	IS8004	0.3	0.5	1	14.49	6.49	4.48	55.2	69.1
DG11004	IS8004	0.3	0.5	3	17.42	9.47	6.97	45.6	60.0
DG11004	IS8004	0.3	0.5	5	18.88	11.25	8.17	40.4	56.7
DG11004	IS8004	0.5	0.5	1	20.99	14.96	10.09	28.8	52.0
DG11004	IS8004	0.5	0.5	3	24.93	20.33	13.46	18.4	46.0
DG11004	IS8004	0.5	0.5	5	27.78	24.48	15.62	11.9	43.8
ID12002	IS8002	0.3	0.25	1	3.78	0.51	0.48	86.5	87.2
ID12002	IS8002	0.3	0.25	3	4.68	1.81	1.82	61.4	61.2
ID12002	IS8002	0.3	0.25	5	5.40	2.38	2.38	56.0	55.9
ID12002	IS8002	0.5	0.25	1	8.29	4.04	3.98	51.3	51.9
ID12002	IS8002	0.5	0.25	3	10.68	6.11	6.10	42.8	42.8
ID12002	IS8002	0.5	0.25	5	13.68	10.16	9.03	25.7	34.0
ID12002	IS8002	0.3	0.5	1	7.46	3.76	3.70	49.6	50.4
ID12002	IS8002	0.3	0.5	3	9.37	6.00	5.98	36.0	36.1
ID12002	IS8002	0.3	0.5	5	11.32	8.15	8.12	28.0	28.3
ID12002	IS8002	0.5	0.5	1	10.35	7.60	7.48	26.6	27.7
ID12002	IS8002	0.5	0.5	3	15.13	12.52	11.10	17.3	26.6
ID12002	IS8002	0.5	0.5	5	19.21	17.14	14.81	10.8	22.9
XLTD04	IS8004	0.3	0.25	1	3.95	0.40	0.36	89.8	90.8
XLTD04	IS8004	0.3	0.25	3	4.76	0.64	0.63	86.6	86.8
XLTD04	IS8004	0.3	0.25	5	5.47	1.59	1.58	71.0	71.1
XLTD04	IS8004	0.5	0.25	1	8.27	3.47	3.41	58.1	58.7
XLTD04	IS8004	0.5	0.25	3	10.49	5.47	5.42	47.8	48.4
XLTD04	IS8004	0.5	0.25	5	11.67	8.71	7.71	25.3	33.9
XLTD04	IS8004	0.3	0.5	1	8.16	3.62	3.52	55.6	56.9
XLTD04	IS8004	0.3	0.5	3	9.45	5.45	5.41	42.3	42.8
XLTD04	IS8004	0.3	0.5	5	10.27	6.68	6.64	35.0	35.4
XLTD04	IS8004	0.5	0.5	1	11.15	8.02	7.66	28.0	31.3
XLTD04	IS8004	0.5	0.5	3	14.91	12.14	10.35	18.6	30.6
XLTD04	IS8004	0.5	0.5	5	17.35	15.59	12.52	10.2	27.8

Table I - 5. Drift onto reference range for potato, for sprayer with 0, 1 or 2 end nozzles; spray liquid water.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	3.41	0.72	0.25	79.0	92.5
XR11004	UB8504	0.3	0.25	3	2.80	1.17	0.95	58.2	66.0
XR11004	UB8504	0.3	0.25	5	2.17	1.20	1.01	45.0	53.7
XR11004	UB8504	0.5	0.25	1	6.77	2.57	1.82	62.0	73.2
XR11004	UB8504	0.5	0.25	3	9.30	3.69	3.12	60.3	66.5
XR11004	UB8504	0.5	0.25	5	10.64	3.51	2.98	67.0	72.0
XR11004	UB8504	0.3	0.5	1	3.60	1.26	0.40	64.9	89.0
XR11004	UB8504	0.3	0.5	3	2.66	1.40	1.19	47.3	55.3
XR11004	UB8504	0.3	0.5	5	1.90	1.19	1.04	37.7	45.2
XR11004	UB8504	0.5	0.5	1	7.46	3.82	2.52	48.8	66.2
XR11004	UB8504	0.5	0.5	3	7.82	3.69	3.55	52.9	54.6
XR11004	UB8504	0.5	0.5	5	7.50	2.94	2.80	60.7	62.7
DG11004	IS8004	0.3	0.25	1	2.23	0.62	0.30	72.5	86.6
DG11004	IS8004	0.3	0.25	3	1.86	0.80	0.67	57.2	64.2
DG11004	IS8004	0.3	0.25	5	1.47	0.79	0.63	46.7	57.0
DG11004	IS8004	0.5	0.25	1	6.23	1.87	1.37	70.0	78.0
DG11004	IS8004	0.5	0.25	3	7.83	2.54	1.99	67.6	74.6
DG11004	IS8004	0.5	0.25	5	9.60	2.29	1.81	76.2	81.2
DG11004	IS8004	0.3	0.5	1	2.43	1.04	0.49	57.4	79.9
DG11004	IS8004	0.3	0.5	3	1.82	0.95	0.84	48.0	54.1
DG11004	IS8004	0.3	0.5	5	1.31	0.73	0.64	44.0	51.2
DG11004	IS8004	0.5	0.5	1	6.92	2.72	1.87	60.8	73.0
DG11004	IS8004	0.5	0.5	3	6.83	2.29	2.08	66.4	69.5
DG11004	IS8004	0.5	0.5	5	7.36	1.88	1.58	74.4	78.5
ID12002	IS8002	0.3	0.25	1	0.18	0.16	0.16	13.3	12.8
ID12002	IS8002	0.3	0.25	3	0.30	0.28	0.29	7.8	4.7
ID12002	IS8002	0.3	0.25	5	0.26	0.23	0.24	9.2	6.7
ID12002	IS8002	0.5	0.25	1	0.69	0.57	0.51	17.6	27.0
ID12002	IS8002	0.5	0.25	3	1.80	0.75	0.78	58.3	56.5
ID12002	IS8002	0.5	0.25	5	2.34	0.67	0.68	71.4	70.8
ID12002	IS8002	0.3	0.5	1	0.27	0.26	0.24	5.2	11.6
ID12002	IS8002	0.3	0.5	3	0.30	0.30	0.31	-1.6	-3.6
ID12002	IS8002	0.3	0.5	5	0.22	0.22	0.22	2.4	-0.6
ID12002	IS8002	0.5	0.5	1	0.83	0.67	0.56	19.1	32.5
ID12002	IS8002	0.5	0.5	3	1.69	0.73	0.77	56.7	54.6
ID12002	IS8002	0.5	0.5	5	2.25	0.54	0.56	75.9	75.2
XLTD04	IS8004	0.3	0.25	1	0.22	0.10	0.10	53.9	55.2
XLTD04	IS8004	0.3	0.25	3	0.26	0.19	0.19	27.3	28.3
XLTD04	IS8004	0.3	0.25	5	0.21	0.18	0.18	15.7	15.3
XLTD04	IS8004	0.5	0.25	1	0.77	0.40	0.33	47.4	57.2
XLTD04	IS8004	0.5	0.25	3	1.79	0.58	0.59	67.7	67.2
XLTD04	IS8004	0.5	0.25	5	1.90	0.52	0.53	72.6	72.1
XLTD04	IS8004	0.3	0.5	1	0.26	0.19	0.15	28.2	41.4
XLTD04	IS8004	0.3	0.5	3	0.26	0.23	0.22	11.1	14.9
XLTD04	IS8004	0.3	0.5	5	0.18	0.17	0.18	5.8	2.6
XLTD04	IS8004	0.5	0.5	1	0.89	0.52	0.39	41.5	55.9
XLTD04	IS8004	0.5	0.5	3	1.33	0.55	0.57	58.3	56.8
XLTD04	IS8004	0.5	0.5	5	1.59	0.45	0.46	71.7	70.9

Table I - 6. Drift onto reference range for potato, for sprayer with 0, 1 or 2 end nozzles; spray liquid water+Agral.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	3.54	0.74	0.27	79.0	92.5
XR11004	UB8504	0.3	0.25	3	2.92	1.15	0.94	60.6	67.8
XR11004	UB8504	0.3	0.25	5	2.28	1.20	0.97	47.7	57.6
XR11004	UB8504	0.5	0.25	1	7.45	2.65	1.86	64.4	75.1
XR11004	UB8504	0.5	0.25	3	8.99	3.74	3.15	58.4	65.0
XR11004	UB8504	0.5	0.25	5	11.00	4.20	3.05	61.8	72.3
XR11004	UB8504	0.3	0.5	1	3.78	1.31	0.42	65.4	89.0
XR11004	UB8504	0.3	0.5	3	2.91	1.46	1.18	49.9	59.4
XR11004	UB8504	0.3	0.5	5	1.93	1.28	1.12	33.5	41.9
XR11004	UB8504	0.5	0.5	1	7.60	3.90	2.59	48.7	66.0
XR11004	UB8504	0.5	0.5	3	8.05	3.64	3.50	54.7	56.5
XR11004	UB8504	0.5	0.5	5	7.77	2.97	2.72	61.9	65.0
DG11004	IS8004	0.3	0.25	1	2.36	0.72	0.45	69.6	80.9
DG11004	IS8004	0.3	0.25	3	2.01	0.94	0.83	53.3	58.9
DG11004	IS8004	0.3	0.25	5	1.59	0.88	0.75	44.8	53.0
DG11004	IS8004	0.5	0.25	1	6.12	2.15	1.68	65.0	72.6
DG11004	IS8004	0.5	0.25	3	8.61	2.85	2.37	66.9	72.4
DG11004	IS8004	0.5	0.25	5	10.29	2.54	2.06	75.3	80.0
DG11004	IS8004	0.3	0.5	1	2.55	1.22	0.69	52.0	72.8
DG11004	IS8004	0.3	0.5	3	1.78	1.07	0.98	40.0	44.7
DG11004	IS8004	0.3	0.5	5	1.30	0.81	0.72	37.9	44.4
DG11004	IS8004	0.5	0.5	1	6.87	3.01	2.21	56.2	67.9
DG11004	IS8004	0.5	0.5	3	7.41	2.59	2.42	65.1	67.4
DG11004	IS8004	0.5	0.5	5	7.05	2.04	1.76	71.1	75.0
ID12002	IS8002	0.3	0.25	1	0.18	0.19	0.20	-7.9	-11.2
ID12002	IS8002	0.3	0.25	3	0.30	0.31	0.33	-2.5	-9.2
ID12002	IS8002	0.3	0.25	5	0.26	0.26	0.28	-1.2	-7.3
ID12002	IS8002	0.5	0.25	1	0.77	0.64	0.60	17.1	22.6
ID12002	IS8002	0.5	0.25	3	1.85	0.82	0.87	55.8	53.0
ID12002	IS8002	0.5	0.25	5	2.45	0.73	0.75	70.3	69.2
ID12002	IS8002	0.3	0.5	1	0.27	0.30	0.30	-12.1	-8.7
ID12002	IS8002	0.3	0.5	3	0.30	0.34	0.36	-15.3	-21.2
ID12002	IS8002	0.3	0.5	5	0.22	0.24	0.25	-7.7	-14.9
ID12002	IS8002	0.5	0.5	1	0.79	0.75	0.66	5.5	17.0
ID12002	IS8002	0.5	0.5	3	1.76	0.81	0.86	54.0	51.1
ID12002	IS8002	0.5	0.5	5	2.69	0.60	0.64	77.7	76.3
XLTD04	IS8004	0.3	0.25	1	0.23	0.16	0.16	31.7	29.2
XLTD04	IS8004	0.3	0.25	3	0.28	0.25	0.26	9.8	5.7
XLTD04	IS8004	0.3	0.25	5	0.22	0.22	0.23	3.4	-2.0
XLTD04	IS8004	0.5	0.25	1	0.92	0.52	0.46	43.2	50.0
XLTD04	IS8004	0.5	0.25	3	2.06	0.69	0.73	66.7	64.5
XLTD04	IS8004	0.5	0.25	5	2.28	0.59	0.62	74.0	72.7
XLTD04	IS8004	0.3	0.5	1	0.29	0.27	0.24	7.3	16.7
XLTD04	IS8004	0.3	0.5	3	0.27	0.28	0.28	-2.2	-4.2
XLTD04	IS8004	0.3	0.5	5	0.19	0.20	0.21	-3.2	-10.3
XLTD04	IS8004	0.5	0.5	1	1.39	0.64	0.53	53.9	61.7
XLTD04	IS8004	0.5	0.5	3	1.42	0.64	0.69	54.5	51.5
XLTD04	IS8004	0.5	0.5	5	1.47	0.50	0.53	65.7	63.6

Table I - 7. Drift onto reference range for sugar beet, for sprayer with 0, 1 or 2 end nozzles; spray liquid water.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	2.19	0.47	0.19	78.3	91.5
XR11004	UB8504	0.3	0.25	3	2.49	0.94	0.80	62.2	67.8
XR11004	UB8504	0.3	0.25	5	2.02	1.03	0.93	49.3	54.0
XR11004	UB8504	0.5	0.25	1	6.17	1.94	1.04	68.5	83.1
XR11004	UB8504	0.5	0.25	3	8.89	3.12	2.78	64.9	68.7
XR11004	UB8504	0.5	0.25	5	10.35	3.27	2.85	68.4	72.5
XR11004	UB8504	0.3	0.5	1	3.12	0.98	0.29	68.5	90.8
XR11004	UB8504	0.3	0.5	3	2.70	1.37	1.11	49.2	58.8
XR11004	UB8504	0.3	0.5	5	2.11	1.26	1.12	40.4	46.9
XR11004	UB8504	0.5	0.5	1	7.71	3.07	1.64	60.2	78.8
XR11004	UB8504	0.5	0.5	3	8.32	3.91	3.66	53.0	56.1
XR11004	UB8504	0.5	0.5	5	9.16	3.34	3.17	63.5	65.3
DG11004	IS8004	0.3	0.25	1	1.30	0.33	0.15	74.4	88.9
DG11004	IS8004	0.3	0.25	3	1.62	0.61	0.50	62.4	69.0
DG11004	IS8004	0.3	0.25	5	1.36	0.64	0.54	52.8	60.3
DG11004	IS8004	0.5	0.25	1	5.56	1.32	0.72	76.3	87.0
DG11004	IS8004	0.5	0.25	3	7.37	2.07	1.67	71.9	77.4
DG11004	IS8004	0.5	0.25	5	9.10	2.11	1.70	76.8	81.3
DG11004	IS8004	0.3	0.5	1	1.98	0.67	0.27	66.1	86.2
DG11004	IS8004	0.3	0.5	3	1.84	0.92	0.77	49.7	58.1
DG11004	IS8004	0.3	0.5	5	1.44	0.78	0.67	45.8	53.0
DG11004	IS8004	0.5	0.5	1	6.57	2.04	1.10	68.9	83.3
DG11004	IS8004	0.5	0.5	3	7.19	2.42	2.13	66.3	70.4
DG11004	IS8004	0.5	0.5	5	8.82	2.15	1.82	75.7	79.4
ID12002	IS8002	0.3	0.25	1	0.13	0.07	0.08	43.4	41.4
ID12002	IS8002	0.3	0.25	3	0.19	0.19	0.20	1.1	-4.3
ID12002	IS8002	0.3	0.25	5	0.21	0.19	0.20	7.8	3.5
ID12002	IS8002	0.5	0.25	1	0.36	0.29	0.30	20.1	18.5
ID12002	IS8002	0.5	0.25	3	1.62	0.59	0.61	63.6	62.2
ID12002	IS8002	0.5	0.25	5	2.22	0.60	0.61	73.1	72.6
ID12002	IS8002	0.3	0.5	1	0.21	0.13	0.13	38.0	38.9
ID12002	IS8002	0.3	0.5	3	0.27	0.28	0.28	-0.5	-2.6
ID12002	IS8002	0.3	0.5	5	0.23	0.23	0.23	3.0	0.3
ID12002	IS8002	0.5	0.5	1	0.65	0.41	0.38	37.5	41.3
ID12002	IS8002	0.5	0.5	3	1.71	0.73	0.75	57.1	56.0
ID12002	IS8002	0.5	0.5	5	2.33	0.62	0.63	73.5	72.8
XLTD04	IS8004	0.3	0.25	1	0.10	0.04	0.04	56.6	58.2
XLTD04	IS8004	0.3	0.25	3	0.17	0.13	0.13	23.6	22.8
XLTD04	IS8004	0.3	0.25	5	0.18	0.14	0.14	20.0	18.1
XLTD04	IS8004	0.5	0.25	1	0.40	0.21	0.20	47.3	50.5
XLTD04	IS8004	0.5	0.25	3	1.62	0.45	0.45	72.5	72.0
XLTD04	IS8004	0.5	0.25	5	1.83	0.47	0.48	74.2	73.8
XLTD04	IS8004	0.3	0.5	1	0.18	0.09	0.08	49.8	53.8
XLTD04	IS8004	0.3	0.5	3	0.24	0.21	0.20	12.2	16.4
XLTD04	IS8004	0.3	0.5	5	0.19	0.17	0.18	9.2	6.8
XLTD04	IS8004	0.5	0.5	1	0.72	0.31	0.26	56.2	63.3
XLTD04	IS8004	0.5	0.5	3	1.35	0.56	0.56	58.6	58.1
XLTD04	IS8004	0.5	0.5	5	1.66	0.50	0.51	69.8	69.0

Table I - 8. Drift onto reference range for sugar beet, for sprayer with 0, 1 or 2 end nozzles; spray liquid water+Agral.

nozzle	endnoz	boomhgt [m]	crophgt [m]	windspd [m/s]	drift0 [%dose]	drift1 [%dose]	drift2 [%dose]	reduc1 [%]	reduc2 [%]
XR11004	UB8504	0.3	0.25	1	2.24	0.48	0.20	78.4	91.0
XR11004	UB8504	0.3	0.25	3	2.58	0.94	0.79	63.7	69.5
XR11004	UB8504	0.3	0.25	5	2.13	1.03	0.91	51.5	57.3
XR11004	UB8504	0.5	0.25	1	6.64	1.98	1.04	70.2	84.3
XR11004	UB8504	0.5	0.25	3	8.71	3.16	2.77	63.8	68.2
XR11004	UB8504	0.5	0.25	5	10.80	3.93	2.90	63.6	73.2
XR11004	UB8504	0.3	0.5	1	3.31	1.02	0.30	69.3	91.1
XR11004	UB8504	0.3	0.5	3	2.93	1.44	1.12	50.9	61.7
XR11004	UB8504	0.3	0.5	5	2.13	1.37	1.20	35.8	43.6
XR11004	UB8504	0.5	0.5	1	7.84	3.14	1.66	60.0	78.8
XR11004	UB8504	0.5	0.5	3	8.59	3.87	3.57	55.0	58.4
XR11004	UB8504	0.5	0.5	5	9.39	3.40	3.13	63.8	66.7
DG11004	IS8004	0.3	0.25	1	1.35	0.36	0.21	73.2	84.6
DG11004	IS8004	0.3	0.25	3	1.73	0.71	0.62	59.0	64.0
DG11004	IS8004	0.3	0.25	5	1.46	0.72	0.64	50.8	55.9
DG11004	IS8004	0.5	0.25	1	5.25	1.49	0.92	71.7	82.5
DG11004	IS8004	0.5	0.25	3	8.03	2.32	1.97	71.1	75.5
DG11004	IS8004	0.5	0.25	5	9.94	2.33	1.92	76.6	80.7
DG11004	IS8004	0.3	0.5	1	2.04	0.77	0.38	62.0	81.2
DG11004	IS8004	0.3	0.5	3	1.80	1.05	0.91	41.8	49.5
DG11004	IS8004	0.3	0.5	5	1.44	0.87	0.77	39.6	46.2
DG11004	IS8004	0.5	0.5	1	6.49	2.25	1.35	65.3	79.2
DG11004	IS8004	0.5	0.5	3	7.79	2.72	2.47	65.1	68.3
DG11004	IS8004	0.5	0.5	5	8.52	2.32	2.01	72.8	76.4
ID12002	IS8002	0.3	0.25	1	0.13	0.09	0.09	32.2	28.3
ID12002	IS8002	0.3	0.25	3	0.20	0.21	0.23	-9.7	-19.6
ID12002	IS8002	0.3	0.25	5	0.21	0.21	0.23	-1.9	-9.8
ID12002	IS8002	0.5	0.25	1	0.38	0.33	0.35	13.2	8.7
ID12002	IS8002	0.5	0.25	3	1.65	0.64	0.68	61.1	58.8
ID12002	IS8002	0.5	0.25	5	2.35	0.66	0.68	71.9	70.9
ID12002	IS8002	0.3	0.5	1	0.21	0.16	0.16	25.2	23.2
ID12002	IS8002	0.3	0.5	3	0.27	0.31	0.33	-13.4	-19.0
ID12002	IS8002	0.3	0.5	5	0.23	0.25	0.26	-6.6	-12.9
ID12002	IS8002	0.5	0.5	1	0.61	0.46	0.45	24.2	25.2
ID12002	IS8002	0.5	0.5	3	1.77	0.80	0.84	54.6	52.4
ID12002	IS8002	0.5	0.5	5	2.77	0.68	0.72	75.5	74.1
XLTD04	IS8004	0.3	0.25	1	0.10	0.06	0.07	39.5	35.0
XLTD04	IS8004	0.3	0.25	3	0.18	0.17	0.19	2.8	-3.7
XLTD04	IS8004	0.3	0.25	5	0.19	0.17	0.18	8.0	1.1
XLTD04	IS8004	0.5	0.25	1	0.42	0.28	0.28	33.2	33.2
XLTD04	IS8004	0.5	0.25	3	1.86	0.54	0.57	71.0	69.2
XLTD04	IS8004	0.5	0.25	5	2.19	0.54	0.56	75.6	74.4
XLTD04	IS8004	0.3	0.5	1	0.20	0.13	0.13	34.2	35.2
XLTD04	IS8004	0.3	0.5	3	0.25	0.26	0.26	-0.6	-2.8
XLTD04	IS8004	0.3	0.5	5	0.20	0.21	0.22	-1.6	-7.4
XLTD04	IS8004	0.5	0.5	1	1.23	0.41	0.37	66.5	69.8
XLTD04	IS8004	0.5	0.5	3	1.44	0.65	0.68	54.7	52.8
XLTD04	IS8004	0.5	0.5	5	1.55	0.56	0.60	63.6	61.5