Appendix 1—detailed Materials and Methods

Research plot establishment. This experiment was conducted from 2011-2013 at the Kellogg Biological Station in Hickory Corners, Michigan (lat 42.4058, lon -85.3845). Prior to use in this experiment, these fields were in cabbage. We included three tillage treatments: conventional, full-width tillage (CT) and two ST treatments—one with strips located in the same position from year to year (ST same) and another in which the strip location was offset from year to year (ST offset). These tillage treatments were applied to main plots that were 3.1 m wide by 20.9 m long. Main plots were split in half to examine both low- and high-intensity weed management strategies on a subplot level (3.1 m wide by 10.45 m long). All plots had either a spring-planted oat cover crop (2011 and 2012) or a fall-planted winter rye cover crop (2013) prior to sweet corn.

Cover crops were terminated with a burndown application of glyphosate (Table 1). Once desiccated, cover crop residue was flail mowed. Fertilizer was applied immediately prior to tillage. The initial pre-tillage fertilizer application was broadcast in CT but banded approximately 15 cm deep in ST (Table 2). This pre-tillage fertilizer application also included P and K according to soil test recommendations. In ST plots, a Hiniker® Model 6000 two-row strip-tiller (equipped with notched trash-cleaning discs, cutting-coulter, shank-point assembly, berming disks and rolling basket) was used to create 25 cm wide by 25 cm deep strips at 76.2 cm between-strip spacing (center to center). CT was accomplished with a 3.1 m wide chisel plow followed by two passes with a field cultivator. Sweet corn (variety 'Providence' in 2011 and 2012 and 'BC 0805', a Bt variety in 2013) was planted with 0.19 m IR spacing using a Monosem no-till vacuum planter. In all plots, 45 kg/ha N as urea was banded 5 cm down and 5 cm to the side of the seed with the planter (Table 2). Sweet corn was side-dressed using UAN (45 kg/ha nitrogen) when the plants were approximately 20 cm tall and at the V6 growth stage (with six fully expanded leaves). This application was targeted to the IR zone in both tillage types (Table 2).

Atrazine and s-metolachlor were applied at 8 oz/acre immediately after planting in all plots. In the low-intensity weed management subplots, this herbicide application was the sole weed management used. In the high-intensity weed management subplots, one hand-weeding pass was also used to remove larger weed escapes.

Data collection and analysis. All sweet corn ears were collected from a seven meter long harvest area within the center two rows of each plot. Ears greater than 5 cm in diameter were considered marketable. Fresh weight and number of all ears was recorded; dry weight of a subsample was also obtained to determine moisture content. Weeds were identified to species and collected at crop harvest by clipping all aboveground biomass from two 0.25 m2 quadrats from both the IR and BR zone in each plot. All biomass was dried at 60°C until a constant weight was achieved and then weighed.

During crop growth, soil samples were collected at least biweekly and soil nitrate and ammonium content were analyzed as described below. Deep soil cores were also collected in the fall after harvest using a hydraulic probe (Geoprobe 540MT; Geoprobe Systems; Salina, KS); these were collected from the BR zone in 2011 and 2012 and both IR and BR zones in 2013. After collection, they were sectioned into five 20-cm sections (0-20 cm deep, 20-40 cm deep, etc.) and dried, ground, and extracted with a 1M KCl solution to determine nitrate and ammonium content (Anonymous 2012). Nitrate data were summed over the deep sections (>20 cm) to consider all nitrate that could be lost from the agroecosystem in the absence of a cover crop.

Nitrous oxide flux (NOF) was measured using the static chamber method described by Kahmark and Miller (2008) in 2011 and 2013. Two chambers were installed in each plot—one IR and one BR. Chambers were only removed when necessary for tillage and planting operations. Sampling occurred on approximately weekly intervals and were analyzed at the Kellogg Biological Station using a gas chromatograph equipped with a 63Ni electron capture detector operating at 350 C (Kahmark and Millar, 2008).

To determine field-wide potential N loss, the average residual soil nitrate and nitrous oxide flux was calculated based on the relative area occupied by the BR and IR zones (the BR zone is approximately twice the width of the IR zone). For deep soil cores, a weighted average of nitrate values from the surface soil samples (0-20 cm) was determined and added to the nitrate value from the deep samples (20-100 cm). Season-long soil surface (0-20 cm) nitrate and ammonium levels were also area-corrected in the same way. All data were analyzed with one-, two-, or three-way analysis of variance using PROC MIXED in SAS ® version 9.3 (SAS Institute, Cary, NC) with $\alpha=0.1$ as the significance level. Replicates within each experiment were considered a random factor, while year, tillage treatments, and weed management intensity treatments were fixed factors. If there were no significant year*treatment interactions, data were pooled to examine treatments. For zone-specific (IR or BR) soil nitrate data (i.e. all data collected from the surface) and nitrous oxide flux, zone was treated as a fixed subplot factor while tillage treatment was considered the fixed main plot factor.

On-farm trials. On farm trials were conducted at George Van Houtte's farm in Romeo, MI in 2012 and at the Zilke Vegetable Farm in Milan, MI in 2012 and 2013. In 2012, four treatments were examined at each farm—two tillage types (ST and the farmer's typical CT practice prior to sweet corn), both with and without a spring-planted oat cover crop. Oats were sown in April and terminated with glyphosate in early June, when they were approximately 6-8" tall. CT at the Van Houtte farm was accomplished with one pass of a chisel plow followed by two passes of a roto-turner for secondary tillage. At the Zilke farm, CT in 2012 was also one pass with a chisel plow followed by two passes with a field cultivator. ST at both sites was as previously described for the research station experiments. Sweet corn (variety BC 0805) was planted at all sites immediately after tillage; fertilizer was applied as described above and in Table 2. Sweet corn was harvested using the same protocol used at the research station.

Rather than spring-planted oats, we tilled directly into fall-planted wheat at the Zilke farm in 2013. CT in this year was accomplished with one pass of a moldboard plow followed by two passes with a field cultivator; ST was as described above and wheat in the BR zone was killed with glyphosate prior the planting.

Partial budgets. Tillage costs were estimated using the Farm Machinery Economic Cost Estimation Spreadsheet (Machdata.XLSM; Lazarus 2014), a spreadsheet that determines ownership and operating costs for equipment using an economic engineering approach. Local dealers provided cost estimates for new six-row ST equipment, while websites selling used farm equipment were surveyed for these prices. Power requirements for these strip tillers were based on equipment specifications and dealer recommendations (25-35 HP per shank), while those provided by Lazarus (2014) were used for the conventional tillage options analyzed. Tillage was assumed to use 20% of the hours operated by the power unit; other potential uses include spraying, fertilizing, mowing, etc. An operational speed of 5.5 mph and field efficiency of 85% was assumed. We assumed growers would use the ST equipment on 200 acres, with one pass per year. Other general assumptions were chosen to reflect current costs in Michigan and included $20/hour for skilled labor and $3.60 for a gallon of diesel fuel (Stein 2014), as well as a 4% interest rate and 2% inflation rate.

Cost per acre for ST was determined for three scenarios: 1) a high cost scenario with a new 6 row pull-type strip tiller with attached fertilizer cart and capability to band fertilizers (STH); 2) a medium cost scenario with six new row units mounted on a toolbar (STM); and 3) low cost scenario with the least expensive used strip tiller (STL). Each row unit on the high and medium cost strip tillers is equipped with trash cleaners, cutting disks, a shank, berming disks, and a rolling basket. Given the wide range of available used ST equipment, the low cost option may have all of these components. To add fertilizer banding capability to the two lower cost scenarios, $2000 for a fertilizer tank or hopper, tubes, and metering unit was added to the purchase price. All scenarios assumed an eight-year-old 200 HP tractor for the associated power unit. For comparison, we also priced new and used conventional tillage equipment with appropriate used power units—a 15’ chisel plow (CP) with a 130 HP tractor and 18’ field cultivator (FC) with a 105 HP tractor. Because ownership and operating costs are highly dependent on the number of acres on which the implement is used, and on the number of years of use before the implement is sold or traded, we also conducted a sensitivity analysis to see how changes in these parameters would affect the total cost for the medium cost scenario.

Costs expected to change upon adoption of ST were used in the partial budget analysis. These included costs related to soil preparation, fertilization passes, herbicide products and applications, and cultivation. Because all of our ST scenarios included the capability to band fertilizers, the cost of an additional broadcast fertilization pass used with full-width tillage was eliminated. We also eliminated the cultivation pass in the ST partial budget. The partial budgets included four parts—additional revenue, additional costs, reduced revenue, and reduced costs. These were summed together for each scenario in the partial budget to produce changes in profit. These changes were compared to the total production costs.