Supplementary material I:

Weedy Sorghum Case Study

Herein, we would like to share the experiences of Werle, Lindquist, Tenhumberg et al. with the development of population dynamic simulation models to assess management options to mitigate risks of resistance to acetolactate synthase (ALS)-inhibitor herbicides in shattercane [*Sorghum bicolor* (L.) Moench *ssp. drummondii* (Nees ex Steud.) de Wet ex Davidse] and johnsongrass *[Sorghum halepense (L.) Pers.]* populations, respectively, in the United States grain sorghum [*Sorghum bicolor* (L.) Moench subsp. *Bicolor*] production areas where the Inzen technology (grain sorghum tolerant to ALS-inhibitor herbicides; Corteva Agriscience, Wilmington, DE, United States) is likely to be adapted after its commercial deployment. The core structure of their models was based on: i) weed demography, ii) genetics and inheritance of the resistance trait, and iii) crop and weed management strategies.

The coexistence of sympatric weedy relatives (shattercane and johnsongrass) poses a significant threat to the potential lifespan of the upcoming Inzen sorghum Technology (ALS-resistant grain sorghum) whereas crop-to-weed gene flow encompasses one of the main concerns regarding the introduction of this technology in United States sorghum production areas. Shattercane is conspecific with grain sorghum; they are both annual, diploid (2n = 2x = 20), sexually compatible, and may be cross-pollinated by wind, which can result in hybridization where floral synchrony occurs [1-3]. Johnsongrass is a tetraploid (2n = 4x =40), rhizomatous, perennial, self-pollinated weed species that can propagate vegetatively and reproduce sexually. Despite the difference in ploidy levels, johnsongrass and grain sorghum have been reported to outcross and produce hybrids at a low frequency [4-6] via unreduced sorghum gametes (diploid pollen).

The simulation model for shattercane [7] was developed first. This is a less complex model due to the annual life cycle and similar ploidy level for the crop and weed; moreover, extensive weed demographics and genetics data were published in the literature due in part to the fact that shattercane was a major weed in annual cropping systems in the 1980-1990s in the United States Midwest [8,9] facilitating model development and enhancing predictions. Seed predation data were not available for shattercane and had to be adapted from johnsongrass [10]. Shattercane fecundity in response to interspecific and intraspecific competition data were also not available in the literature; thus, authors travelled across commercial fields to collect shattercane density and seed production and crop density data to generate a proxy density-dependent seed production function. The model predicted the rapid evolution of ALS resistance if Inzen grain sorghum is planted continuously because of high selection pressure (ALS-inhibiting herbicide application) and crop-to-weed gene flow. Rotating Inzen with conventional grain sorghum did not assist with shattercane management. Rotating Inzen with non-sorghum crops combined with the use of effective herbicide options assisted with maintaining shattercane population density at low levels while postponing resistance evolution to some extent. These findings are being used as part of the Inzen technology's stewardship program. This model provided valuable insight on resistance management in Inzen sorghum technology and can also be used for risk assessment of novel traits in grain sorghum and other crops that have weedy relatives (e.g., rice [*Oryza sativa* L.], sunflowers [*Helianthus annuus* L.]). Moreover, by setting crop-to-weed gene flow, this model can also be used to predict population dynamics and resistance evolution in annual weed species not related to crops.

Next, the same group of researchers are developing a simulation model for johnsongrass (Holmes, Lindquist, Werle, Tenhumberg et al. *In Review*). This is a very complex model given the perennial and polyploid nature of the weed species under consideration. Moreover, given the complex life history of johnsongrass and lack of comprehensive demographics data in the literature, researchers are having to conduct several field experiments to generate research-based parameter estimates, adapt estimates from other perennial weed species, and use stochastic approaches to determine the life cycle parameters having the biggest impact on population dynamics, demonstrating the areas where further research is needed. Moreover, novel molecular techniques and ecological studies are shedding light regarding the likelihood and complexity regarding cross-pollination between diploid grain sorghum and poliploid Johnsongrass, hybrid viability and ecology [6]. Through this "*Weedy Sorghum Case Study*" we demonstrate how successful modeling efforts are dependent on well understood ecological and genetic processes encompassing long-term weed population dynamics.

Supplementary Material II:

A systematic search for publications was conducting using Web of Science (© 2020 Clarivate Analytics) on 16 March 2020. The search strategy used subject headings and key words with the exact phrases "Decision Support" and "Weed Management" or "Weed Control". The literature was further limited to English publications.

The search produced 138 entries. Entries included in the table are those that either presented a decision support tool (DST) focused on weed management, or presented data or concepts supporting development of weed management DSTs. Decision support tools focused on crop or cover crop development (i.e., crop simulation models) were not included in this table. This is not an exhaustive registry of publications pertaining to DSTs for weed management. Rather, this table is meant to provide insight on the levels of interest and application for weed management DSTs.

Table S1. A list of research publications focused on weed management decision support tools.

Number	Author(s)	Citation	Primary focus of publication
1	Colas et al.	*Eur. J. Agron.* **2020**, *114*, 126010	Presentation and/or field evaluation of a DST
2	Bessette et al.	*Renew. Agr. Food Syst.* **2019**, *34*, 460-471	Quantitative data or concepts supporting DST development
3	Bessette et al.	*Weed Sci.* **2019**, *67*, 463-473	Presentation and/or field evaluation of a DST
4	Papadopoulus et al.	*Environ. Monit. Assess.* **2018**, *190*, 622	Quantitative data or concepts supporting DST development
5	Gonzalez-Andujar and Bastida	*Int. J. Plant Prod.* **2018**, *12*, 219-223	Quantitative data or concepts supporting DST development
6	Ip et al.	*Comput. Electro. Agric.* **2018**, *151*, 376-383	Quantitative data or concepts supporting DST development
7	Huang et al.	*Sensors* **2018**, *18*, 2113	Quantitative data or concepts supporting DST development
8	Renzi et al.	*Grass Forage Sci.* **2018**, *73*, 146-158	Quantitative data or concepts supporting DST development
9	Aurambout and Endress	*Ecol. Inform.* **2018**, *43*, 146-156	Quantitative data or concepts supporting DST development
10	Fletcher and Reddy	*Weed Technol.* **2018**, *32*, 20-26	Quantitative data or concepts supporting DST development
11	Corbin et al.	*Restoration Ecol.* **2017**, *25*, S170-S-177	Presentation and/or field evaluation of a DST
12	Lindsay et al.	*Weed Technol.* **2017**, *31*, 915-927	Presentation and/or field evaluation of a DST

13	Stone and Andreu	*Ecol. Restor.* **2017**, *35*, 255-265	Presentation and/or field evaluation of a DST
14	van Evert et al.	*Weed Res.* **2017**, *57*, 218-233	Quantitative data or concepts supporting DST development
15	Vasileiadis et al.	*Crop Prot.* **2017**, *97*, 60-69	Presentation and/or field evaluation of a DST
16	Franco et al.	*Precis. Agric.* **2017**, *18*, 366-382	Quantitative data or concepts supporting DST development
17	Song et al.	*Weed Sci.* **2017**, *65*, 371-380	Quantitative data or concepts supporting DST development
18	Yound et al.	*Weed Res.* **2017**, *57*, 1-5	Quantitative data or concepts supporting DST development
19	Lacoste and Powles	*Comput. Electron. Agri.* **2016**, *121*, 260-268	Quantitative data or concepts supporting DST development
20	Zwickle et al.	*Agroecol. Sustain. Food Syst.* **2016**, *40*, 635-659	Quantitative data or concepts supporting DST development
21	Sonderskov et al.	*Crop Prot.* **2015**, *76*, 15-23	Presentation and/or field evaluation of a DST
22	Dhakai and Scanlan	*Agric. Syst.* **2015**, *138*, 100-115	Quantitative data or concepts supporting DST development
23	Kurokawa et al.	*Weed Biol. Manag.* **2015**, *15*, 113-121	Quantitative data or concepts supporting DST development
24	de Mol et al.	*Weed Res.* **2015**, *55*, 370-379	Quantitative data or concepts supporting DST development
25	Lacoste and Powles	*Weed Sci.* **2015**, *63*, 676-689	Presentation and/or field evaluation of a DST
26	Cristaudo et al	*Plant Biosyst.* **2015**, *149*, 337-345	Quantitative data or concepts supporting DST development
27	Rossi et al.	*World Mycotoxin J.* **2015**, *8*, 629-640	Presentation and/or field evaluation of a DST
28	Renton et al.	*Crop Pasture Sci.* **2015**, *66*, 610-621	Presentation and/or field evaluation of a DST
29	Summers et al.	*Environ. Modell. Softw.* **2015**, *63*, 217-229	Presentation and/or field evaluation of a DST
30	Lacoste and Powles	*Weed Technol.* **2014**, *28*, 703-720	Presentation and/or field evaluation of a DST

31	Montull et al.	*Crop Prot.* **2014**, *64*, 110-114	Presentation and/or field evaluation of a DST
32	Kragt and Llewellyn	*Appl. Econ. Perspect. Policy* **2014**, *36*, 351-371	Quantitative data or concepts supporting DST development
33	Chantre et al.	*J. Agri. Sci*. **2014**, *152*, 254-262	Quantitative data or concepts supporting DST development
34	Blanco et al.	*Ecol. Model.* **2014**, *272*, 293-300	Quantitative data or concepts supporting DST development
35	Sonderskov et al.	*Weed Technol.* **2014**, *28*, 19-27	Presentation and/or field evaluation of a DST
36	Longchamps et al.	*Weed Sci.* **2014**, *62*, 177-185	Quantitative data or concepts supporting DST development
37	Lundy et al.	*Agric. Syst.* **2014**, *123*, 12-21	Quantitative data or concepts supporting DST development
38	Fickett et al.	*Weed Technol.* **2013**, *27*, 54-62	Quantitative data or concepts supporting DST development
39	Hunt et al.	*Crop Pasture Sci.* **2013**, *64*, 922-934	Presentation and/or field evaluation of a DST
40	Chantre et al.	*Comput. Electron. Agri*. **2012**, *88*, 95-102	Quantitative data or concepts supporting DST development
41	Casagrade et al.	*Agron. Sustain. Dev.* **2012**, *32*, 715-726	Quantitative data or concepts supporting DST development
42	Eizenberg et al.	*Weed Sci.* **2012**, *60*, 316-323	Quantitative data or concepts supporting DST development
43	Gerhards et al.	*Weed Res.* **2012**, *52*, 6-15	Quantitative data or concepts supporting DST development
44	Nyamai et al.	*Invasive Plant Sci. Manag.* **2011,** *4*, 306-316	Presentation and/or field evaluation of a DST
45	Jeschke et al.	*Weed Sci.* **2011**, *59*, 416-423	Quantitative data or concepts supporting DST development
46	Gonzalez-Andujar et al.	*Weed Res.* **2011**, *51*, 304-309	Presentation and/or field evaluation of a DST
47	Masin et al.	*Weed Sci.* **2011**, *59*, 270-275	Quantitative data or concepts supporting DST development
48	Day	*J. Agri. Sci*. **2011**, *149*, 55-61	Quantitative data or concepts supporting DST development

49	Ford et al.	*Weed Technol.* **2011**, *25*, 107-112	Presentation and/or field evaluation of a DST
50	Beckie et al.	*Weed Technol.* **2011**, *25*, 159-164	Presentation and/or field evaluation of a DST
51	Hunt and Kirkegaard	*Crop Pasture Sci.* **2011**, *62*, 915-929	Presentation and/or field evaluation of a DST
52	Benjamin et al.	*Crop Prot.* **2010**, *29*, 1264-1273	Quantitative data or concepts supporting DST development
53	Torra et al.	*Weed Res.* **2010**, *50*, 127-139	Presentation and/or field evaluation of a DST
54	Gonzalez-Andujar et al.	*Weed Res.* **2010**, *50*, 83-88	Presentation and/or field evaluation of a DST
55	Jeschke et al.	*Weed Technol.* **2009**, *23*, 477-485	Quantitative data or concepts supporting DST development
56	Cavalli et al.	*J. Environ. Manag.* **2009**, *90*, 2199-2211	Quantitative data or concepts supporting DST development
57	Benjamin et al.	*Weed Res.* **2009**, *49*, 207-216	Presentation and/or field evaluation of a DST
58	Parsons et al.	*Comput. Electron. Agric.* **2009**, *65*, 155-167	Presentation and/or field evaluation of a DST
59	Canner et al.	Weed Sci. **2009**, *57*, 175-186	Quantitative data or concepts supporting DST development
60	Simard et al.	*Weed Sci.* **2009**, *57*, 187-193	Presentation and/or field evaluation of a DST
61	Gutjahr et al.	*J. Plant Dis. Prot*. **2008**, *21*, 143-148	Quantitative data or concepts supporting DST development
62	Talgre et al.	*Zemdirbyste* **2008**, *95*, 194-201	Presentation and/or field evaluation of a DST
63	Vanaga et al.	*Zemdirbyste* **2008**, *95*, 227-234	Presentation and/or field evaluation of a DST
64	Rasmussen et al.	*Weed Res.* **2007**, *47*, 299-310	Quantitative data or concepts supporting DST development
65	Sikkema et al.	*Weed Technol.* **2007**, *21*, 647-655	Presentation and/or field evaluation of a DST
66	Mace et al.	*Agric. Syst.* **2007**, *93*, 115-142	Quantitative data or concepts supporting DST development

67	Robinson et al.	*Weed Technol.* **2007**, *21*, 88-96	Quantitative data or concepts supporting DST development
68	Hock et al.	*Weed Technol.* **2007**, *21*, 219-224	Presentation and/or field evaluation of a DST
69	Gerhards and Oebel	*Weed Res.* **2006**, *46*, 185-193	Presentation and/or field evaluation of a DST
70	Hock et al.	*Weed Technol.* **2006**, *20*, 478-484	Presentation and/or field evaluation of a DST
71	Richardson et al.	*Forestry* **2006**, *1*, 29-42	Presentation and/or field evaluation of a DST
72	Blackshaw et al.	*Weed Biol. Manag.* **2006**, *6*, 10-17	Quantitative data or concepts supporting DST development
73	Schmidt et al.	*Weed Technol.* **2005**, *19*, 1056-1064	Presentation and/or field evaluation of a DST
74	Shaw	*Weed Sci.* **2005**, *53*, 264-273	Quantitative data or concepts supporting DST development
75	Wilkerson et al.	*Weed Technol.* **2004**, *18*, 1101-1110	Presentation and/or field evaluation of a DST
76	Hamill et al.	*Weed Technol.* **2004**, *18*, 723-732	Presentation and/or field evaluation of a DST
77	Richardson et al.	*Appl. Eng. Agric.* **2004**, *20*, 259-267	Presentation and/or field evaluation of a DST
78	Lyon et al.	*Weed Technol.* **2004**, *18*, 315-324	Presentation and/or field evaluation of a DST
79	Schmidt and Johnson	*Weed Technol.* **2004**, *18*, 412-418	Presentation and/or field evaluation of a DST
80	Neeser et al.	*Weed Sci.* **2004**, *52*, 115-122	Presentation and/or field evaluation of a DST
81	Vanaga et al.	*J. Plant Dis. Prot.* **2004**, *19*, 779-785	Presentation and/or field evaluation of a DST
82	Schwartz et al.	*J. Plant Dis. Prot.* **2004**, *19*, 989-994	Presentation and/or field evaluation of a DST
83	Gerhards and Christensen	*Weed Res.* **2003**, *43*, 385-392	Presentation and/or field evaluation of a DST
84	Lemieux et al.	*Weed Res.* **2003**, *43*, 323-332	Presentation and/or field evaluation of a DST

85	Harker and Blackshaw	*Weed Technol.* **2003**, *17*, 829-835	Quantitative data or concepts supporting DST development
86	Christensen et al.	*Weed Res.* **2003**, *43*, 276-284	Quantitative data or concepts supporting DST development
87	Berti et al.	*Weed Sci.* **2003**, *51*, 618-627	Presentation and/or field evaluation of a DST
88	Kriticos et al.	*Ecol. Model.* **2003**, *163*, 187-208	Presentation and/or field evaluation of a DST
89	Jordan et al.	*Weed Technol.* **2003**, *17*, 358-365	Presentation and/or field evaluation of a DST
90	Bennett et al.	*Weed Technol.* **2003**, *17*, 412-420	Presentation and/or field evaluation of a DST
91	O'Donovan and McClay	*Can. J. Plant Sci.* **2002**, *82*, 861-863	Quantitative data or concepts supporting DST development
92	Wilkerson et al.	*Weed Sci.* **2002**, *50*, 411-424	Quantitative data or concepts supporting DST development
93	Kristensen and Rasmussen	*Comput. Electron. Agric.* **2002**, *33*, 197-217	Presentation and/or field evaluation of a DST
94	Bostrom and Fogelfors	*Weed Sci.* **2002**, *50*, 186-195	Presentation and/or field evaluation of a DST
95	Scott et al.	*Weed Sci.* **2002**, *50*, 91-100	Presentation and/or field evaluation of a DST
96	Werner et al.	*J. Plant Dis. Prot.* **2002**, *18*, 391-398	Presentation and/or field evaluation of a DST
97	Weaver	*Can. J. Plant Sci.* **2001**, *4*, 821-828	Quantitative data or concepts supporting DST development
98	Scott et al.	*Weed Sci.* **2001**, *49*, 549-557	Presentation and/or field evaluation of a DST
99	Grundy et al.	*J.Appl. Ecol.* **1999**, *36*, 663-678	Quantitative data or concepts supporting DST development
100	Ray et al.	*Can. J. For. Res.* **1999**, *29*, 875-882	Presentation and/or field evaluation of a DST
101	Lindquist et al.	*Weed Sci.* **2002**, 47, 195-200	Quantitative data or concepts supporting DST development
102	Oriade and Dillon	*Agric. Econ.* **1997**, *17*, 45-58	Quantitative data or concepts supporting DST development

103	Oryokot et al.	*Weed Sci.* **1997**, *45*, 684-890	Quantitative data or concepts supporting DST development
104	Oryokot et al.	*Weed Sci.* **1997**, *45*, 488-496	Quantitative data or concepts supporting DST development
105	Berti and Zanin	*Crop Prot.* **1997**, *16*, 109-116	Presentation and/or field evaluation of a DST
106	Stigliani et al.	*Weed Technol.* **1996**, *10*, 781-794	Presentation and/or field evaluation of a DST
107	Wiles et al.	*Agric. Syst.* **1996**, *50*, 355-376	Presentation and/or field evaluation of a DST
108	Odonovan	*Can. J. Plant Sci.* **1996**, *76*, 3-7	Presentation and/or field evaluation of a DST
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