Effects of farmland heterogeneity on pollination potential of agricultural landscapes across Eastern Ontario

by

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Abstract

Increasing farmland heterogeneity (spatial heterogeneity of crop cover) may enhance the pollination potential of agricultural landscapes, without taking arable land out of production. We tested the predictions that increasing the compositional heterogeneity of crop cover (measured as increasing crop diversity) and/or increasing the configurational heterogeneity of crop cover (measured as decreasing mean field sizes) will increase pollination potential of agricultural landscapes. We deployed flowering, self-incompatible plant species in landscapes selected to minimize the correlation between crop diversity and mean field size, and used their reproductive success as a metric for the pollination potential. We did not find any support for the prediction that increasing crop diversity and/or decreasing mean field size increased pollination potential of agricultural landscapes. Based on our results, we suggest that policies aimed at increasing farmland heterogeneity may not enhance pollination services in Eastern Ontario agricultural landscapes.

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Introduction

Bees provide critical pollination services to the wild plant community and pollinator dependent crops in agricultural regions. In a study of global dependence of flowering angiosperms on insect pollinators, Ollerton et al. (2011) estimated that 87.5% of flowering plant species were dependent on insect pollinators. Estimates suggest that 35% of global crop production depends on insect pollination (Klein et al. 2007). Managed bees (such as *Apis mellifera*) are often relied upon in agro-ecosystems for pollination services; however declines in managed bee populations have revealed the critical role that wild pollinating bees play in agro-ecosystem pollination services. Many pollinator dependent crops yields are enhanced by wild bees including (but not exclusive to) Oilseed Rape (Jauker et al. 2012), Sunflower (*Helianthus annuus*) (Greenleaf and Kremen 2006), low bush Blueberry (*Vaccinium angustifolium*.) (Cutler et al. 2015), Tomato (*Solanum lycopersicum*) (Greenleaf and Kremen 2006b) and Coffee (*Coffea spp*) (Klein et al. 2003). Winfree et al. (2007) showed that even when Honeybees were present and pollinating in an agricultural landscape, native bees were still responsible for 62% of the pollen deposition in Watermelon crops. This showed that in the presence of managed pollinators, native pollination service is still critical to fulfilling pollination requirements for some crop species.

The pollination service provided by native bees depends on both the diversity and abundance of flower visiting native bees. Insect pollinated plants (entomophilous) flowering in agricultural landscapes show higher reproductive success when the diversity of native bees is higher (Albrecht et al. 2007, Klein et al. 2003). This occurs because a higher diversity of pollinators leads to a higher functional diversity in pollinator behavior

on flowering plants, resulting in more successful pollination events (Hoehn et al. 2008). Plants exposed to higher pollinator abundances also show higher reproductive success in agricultural landscapes (Albrecht et al. 2007, Morandin and Winston 2005, Steffan-Dewenter and Tschartnke 1999). This occurs because a higher number of pollinators visiting flowers means more outcrossing events between flowering plants, leading to higher seed set and reducing pollinator deficit in entomophilous plants (Morandin and Winston 2005). Increasing either the diversity or abundance of native bees should increase the reproductive success of pollinator dependent plants in agricultural landscapes.

Declines in native pollinator abundance and diversity linked to agricultural intensification threaten pollination services. Agricultural intensification at a landscape scale involves changes to landscape structure, as structurally complex and diverse landscapes are replaced with large scale, homogenous monoculture farming practices. This involves the conversion of pollinator habitat (such as perennial grasslands) to crop cover, and the destruction of semi-natural edge habitats bordering crop cover as small fields are aggregated into larger fields (Tsharntke et al. 2005). The loss of this natural and semi-natural cover has been identified as one of the drivers of declines in the abundance and diversity of native bees in agriculturally dominated regions (Brown and Paxton 2009, Potts et al. 2010).

Increasing the proportion of semi-natural cover in agricultural landscapes enhances native bees and their pollination service to the landscape. The positive effects of increasing the amount and diversity of semi-natural area in agricultural landscapes on native bees have been well established (Steffan-Dewenter et al. 2002, Le Feon et al.

2010, Hendrickx et al. 2007, Ricketts et al. 2008). Semi-natural cover such as field boundaries between crops and perennial grasslands provide critical nesting and floral resources in agricultural landscapes, promoting a more stable and diverse native bee community (Hannon and Sisk 2009, Ockinger and Smith 2007). While some crops may provide resources to pollinators, these effects depend on there being sufficient semi-natural cover in the landscape to provide floral resources once the crop is not in flower, as well as sufficient nesting sites (Mandelik et al. 2012). Pollination services provided by native bees depend on the proximity of semi-natural areas (Chateil and Porcher 2015) and the amount (Bennett and Isaacs 2014) of semi-natural area in agricultural landscapes.

It is critical to consider ways of mitigating loss of pollination services in agricultural landscapes without taking arable land out of production. A common recommendation for conserving native bee diversity in agricultural landscapes is the preservation or creation of semi-natural cover (such as semi-natural field boundaries, perennial grasslands) (Banaszak 1992). However, the creation of semi-natural cover in intensively managed agricultural landscapes can involve the reduction or limiting the expansion of crop cover. Farmers attempting to maximize the economic value of their land are unlikely to adopt conservation measures that reduce potential yield of their land, despite the ecological benefits of semi-natural cover in their land (Burton et al. 2008). It is therefore important to find ways of enhancing pollination services in agricultural landscapes without reducing arable crop fields.

Altering the spatial patterning of crop cover may alter the pollination potential of an agricultural landscape. Agricultural landscapes are mosaics of semi-natural and crop cover, and the persistence of native bees in an agricultural landscape depends on the

interplay between these cover types (Mandelik et al. 2012, Kovacs-Hostyanszki et al. 2013). Crops can provide resources to native bees that supplement those available in semi-natural cover (Carre et al. 2009, Kennedy et al. 2013). Crop fields can also act as barriers to pollinator movement when they contain no resources or corridors to pollinator movement when they contain resources (Kremen et al. 2007). Altering the composition and arrangement of crop cover may affect pollinators and pollination services, and should be considered as a possible way of enhancing pollination potential of agricultural landscapes.

Farmland heterogeneity is made up of two elements; compositional and configurational heterogeneity of the cropped areas, each of which may influence native bees. When considering farmland (referring to the cropped area in an agricultural landscape) heterogeneity, we can define compositional heterogeneity as the diversity and evenness of crop cover types and can be measured with metrics such as Shannon diversity index for crop species (see Fahrig et al. 2015). Farmlands with higher compositional heterogeneity may present a higher diversity of resources to native species that require multiple cover types throughout their life history (landscape complementation) (Fahrig et al. 2011). We can define configurational heterogeneity of farmlands as the degree of spatial complexity in the arrangement of crop covers in the landscape, which can be measured with metrics such as mean field size (see Fahrig et al. 2015). Landscapes with smaller, more complex-shaped fields will have more semi-natural border between crop cover types, and between crop cover and semi-natural cover, increasing the interspersed of cover types and leading to higher resource availability to native species (Fahrig et al. 2011). Figure 1 demonstrates how increasing compositional

heterogeneity can occur independently from configurational heterogeneity and vice versa. Compositional heterogeneity is higher in landscapes with more diverse and even proportions of cover types. Configurational heterogeneity is higher in landscapes with higher interspersion of crop types and higher edge density.

Agricultural landscapes with higher crop diversity (higher compositional heterogeneity of farmland) should support higher pollination levels, due to a higher diversity in resources available to native bees. Crop cover can offer resources at different points in the season to pollinators, depending on the crop species and management. These resources can supplement those available to native bees from semi-natural cover in agricultural landscapes, and create a more temporally continuous source of resources (Mandelik et al. 2012). Mass flowering crops such as Oilseed rape (*Brassica napus*) can enhance colony growth (Westphal et al. 2009), abundances of social Bumblebees (*Bombus spp.*) (Westphal et al. 2003), and species richness of solitary, cavity nesting bees nesting in semi-natural cover in the landscape by providing large quantities of floral resources (nectar and/or pollen) at critical points in the season (Diekötter et al. 2014). No tillage crops such as low-intensity forage crops and pasture can also present nesting sites for ground nesting bees (Svensson et al. 2000, Shuler et al. 2005), and pollen shedding anemophilous (such as Corn, *Zea mays*) crops can offer pollen (Danner et al. 2014). In Eastern Ontario, a landscape with high farmland heterogeneity would contain a higher diversity and evenness of crop types such as Corn (source of pollen), Soybean (nectar and pollen), Alfalfa (nectar and pollen), mixed vegetable (nectar and pollen, depending on species), Hay mixes (nectar, pollen, nesting sites), pastures (nectar, pollen, nesting sites), Canola (nectar, pollen), and cereal (no benefit). Westphal et al. (2003) found that a range

in mass flowering crops (*B. napus*, *Trifolium spp.*, *Phacelia tanacetifolia*, *Sinapis arvensis* and *Helianthus annuus*) could provide a temporally stable source of resources to pollinators in agricultural landscapes. Increasing the diversity of crop species can increase the diversity in timing and availability of these complementary resources to pollinators in agricultural landscapes. We predict that increasing the compositional heterogeneity of farmland (measured as increasing Shannon Diversity index for crop types) will result in higher pollination services in the landscape.

Agricultural landscapes with smaller crop fields (higher configurational heterogeneity of farmland) should have higher pollination levels than landscapes with larger crop fields, due to a higher interspersed and accessibility of resources to pollinators. Landscapes with smaller fields will have more semi-natural field boundaries between crops in the landscape and lower distances between semi-natural cover. Native bee species have been shown to modify their flight behavior to follow linear, semi-natural field boundaries in agricultural landscapes, and flowers connected by a higher number of field boundaries show higher pollinator activity in agricultural landscapes (Cranmer et al. 2012). Cranmer et al. (2012) showed that native bees used these linear landscape elements (such as hedgerows) to commute through an agricultural matrix, even when they lack resources. Longer distances between semi-natural cover have also been shown to negatively impact pollinator density, diversity and pollination potential of agricultural landscapes (Steffan-Dewenter and Tscharntke 1999, Ricketts et al. 2008). Landscapes with smaller fields and higher densities of field boundaries should have higher resource interspersed and therefore higher accessibility of resources to foraging pollinators. In support of this, Fahrig et al. (2015) found that, for a given amount of semi-natural cover,

landscapes with smaller fields supported a higher diversity of native bees than landscapes with larger fields. We predict that increasing the configurational heterogeneity of farmland (measured as decreasing mean field size) will result in higher pollination services in agricultural landscapes.

It is important to separate and examine the relative effects of compositional and configurational heterogeneity, as they may contribute independently to pollination potential of a landscape. Agricultural landscapes with smaller fields tend to have higher crop diversity, as a reflection of decreased land use intensity (Tschamtker et al. 2005), leading to a correlation between farmland compositional and configurational heterogeneity. While increasing both farmland compositional and configurational heterogeneity may both enhance pollination potential, the relative strength of the effects may differ. This may influence policies designed to increase pollination potential, as it may prove more effective to increase crop diversity, rather than decrease mean field size (and vice versa). It is therefore important to separate and examine the relative effects of compositional and configurational heterogeneity on pollination potential.

The main goal of this study is to examine the effects of farmland compositional and configurational heterogeneity on pollination potential in agricultural landscapes, using data collected in 2011 and 2012. We chose the Shannon Diversity Index for crop diversity (SHDI) as a measure of farmland compositional heterogeneity, and mean field size (MFS) as a measure of farmland configurational heterogeneity. We tested the predictions that landscapes with (a) higher crop diversity (higher farmland compositional heterogeneity) and (b) lower mean field sizes (higher farmland configurational heterogeneity) will have higher pollination potential. We generated crop diversity and

mean field size metrics at multiple spatial scales for agricultural landscapes across Eastern Ontario. Using a phytometer protocol, we deployed flowering, self-incompatible plant species in each landscape to directly sample the pollination potential. We first tested for a relationship between pollination potential and native bee abundance and diversity using data from 2011, and then tested for relationships between pollination potential and farmland compositional and configurational heterogeneity using data from both 2011 and 2012. Finally, we combined our results with previous research on farmland effects on pollinators in order to make recommendations on ways to increase the pollination potential of agricultural landscapes.

2 Methods

2.1 Overview

This study was conducted in the summers of 2011 and 2012, in agricultural landscapes across Eastern Ontario selected to minimize correlation between crop diversity and mean field size.

We first tested the relationship between native bees and pollination potential in the summer of 2011 by placing both phytometer plants and pan traps in our study landscapes to directly sample the pollination potential and native bee abundance/diversity for the same period of time.

We tested our predictions that increasing crop diversity and decreasing mean field size should have positive effects on pollination potential using data from landscapes sampled in 2011 and 2012. Using a similar phytometer approach to 2011, we sampled the pollination potential of a new set of landscapes in 2012. We quantified crop diversity and mean field size at multiple scales for the landscapes sampled in 2011 and 2012, and used

the data to test for the potential effects of farmland heterogeneity on pollination potential of agricultural landscapes.

2.2 Study Region and Landscape Selection

This study was set in an agriculturally dominated region of Eastern Ontario, bordering the Ottawa River to the North, the St. Lawrence River to the South, the Quebec border to the East and the Canadian Shield to the West. Roughly half of the 15,500 km² was made up of crop and pasture cover, and ~38% made up of mixed and deciduous forest (Statistics Canada 2006).

Landscapes were selected by Pasher et al. (2013), as part of a project examining the effects of farmland heterogeneity on biodiversity (Fahrig et al. 2015). Pasher et al. (2013) used a moving window analysis on satellite imagery (Landsat-5 images 30 m x 30m from 2007 growing season) to select potential 3km x 3km landscapes that held between 40% and 90% agricultural cover (Figure 2). The set of study landscapes were selected to (1) maintain a minimum distance of 3.5 km between landscape centers to avoid spatial autocorrelation, and (2) minimize the correlation between Shannon-Diversity Index for crop diversity and mean field size (Pasher et al. 2013). We calculated landscape metrics at three scales around the central point of each landscapes: 1km x 1km, 2km x 2km, and 3km x 3km (Figure 3). We used 89 different landscapes (42 in 2011 and 47 in 2012).

Within each of the central 1 km x 1 km landscapes, we selected three study transects. These transects were located along the edges of the semi-natural cover between two active crop fields. Transects were selected so that they were a minimum of 200 m apart, a minimum of 50 m from non-cropped areas (forests, wetlands, fallow fields,

farmhouses and roads) and a minimum of 50 m from the edge of the 1km x 1km landscape. Transects were 50 m long, and ran parallel to the edge of the field boundary. We placed our phytometer plants and pan traps along these transects (Figure 4).

2.3 Response Variables

2.3.1 2011 Phytometer protocol

We used a phytometer protocol to sample pollination potential of our study landscapes (Woodcock et al 2014). We placed flowering, pollinator dependent plants on the transects in our landscapes for 4 day periods, sampling each landscape once from July 1st – August 31st. We designed our deployment schedule so that we spent 4 days deploying plants in landscapes (2 landscapes/day), and then 4 days retrieving them in the order they were deployed.

To test for a relationship between pollination potential and bee abundance and diversity (2011), we required a phytometer plant species that was (a) self-incompatible, (b) insect pollinator dependent, and (c) represented a flower color and structure found in our study region. We chose *Brassica juncea*, which has open-access, yellow flowers, and is closely related to several local species (*Brassica spp.*). While *B. juncea* can self-pollinate to a certain degree, it does increase seed set in response to more pollination activity (Rakow and Woods 1987).

Seeds of *B. juncea* were sown in the greenhouse and transplanted to 2L pots after germination. *B. juncea* pots initially contained 5 seedlings each. Plants were watered as necessary and after 2-3 weeks of growth, we thinned *B. juncea* to the 3 healthiest individuals per pot. Plants were reared in a pollinator free greenhouse. In the week leading to transportation of the plants to the field, we placed them outside (with any open

flowers protected from pollinators with cheesecloth bags), beginning with an hour of exposure in shade and increasing the time and sun exposure until they were deemed able to survive the 4 days in the field. When transferred to the field the 2L pots were placed in 3L pots containing hydrated soil polymer to prevent water loss over the 4 days. We placed bamboo rods in the pots for support. Plants were transplanted to the field in a covered pickup truck to avoid pollination on the way to the field sites.

We placed a pot of 3 *B. juncea* individuals at each transect in the 42 study landscapes in 2011. We used yellow colored string to mark flowers that had opened in greenhouse prior to deployment in the field. These plants were located at least 3 m from the pan traps to reduce competition between pan traps and phytometer plants (Figure 5). Plants were placed so that flower height matched the edge height of the surrounding vegetation. The plants were left in the field for a 4 day period. After the 4 day period, plants were assessed for damage and returned to the greenhouse to allow seeds to develop. A pink string was used to mark flowers that had opened after deployment in the field.

Once the seed pods from flowers that had been exposed to the field had developed, they were harvested and placed in coin envelopes. We recorded the total number of seed pods as the number of successful (containing seeds) and unsuccessful (no seed development). Envelopes were placed in a dark room at room temperature to dry out. We counted and recorded the number of seeds from each seed pod. We then used the total number of seeds and the total number of seed pods from all of the individual plants on each transect to calculate the mean seeds/total pod *per* transect (referred to as mean

seed set/transect) as a response variable for testing the effects of native bee diversity and abundance.

We used the total seeds and pods from all three transects to generate a single, landscape level metric representing the amount of pollination at a landscape scale over the 4 day period (referred to as mean seed set/landscape). From this metric, we inferred the pollination potential of the landscape, and used it as a response variable to test the effects of farmland heterogeneity.

2.3.2 2012 Phytometer Protocol

In 2012, we placed phytometer plants of three species at each of the 3 transects within the 47 landscapes. The 2012 landscapes were different from the 2011 landscapes (Figure 2). We used the data from the three transects to generate a landscape level metric for the amount of pollination experienced by each phytometer species.

We designed our field schedule in a similar manner as 2011, where we deployed phytometer plants for 4 days, then spent 4 days retrieving them in the same order (so each plant was exposed to 4 days of pollination in the field). We sampled 47 landscapes in 2012, from June 10th to August 31st.

We chose 3 phytometer species based on the same criteria used in 2011. *Brassica rapa* is known as a hardy, self-incompatible species that is readily visited by native bees (Morandin and Winston 2005). *B. rapa* develops yellow, open access flowers. *Raphanus sativus* (“Sparkler variety”) develops white, open access flowers. The self-incompatibility of *R. sativus* has been established, and this species has been used in phytometer experiments sampling pollination levels in other studies (Steffan-Dewenter and

Tscharntke 1999, Albrecht et al. 2007). Finally, *Delphinium grandiflorum* develops a restricted access blue/purple flower with a long corolla tube accessible to long-tongue bees. We know less about the self-incompatibility of this variety of *D. grandiflorum*, but the species was recommended as a candidate for a phytometer species to sample pollination by the ALARM FSN experiment (“Assessing large scale risks for biodiversity with tested methods – Field Site Network protocols” - see Hammen et al. 2010).

For *B. rapa* and *R. sativus*, we followed a similar greenhouse protocol to that used in 2011. We were unable to grow *D. grandiflorum* in the greenhouse, and so we purchased seedlings from a local supplier. We transplanted 3 *D. grandiflorum* individuals to each 2L pot. We staggered our planting schedule so that we would have flowering individuals of *B. rapa* and *R. sativus* throughout the season. The flowering period of *D. grandiflorum* lasted throughout our study season.

We placed 3, single species, pots of plants on each transect of our study landscapes. Pots were placed 1m apart from one another, and a minimum of 3m from pan traps on the center and one end of the transect (Figure 5).

For each phytometer species, we counted the total seeds and pods (successful + unsuccessful) from each plant in the landscape from the three transects, and combined them to generate a single, landscape level metric representing the amount of pollination occurring in the landscape over the 4 day period (referred to as mean seed set/landscape). From this metric, we inferred the pollination potential of the landscape, and used it as a response variable to test the effects of farmland heterogeneity.

Greenhouse Pollination Tests

To evaluate the self-incompatibility of the phytometer species and the amount of pollinator activity in the greenhouse, we ran a series of tests in the greenhouse. We selected 40 individual plants from each species, and tested each under 4 conditions. The first set of plants were hand pollinated (using a fine paintbrush) from other flowers on the same plant, the second set were hand pollinated from flowers on different plants, the third set were not pollinated, but were covered with a cheesecloth bag and the final set were left open to the greenhouse. We did not have enough plants to complete testing for *D. grandiflorum*, so testing was performed on only *B. rapa* and *R. sativus*.

2.4 Predictor variables

2.4.1 Pan trapping for native bee species richness and abundance

We used a pan trapping protocol in 2011 to sample the diversity and abundance of native bees at the same transects at which we sampled the pollination potential. The pan trapping protocol followed the same schedule as our phytometer protocol, so that each transect was sampled for both native bees and pollination levels over the same 4 day period.

At each study transect, we placed 3 pairs of pan traps (consisting of colored plastic cups) on wooden poles so that traps were at surrounding vegetation height. Pairs of traps were placed at the ends and center of the transect, 25 m apart. We used blue, white and yellow traps (16 oz. plastic cups with adjustable height on wooden dowel), and ensured that no pair of traps were the same colour to allow for pollinator preference for a particular color of trap. Traps were filled 2/3 with water, and Blue Dawn TM dish soap added at a rate of 10 drops per litre to lower the surface tension. After the 4 days in the field, the pan traps were collected and the captured insects stored in 70% ethyl alcohol.

They were later dried, fluffed, pinned and identified by specialists at Agriculture Canada and the American Museum of Natural History to species level where possible. We used the species richness and abundance of native bees as predictors to test the relationship between native bee pollinators and pollination levels.

While we did deploy pan traps in 2012, results were not available by the time of this analysis. We therefore could not test the relationship between pollinators and pollination using data collected from 2012.

Confounding Variables

We sampled the local flowering abundance/diversity on the transect, the closest crop type and the Julian date of deployment as possible confounding variables. We measured the abundance and diversity of flowering plants along each transect to gauge the degree of competing flowers to the phytometer plants as a potential confounding variable. Each flowering plant species was identified to species and given an abundance rank (1- few individuals, 3 – abundant individuals). Adding together the rank values for each species provided a single value for each transect representing both the diversity and abundance of flowering plants on the transect. We referred to this metric as “Flowering Plant Index”. We recorded the crop types of the fields closest to our study plants (referred to as adjacent crop type) transects to control for local effects of crop type. We also recorded the Julian date to account for temporal effects on pollinator behavior, as the date on which phytometer plants and pan traps were placed on the transects (the 1st of the 4 day period in the field).

2.4.2 Metrics of farmland heterogeneity

To obtain accurate measures of crop diversity and mean field size, we commissioned aerial photography (40 cm pixels) of each of the 47 landscapes sampled in 2012. We created square land cover maps at multiple scales (1kmx1km, 2kmx2km, 3kmx3km) at 40 cm resolution. Field crews then identified cover types on the photos. For each landscape, we calculated 2 landscape variables; mean field size (configurational heterogeneity of farmland) and the Shannon Diversity of cropland cover (compositional heterogeneity of farmland). We calculated the landscape variables at three scales based on 1km x 1km, 2km x 2km and 3km x 3km squares around the landscape centers.

Confounding Variables

We calculated two possible confounding variables at the 3 landscape scales; the proportion of agricultural cover and the proportion of Soybean (*Glycine max*) cover in the landscape. We included the proportion of agricultural cover to control for potential effects of agricultural cover on pollination potential. We also included the proportion of Soybean cover in the landscapes. Flowering Soybean attracts native bee pollinators in agricultural landscapes, providing nectar and pollen reward during the blooming period (Bennett and Isaacs 2014, Milfont et al. 2013). We included the proportion of agricultural cover as a potential confound on pollination potential.

We included two other potential confounding variables; the flowering plant index at a landscape level and the Julian date. We took the sum of flowering plant index values across the three transects to get a single value for each landscape. Julian date was included as the first day of phytometer deployment.

2.5 Statistical Analysis

2.5.1 2011: Relationship between *B. juncea* reproductive success and native bee species richness and abundance

At each transect, we used the mean seed set/transect from *B. juncea* to test the effects of native bee species richness and abundance on pollination potential. We did not transform the *B. juncea* mean seed set/transect.

Selecting Confounding Variables

We calculated correlations between the potentially confounding variables and our native bee species richness and abundance. Potentially confounding variables included survey field crop type, Flowering Plant Index and Julian date. When possible, we transformed confounding variables as necessary to achieve approximately normal distributions.

To select which confounding variables to include when examining the effect of species richness and abundance on *B. juncea* mean seed set/transect, we fit general linear models relating the mean seed set of *B. juncea* for each transect to all possible combinations of potential confounding variables. We then ranked these models using AICc values including a null model. If the null model fell outside the top models (AICc > 2), then confounding variables that appeared in the top models were included in the analysis.

Native bee species richness and abundance vs. *B. juncea* mean seed set/transect

We tested the predictions bee diversity and abundance would have a positive effect on seed set of *B. juncea* using general linear models. We log transformed the native bee abundance, and square root transformed the species richness. We fit 2 general linear models, one containing the species richness and the other containing total bee abundance.

We then ranked the models using AICc, and included a null (intercept only) model for comparison.

2.5.2 Effects of farmland heterogeneity on pollination potential of agricultural landscapes

Phytometer response variables

We calculated the mean seed set/landscape separately for each species of phytometer plant from 2011 and 2012. We examined the mean seed set/landscape for each species (*B. juncea*, *B. rapa*, *R. sativus*, *D. grandiflorum*) for normality, and transformed when necessary.

Selecting confounding variables

We calculated the Pearson coefficients between confounding variables and predictor variables (crop diversity, mean field size). Potential confounding variables included the proportion of agricultural cover, the proportion of Soybean cover, Flowering plant index/landscape, and Julian date. To select which of these variables to include, we created general linear models relating the mean seed set/landscape for each phytometer species (*B. juncea*, *B. rapa*, *R. sativus*, and *D. grandiflorum*) to all possible combinations of the confounding variables. We ranked these models using AICc values, including a null model.

To control for the effects of the confounding variables when testing for effects of farmland heterogeneity variables on pollination potential, we fit a general linear model containing the potential confounding variables found to be important (above) to the mean seeds/pod per landscape. We then used the residuals of this model as the response

variable when testing for the effects of crop diversity and mean field size on pollination potential. When no confounding variables were found to be important, we used the mean seeds/landscape as response variable.

Determining scales of effect for landscape variables

To test the effects of landscape scale variables (potentially confounding landscape variables and farmland heterogeneity variables) on pollination potential, we first determined which scale of effect to calculate proportion crop cover, proportion Soybean cover, Shannon diversity for crop types and mean field size. We ran simple linear regressions of our response variable (seeds/pod per landscape) on the three predictor variables at each scale. The scale at which the predictor showed the strongest effect (absolute Pearson correlation coefficient) was used in further analysis. We did this separately for each phytometer species.

Farmland Heterogeneity Effects

We tested the predictions that increasing crop diversity and decreasing mean field sizes will each result in higher pollination potential of our agricultural landscapes (mean seed set per landscape). We first transformed the landscape predictors to achieve normality. The variables were then standardized in order to compare their relative effects (Smith et al. 2009).

For each phytometer species, we fit general linear models relating the mean seed set/landscape (or residual mean seed set/landscape if potential confounding variables controlled for) to all possible combination of the landscape variables at the scales that showed the strongest response (Shannon Diversity of crop types, mean field size). We

then ranked these models by AICc values, and included an intercept only model as a null model.

For each landscape predictor, we multiplied the coefficients from each model that contained that predictor by the model weight. We then averaged these weighted coefficients to give us standardized, model averaged coefficient estimates for each landscape predictor. This allowed us to compare the direction and relative strength of effects of the landscapes predictor.

All statistical analysis in this study was performed using R (R Core Team 2014).

3 Results

3.1 2011 – Testing the predictions that increasing species richness and abundance of native bees results in higher pollination potential

We trapped 2767 native bees with an average of 18 bees and 5 species per transect. Individuals from 20 genera were captured, with *Lasioglossum spp.* the most abundant (61% of total abundance) (Figure 6). Species richness was normally distributed. We transformed the total bee abundance with a square root transformation to achieve normality.

The *B. juncea* phytometer plants produced an average 9.2 seeds/pod per transect (SD 2.4) and the mean seed set/transect was roughly normally distributed.

Correlations between potential confounding variables and native bee richness and abundance were weak, with absolute values ranging from 0.04-0.11. The strongest correlation was between the flowering plant index and the species richness of native bees

($r = -0.11$) The total abundance and species richness of native bees were strongly correlated ($r = 0.68$) (Table 1).

Selecting potential confounding variables

No models containing combinations of the potential confounding variables had more effect on the mean seed set/transect than the null (intercept-only) model, when ranked with AICc values (Table 2). Therefore we did not include any of the potential confounding variables when examining the effects of bee species richness and abundance on *B. juncea* mean seed set/transect.

Effects of species richness and abundance on mean *B. juncea* seed set/transect

Models relating species richness and total bee abundance separately to mean seed set/transect had no more support than the null (intercept only) model (Table 3). Therefore, our data did not support our predictions.

However, in a post-hoc analysis, we found that the abundance of *Lasioglossum* spp. had a significant, negative effect on the mean seed set/transect of *B. juncea* (Figure 7).

3.2 Effects of farmland heterogeneity on pollination potential of agricultural landscapes

Greenhouse pollination test results

Other than a single pod in *B. rapa*, no seeds were produced from the condition in which the plants were pollinated from flowers on the same plant. While we have no explanation as to why a single flower produced seeds in *B. rapa*, the remaining 9/10 did

not, suggesting that there is little risk that *B. rapa* and *R. sativus* are self-compatible. We found a small amount of seeds produced from flowers that had not been treated, yet covered with cheesecloth. We also found that flowers left exposed to the greenhouse produced a small amount of seeds, indicating a low amount of pollinator activity in the greenhouse. *B. rapa* and *R. sativus* plants produced the highest amount of average seeds/pod when pollinated from other plants (7.3 seeds/pod and 4 seeds/pod, respectively) (Tables 4 and 5, respectively). The results from these tests suggest that self-incompatibility was not a major cause of variation in our seed set results from the field, though we did find a low level of pollination occurring in the greenhouse.

B. rapa phytometer plants produced an average of 3.2 seeds/pod per landscape (SD 1.5). *R. sativus* produced an average of 0.7 seeds/pod per landscape (SD 0.5), and *D. grandiflorum* produced an average of 0.9 seeds/pod per landscape (SD 0.6). Mean seed set of *B. rapa* was normally distributed, and we square root transformed mean seed set/landscape for *R. sativus* and *D. grandiflorum*.

Correlations between potential confounding variables and landscape variables ranged in absolute Pearson correlation coefficients from 0.01 to 0.7. The strongest correlations occurred between the proportion of agricultural cover and log-transformed mean field size ($r = 0.7$). Log-transformed mean field size and Shannon diversity for crop species were negatively correlated at the three scales (1km: $r = -0.28$, 2km: $r = -0.24$, 3km: $r = -0.32$) (Table 6).

The correlations between landscape variables (both farmland heterogeneity on landscape scale confounding variables) at the 3 scales and mean seed set/landscape for phytometer species are shown in Table 7.

Selecting potential confounding variables

The null model fell within the top models ($\Delta AICc < 2$) relating the effects of confounding variables on the mean seed set/landscape of *B. juncea* (2011). We therefore did not include any confounding variables in further analysis using *B. juncea* mean seed set/landscape as a response variable. The null model fell within the top models ($\Delta AICc < 2$) relating the effects of confounding variables on the mean seed set/landscape of *B. rapa* (2012). We therefore did not include any confounding variables in further analysis using *B. rapa* mean seed set/landscape as a response variable. The null model fell outside the top models for the mean seed set/landscape of *R. sativus* and *D. grandiflorum* (2012), suggesting that combinations of confounding variables were having more effect on the response variable than the null model. The top models for *R. sativus* contained Julian date, proportion of agricultural cover and proportion of Soybean cover, which were controlled for in later analysis. The top models for *D. grandiflorum* contained the proportion of agricultural cover and proportion of Soybean cover, which was controlled for in later analysis (Table 8). The strongest effect of confounding variable was the proportion Soybean in the landscape, which was significantly related to the mean seed set/landscape of *R. sativus* and *D. grandiflorum* (Figure 8 and Figure 9, respectively).

Effects of crop diversity and mean field size on pollination potential

We did not find support for our predictions that farmland heterogeneity should result in higher pollination potential in agricultural landscapes. The null model (intercept only) fell within 2 $AICc$ units of the top model, when compared with models containing combinations of the landscape variables (Shannon-Diversity for crops, mean field size)

for the mean seed set/landscape of *B. juncea* (2011), *B. rapa* (2012), *R. sativus* (2012) and *D. grandiflorum* (2012) (Table 9, Table 10, Table 11 and Table 12, respectively). Therefore, we cannot conclude that models containing any combination of Shannon diversity for crop types and/or mean field size had more support than a model containing only the intercept.

4 Discussion

2011 – Pollination potential vs. native bee species richness and abundance

We did not find a relationship between pollination of *B. juncea* and native bee richness or abundance. This was surprising, because previous studies using phytometer plants to sample pollination potential have shown that seed set is sensitive to changes in both the diversity (Klein et al. 2003, Albrecht et al. 2007, Albrecht et al. 2012) and abundance (Albrecht et al. 2017) of visiting bees.

One possible explanation for our result may be the dominance of inefficient pollinators on transects. Less efficient pollinators may interfere with the pollination of entomophilous plants when outnumbering more efficient pollinators (Lau and Galloway 2004). In a post hoc analysis, we found that there was a significant negative relationship between *Lasioglossum spp.* abundance and mean seed set/transect. The *Lasioglossum spp.* genus was the most abundant captured by our pan traps. If the *Lasioglossum spp.* were inefficient pollinators, then higher abundances may have a negative effect on reproductive success of *B. juncea* by outcompeting the more efficient pollinators. Using a phytometer approach, Lau and Galloway (2004) found that when halictid (Family

Halictidae) bees outnumbered more efficient pollinators (in this case, *Bombus spp.*), increasing abundance of inefficient pollinators significantly decreased seed set relative to flowers where inefficient pollinators were excluded. These inefficient pollinators consumed pollen without stigmatal contact, limiting successful cross pollination and excluding more efficient pollinators (Lau and Galloway 2004, Johnson et al. 1995). If members of *Lasioglossum spp.* were not efficient pollinators, than they may have outcompeted more efficient pollinators on the phytometer plants, leading to a negative effect of *Lasioglossum spp.* abundance on pollination potential.

It is interesting to note that we did not detect a significant correlation between the flowering plant index of each transect and the diversity/abundance of native bees (Table 1). Baum and Wallen (2011) found an inverse relationship between local flowering resources and pan trap results when testing the effectiveness of pan trapping, where higher abundance/diversity of native bees were collected at sites with low floral resource availability in pan traps. This was due to the increased attractiveness of pan traps to foraging bees at sites with limited resources. Previous studies have shown that pan traps undersample bee species richness when there is an abundance of local floral resources (Roulston et al. 2007, Wilson et al. 2008). In our study, we included the flowering plant index as a metric of the local flowering resources and found a weak, non-significant correlation with the diversity and abundance of native bees. This suggests that the amount and diversity of local, flowering resources was not significantly influencing our pan trapping results.

Pan traps, while lacking observer bias and cost effective, may not have effectively sampled the abundance and diversity of native bees actively pollinating our phytometer

plants. The diversity and abundance of native bees visiting our phytometer plants may have differed from those captured by the traps, especially when considering that pan traps tend to be biased towards smaller bees (with larger species able to escape capture) (Wilson et al. 2008). This may have been a source of variance in our data, and may have affected our ability to detect the relationship between pollinators and pollination. Pan trapping was the most effective option for our study due to logistical requirements, but directly netting flower visitors from our phytometer plants for a set period of time may have provided native bee diversity and abundance data closer linked to our phytometer data. Popic et al. (2013) found that net sampling captured 22% more species and 30% higher abundance than pan traps, were less biased by local flowering resources, and allowed them to directly sample flower visitors. Sampling the diversity and abundance of bees visiting our plants would create a clearer link between pollinators and pollination when testing the effects of increasing bee diversity/abundance on pollination potential.

Effects of farmland compositional and configurational heterogeneity on pollination potential

We did not find support for our prediction that landscapes with higher crop diversity (higher compositional heterogeneity of farmland) would have higher pollination potential, as inferred from mean seed set/landscape generated by *B. juncea*, *B. rapa*, *R. sativus* and *D. grandiflorum*. We had expected that a higher diversity in crop species would create a more stable supply of resources to supplement those in semi-natural cover, leading to higher pollination services in the landscape.

It is possible that we did not detect an effect of Shannon Diversity of crops on pollination potential due to low variation in the crop diversity of our landscapes. Our

study landscapes were dominated by 4 crop species (Corn, Soybean, Hay/Pasture mix, and Cereal), mostly Corn (*Zea mays*) and Soybean (*Glycine max*) (42.1% and 30.6% of the Crop cover, respectively) (Appendix 1). It is possible that, given the limited range in crop types in our landscape, there was not enough diversity in crop types to affect the stability of resources for native bees. Crop diversity may have a greater effect on pollination services in landscapes with a greater range of crop species. Billeter et al. (2007) found that the crop diversity (measured as the average number of crop species/farm) had a significant positive effect on the diversity of native bees in agricultural landscapes. The crop diversity in this study ranged from 1 to > 7 crop species per farm (Billeter et al. 2007), a higher range in crop types than in our landscapes (1-4). Fahrig et al. (2015) found no effect of crop diversity on native bees in our region, and concluded that this may have been due to low crop diversity in the landscape.

Our results also did not support our prediction that increasing configurational heterogeneity of farmland (decreasing mean field size) should increase the pollination potential of agricultural landscapes. This result was surprising, because Fahrig et al. (2015) found that landscapes with smaller crop fields supported a higher diversity of native bees.

We may not have detected an effect of mean field size on pollination potential because of weak relationships between mean field size and native bee diversity/abundance and between native bee diversity/abundance and pollination potential. The potential effect of mean field size on pollination potential depends on (a) the effect of mean field size on native bee abundance and diversity, and (b) the effects of

native bee abundance and diversity on pollination potential (Kremen et al. 2007). If both relationships were weak, then the potential effects of mean field size on pollination potential may be too weak to detect. While Fahrig et al. (2015) found that native bee diversity was higher in landscapes with smaller fields, the effect was not strong; mean field size explained 9.2% of the variance in bee diversity. As for the relationship between native bee diversity and pollination potential, we found no evidence that increasing diversity of native bees resulted in higher pollination potential in our study region in 2011 (Table 5). This suggests that in our study region, a weak effect of mean field size on native bee diversity and a no support for a relationship between bee diversity and pollination potential means that it was unlikely to find an effect of mean field size on pollination potential.

We detected a significant, positive relationship between the proportion of Soybean cover in the landscape and pollination potential. We found that landscapes with higher proportion of Soybean at the 1km and 2km scales had significantly higher mean seed set/landscape for *D. grandiflorum* and *R. sativus*, respectively. Mass flowering crop species can enhance the abundance, reproductive success and diversity of multiple native bee species (Westphal et al. 2003, Holzshuh et al. 2013, Diekötter et al. 2014), when there is sufficient semi-natural cover in the landscape to provide nesting and additional floral resources post-blooming period. This can lead to higher pollinator activity and higher seed set of entomophilous plants on field boundaries adjacent to mass flowering crops (Cussans et al. 2010, Hanley et al. 2011). Our phytometer experiment in 2012 coincided with the flowering period of Soybean (approximately 4 weeks beginning in roughly July). This suggests that the increased abundance and/or diversity of pollinators

foraging in landscapes with more flowering Soybean may have driven the positive effect we detected of increasing Soybean cover on pollination potential of the landscape.

The positive effect of Soybean cover in the landscape on mean seed set/landscape indicates that our study had sufficient statistical power to detect effects of landscape variables on pollination potential. This suggests that our inability to detect an effect of farmland heterogeneity on pollination potential was not strongly influenced by the power of our study design. Probably the weakest aspect of our design was the short deployment period of phytometer plants in the field (4 days). This was necessary, based on the extensive sampling regime required to sample 319 different transects in 89 landscapes over two years. However, we note that Woodcock et al. (2014) found strong effects of bee diversity and abundance on seed set of multiple phytometer species using a 7 day deployment period. In addition, Bennett and Isaacs (2014) deployed phytometer plants in agricultural landscapes for 7 days and found strong relationships between seed set and landscape structure. This suggests that a short deployment time does not necessarily limit our ability to sample pollination potential. The increase in seed set we detected in landscapes with higher proportion of Soybean cover for *R. sativus* and *D. grandiflorum* supports this, and thus our phytometer protocol should have been able to detect moderate effects of farmland heterogeneity on pollination potential.

Environmental conditions, such as rain, solar radiation, temperature and wind can affect pollinator behavior, and may have added variance to our phytometer results. Tuell and Isaacs (2010) observed that fewer native bees foraged during poor weather (low temperature, high wind speed, low solar radiation, high humidity), and seed set of Highbush Blueberry (*Vaccinium corymbosum*) was 5 times higher when flowers were

exposed to good weather, rather than poor weather. Vicens and Bosch (2000) supported this finding, and found that fewer bees pollinated in conditions with strong wind or even light rain. Fluctuating environmental conditions during the 4 day deployment period may have added variance to our pollination results. The positive relationship we detected between the proportion Soybean cover in the landscape and pollination potential suggests that variance in pollination caused by fluctuating environmental conditions were not preventing us detecting changes in landscape structure in our phytometer experiments. Future studies should attempt to sample environmental conditions while phytometer plants are deployed in case of potential environmental effects.

Implications

Our results suggest that policies aimed at increasing heterogeneity of the cropped parts of agricultural landscapes will not significantly increase pollination potential. This suggests that effective landscape policies for increasing pollination should focus on non-crop cover. The fact remains that policies aimed increasing pollinator habitat at the expense of arable land in farmlands may be unpalatable to landowners without financial incentives (Burton et al. 2008). Here we present two possible mitigation techniques focusing on non-cropped area that can enhance pollination potential of agricultural landscapes without taking arable land out of production.

One potential method for increasing pollination potential of agricultural landscapes without removing cropped area from the landscape is the enhancement and restoration of semi-natural field boundaries. Semi-natural boundaries between crop fields are a common semi-natural cover in farmlands, and are a critical habitat to native pollinators in agricultural landscapes (Hannon and Sisk 2009). Enhancing field

boundaries with natural, diverse seed mixes can provide a continual source of floral resources to native pollinators (Morandin and Kremen 2013a). In fact, preserving and enhancing semi-natural fields boundaries has been recommended as a method of increasing pollinator diversity and abundance in agricultural landscapes (Batary et al. 2011, Carvell et al. 2007, Pywell et al. 2011). Morandin and Kremen (2013b) showed that native bees were more diverse and abundant on restored hedgerows (enhanced with natural seed mix) than unmanaged field boundaries, and restored hedgerows exported native bees into adjacent flowering crop fields. This was supported by the findings of Blaauw and Isaacs (2014), who found that crop pollination potential was higher when crops were adjacent to wildflower-enhanced field boundaries.

Changing from conventional to organic farming techniques is another possible method of enhancing pollination potential of agricultural landscapes, without taking land out of production. Organic farms are managed without herbicides, pesticides and artificial fertilizers, and tend to have higher farmland heterogeneity (higher crop diversity, smaller mean field size than conventionally managed farms (Norton et al. 2009). Organic farmlands have higher pollination potential (measured with crop species seed set) than conventionally managed farmlands in agriculturally dominated landscapes (Andersson et al. 2012, Morandin and Winston 2005). This is likely due to the higher diversity and abundance of native bees persisting in organic farmlands than conventional farmlands (Holzshuh et al. 2007, Holzshuh et al. 2008, Rundlof et al. 2008). While increased farmland heterogeneity (higher crop diversity, smaller fields) has been suggested as a driver of higher native bee diversity and abundance in organic fields (Winfree et al. 2008), the results of our study do not support this (Tables 8, 9, 10). It is more likely that a

higher flowering plant diversity found in organic fields provides a more temporally stable source of resources to pollinators, driving a higher diversity of native bees (Holzshuh et al. 2008). This is supported by the results of Holzshuh et al (2007), who found that organic farmlands had higher species richness and abundance of native bees, as well as a higher diversity of flowering plants when controlling for field sizes and crop diversity.

In conclusion, we did not find support for our predictions that agricultural landscapes with higher crop diversity and lower mean field sizes supported higher pollination potential. We can conclude that policies aimed at manipulating farmland heterogeneity may not provide the predicted increase in pollination services to the landscape.

Figures

Figure 1: Theoretical landscapes showing how configurational heterogeneity can increase independently from compositional heterogeneity, and vice versa. Different colours represent different cover types. Landscapes 1A and 2A have the same level of compositional heterogeneity, but differ in configurational heterogeneity. Landscapes 2A and 2B have the same level of configurational heterogeneity, but differ in compositional heterogeneity.

Figure 2: Map of the study region in Eastern Ontario, Canada, with 1km x 1km landscapes (solid square) and 3km x 3km extents (outlines) highlighted. We tested the effects of native bee diversity and abundance on pollination potential in red landscapes in 2011, while we tested the effects of farmland heterogeneity on pollination potential in black landscapes in 2012.

Figure 3: Typical landscape with cover types digitized at three spatial scales (1km x 1km, 2km x 2km, 3km x 3km), identified by black square outlines. We sampled pollination potential (2011, 2012) and native bee diversity/abundance (2011) within the 1km x 1km landscape.

Figure 4: Typical 1km x 1km study landscape showing locations of transect centers on field boundaries. 50m radii around transect centers are included to show that transects were a minimum of 50m from border of 1km x 1km landscape and a minimum of 50 m from non-crop cover. 100 m radii around the transect centers are included to show minimum of 200m between transects.

Figure 5: Diagram showing the field deployment of pan traps and phytometer plants on a typical transect in one of our study landscapes in 2011. Pairs of pan traps were 25 m apart. Phytometer plants were a minimum of 3 m from pan traps. In 2012, we used a similar deployment, with the exception that we used 3 phytometer species (*B. rapa*, *R. sativus*, *D. grandiflorum*) rather than 1. Pots for these three species were in the same location as in 2011, with 1 m between them.

Figure 6: Abundances of native bees captured in pan traps in 2011, by genus.

Figure 7: Relationship between the reproductive success of *B. juncea* (mean seed set/transect) and (a) log transformed *Lasioglossum* spp. abundance and (b) total abundance of other native bees in 2011. The abundance of *Lasioglossum* spp. was significantly, negatively related to the mean seed set/transect ($R^2 = 0.08$, $df(1,110)$, $p < 0.01$).

Figure 8: Relationship between the proportion of Soybean cover in the landscape and mean seed set/landscape for *R. sativus* ($R^2 = 0.10$, $df(1, 43)$, $p = 0.03$)

Figure 9: Relationship between the proportion of Soybean cover at the 1km scale and the mean seed set/landscape for *D. grandiflorum* ($R^2 = 0.17$, df (1,28), $p = 0.02$)

Tables

Table 1: Pairwise correlations between potentially confounding variables and predictor variables from 2011 analysis. Pearson correlation coefficients are included to show correlation between Julian date, flowering plant index, native bee species richness and total native bee abundance.

	Julian Date	Flowering Plant Index	Species Richness	Total Abundance
Julian Date	1			
Flowering Plant Index	0.11	1		
Species Richness	0.04	-0.11	1	
Total Abundance	-0.03	-0.05	0.68	1

Table 2: Top models (within 2 AICc units of top model) relating combinations of potentially confounding variables (Julian date, flowering plant index, and survey field crop type) to *B. juncea* mean seed set/transect. Models were ranked by lowest AICc values. We included a null model for comparison.

Response Variable:	Model:	df	AICc	Delta AICc	Akaike Weight
<i>B. juncea</i> Mean seed set/transect	Julian Date + Flowering Plant Index	4	511.86	0	0.34
	Flowering Plant Index	3	512.34	0.47	0.27
	Null	2	512.91	1.05	0.20
	Julian Date	3	513.02	1.16	0.19

Table 3: Models relating native bee species richness or abundance to *B. juncea* mean seed set/transect, ranked by lowest AICc values. We included a null model for comparison.

Response Variable:	Model:	df	AICc	Delta AICc	Akaike Weight
<i>B. juncea</i>					
Mean seed set/transect	Total Bee Abundance	3	512.24	0	0.46
	Null	2	512.91	0.67	0.33
	Species Richness	3	513.89	1.65	0.20

Table 4: The number of *B. rapa* seeds per pod from 4 experimental flower pollination conditions testing self-incompatibility and greenhouse pollination levels. Seeds in condition ‘A’ developed from flowers pollinated by other flowers. Seeds in condition ‘B’ developed from flowers that were pollinated from flowers of other plants. Seeds in condition ‘C’ developed from flowers that received no pollination treatment, and were enclosed in cheesecloth to prevent insect pollination. Seeds in condition ‘D’ developed from flowers that were left open to the greenhouse, with no pollination treatment or cheesecloth.

Pod #	Seeds produced per pod			
	Condition:			
	A	B	C	D
1	10	10	0	8
2	0	6	0	9
3	0	11	6	0
4	0	8	6	0
5	0	12	0	4
6	0	6	0	0
7	0	6	0	0
8	0	4	0	5
9	0	2	0	0
10	0	8	0	10
Mean	1	7.3	1.2	3.6

Table 5: The number of *R. sativus* seeds per pod from 4 experimental flower pollination conditions, testing self-incompatibility and greenhouse pollination levels. Seeds in condition ‘A’ developed from flowers pollinated by other flowers. Seeds in condition ‘B’ developed from flowers that were pollinated from flowers of other plants. Seeds in condition ‘C’ developed from flowers that received no pollination treatment, and were enclosed in cheesecloth to prevent insect pollination. Seeds in condition ‘D’ developed from flowers that were left open to the greenhouse, with no pollination treatment or cheesecloth.

Pod #	Seeds produced per pod			
	Condition:			
	A	B	C	D
1	0	4	0	1
2	0	2	2	0
3	0	4	2	0
4	0	2	0	0
5	0	4	0	4
6	0	8	0	2
7	0	6	0	2
8	0	4	0	1
9	0	2	0	0
10	0	4	1	0
Mean	0	4	0.5	1

Table 6: Pairwise correlations between potentially confounding variables and farmland heterogeneity measures. Potentially confounding variables include Julian date, flowering plant index/landscape, proportion Soybean cover (1km, 2km scale), and proportion crop cover (1km, 2km, 3km). Farmland heterogeneity measures include Shannon diversity for crop types (SHDI, 1km, 2km 3km) and mean field size (1km, 2km, 3km).

		Julian date	Flowering plant index	Soybean Cover		Crop Cover			SHDI			MFS		
				1km	2km	1km	2km	3km	1km	2km	3km	1km	2km	3km
Julian date		1												
Flowering plant index		-0.23	1											
Soybean Cover	1km	-0.3	0.13	1										
	2km	-0.25	0.1	0.75	1									
Crop Cover	1km	-0.12	0.08	0.48	0.53	1								
	2km	-0.27	0.17	0.32	0.46	0.75	1							
	3km	-0.22	0.21	0.3	0.47	0.67	0.91	1						
SHDI	1km	0.01	-0.14	-0.33	-0.32	-0.28	0.01	0.1	1					
	2km	0.38	-0.22	-0.4	-0.45	-0.3	-0.24	-0.17	0.74	1				
	3km	0.37	-0.16	-0.29	-0.36	-0.29	-0.3	-0.32	0.49	0.87	1			
MFS	1km	-0.1	0.13	0.41	0.58	0.7	0.42	0.36	-0.58	-0.53	-0.39	1		
	2km	-0.22	0.21	0.41	0.5	0.66	0.66	0.63	-0.37	-0.64	-0.61	0.8	1	
	3km	-0.19	0.23	0.39	0.51	0.65	0.7	0.74	-0.26	-0.58	-0.63	0.69	0.94	1

Table 7: Absolute Pearson correlation coefficients between mean seed set/landscape for phytometer species and landscape variables at multiple scales (1km, 2km, 3km). Landscape variables included farmland heterogeneity variables (Shannon-diversity index for crop types, mean field size) and potentially confounding variables (proportion crop cover, proportion Soybean cover). The scale that each landscape variable showed the strongest correlation with mean seed set/landscape for each species is highlighted in bold.

Predictor	Scale	Mean seed set/landscape			
		<i>B. juncea</i>	<i>B. rapa</i>	<i>R. sativus</i>	<i>D. grandiflorum</i>
Shannon diversity index for crop types	1km	-0.06	0.20	0.16	0.24
	2km	0.06	0.09	0.16	0.27
	3km	0.04	0.05	0.16	0.07
Mean field size	1km	-0.08	0.11	0.31	0.43
	2km	-0.04	0.09	0.28	0.32
	3km	-0.03	0.13	0.35	0.30
Proportion crop cover	1km	-0.24	0.08	0.33	0.30
	2km	-0.03	0.05	0.14	0
	3km	0.11	0.05	0.21	0.05
Proportion Soybean cover	1km	-0.14	0.07	0.24	0.41
	2km	-0.14	0.09	0.32	0.15
	3km	-0.01	0.08	0.31	-0.03

Table 8: Top models (within 2 AICc units of top model) relating combinations of potentially confounding variables (Julian date, flowering plant index, proportion Soybean cover and proportion crop cover) to mean seed set/landscape of *B. juncea*, *B. rapa*, *R. sativus* and *D. grandiflorum*. Models were ranked by lowest AICc values. We included a null model for comparison.

Response Variable	Models	df	AICc	delta AICc	Akaike Weight
<i>B. juncea</i> mean seed set/landscape	Null	2	162.10	0	0.22
	Crop Cover	3	162.10	0.16	0.20
	Soybean Cover	3	163.60	1.56	0.10
<i>B. rapa</i> mean seed set/landscape	Julian Date	3	170.37	0	0.23
	Julian Date + Soybean Cover	4	171.41	1.03	0.13
	Null	2	171.80	1.42	0.11
<i>R. sativus</i> mean seed set/landscape	Julian Date + Crop Cover	4	14.2	0	0.30
	Julian Date + Crop Cover + Soybean Cover	5	15.1	0.91	0.19
	Crop Cover + Soybean Cover	3	16.1	1.86	0.12
<i>D. grandiflorum</i> mean seed set/landscape	Soybean Cover	3	27.8	0	0.26
	Crop Cover + Soybean Cover	4	28.7	0.90	0.17
	Crop Cover	3	29.1	1.30	0.14

Table 9: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on the mean seed set/landscape for *B. juncea* in 2011, including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from the top model (delta AICc) and Akaike weights for each model.

Coefficients		AICc	Delta AICc	Akaike Weight
SHDI (2km)	log-MFS (1km)			
-	-	162.1	0	0.55
-0.17		164.1	2.01	0.20
	0.12	164.3	2.20	0.18
-0.15	0.07	166.5	4.46	0.06

Table 10: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on the mean seed set/landscape for *B. rapa*, including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from top model (delta AICc) and Akaike weights for each model.

Coefficients		AICc	Delta AICc	Akaike Weight
SHDI (1km)	log-MFS (3km)			
-	-	171.80	0	0.42
-0.30		172.30	0.50	0.33
	0.12	173.80	2.00	0.16
-0.28	0.05	174.70	2.86	0.10

Table 11: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on the residual mean seed set/landscape for *R. sativus* including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from top model (delta AICc) and Akaike weights for each model.

Coefficients:		AICc	Delta AICc	Akaike Weight
SHDI (3km)	logMFS (3km)			
-	-	7.9	0	0.54
	0.03	9.7	1.83	0.22
-0.02		10.0	2.15	0.18
0.02	0.003	12.1	4.24	0.06

Table 12: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on residual mean seed set/landscape for *D. grandiflorum*, including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from top model (delta AICc) and Akaike weights for each model.

Coefficients:		AICc	Delta AICc	Akaike Weight
SHDI (2km)	logMFS (1km)			
-	-	23.3	0	0.50
	0.07	24.7	1.33	0.26
-0.01		25.8	2.47	0.15
0.06	0.10	26.8	3.43	0.09

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Appendices

Appendix A: Breakdown of percent crop cover in landscapes at 3km scale by crop species

Appendix B: 2011 data used in testing effects of native bee species richness and abundance on pollination potential of *B. juncea*. Includes response variable (mean seed set/transect *B. juncea*), potentially confounding variables (Flowering plant index, adjacent crop type, Julian date) and bee predictor variables (bee species richness, total bee abundance, *Lasioglossum spp.* abundance and remaining abundance (abundance excluding *Lasioglossum spp.* abundance)).

Landscape	Transect	mean seed set/transect	Flowering plant index	Adjacent crop type	Julian date	Total bee abundance	Bee species richness	<i>Lasioglossum spp.</i> abundance	Abundance (excluding <i>Lasioglossum spp.</i>)
1	1	10.41	3	hay	11210	15	4	10	5
1	2	11.74	3	cereal	11210	40	11	5	35
1	3	11.68	10	corn	11210	24	6	3	21
4	1	9.58	9	hay	11227	8	3	6	2
4	5	12.58	13	corn	11227	25	11	9	16
4	6	10.84	12	soybean	11227	4	3	2	2
10	1	9.05	1	corn	11203	17	9	4	13
12	3	13.70	5	soybean	11188	8	5	4	4
12	4	5.73	5	soybean	11188	10	5	5	5
12	6	10.16	7	soybean	11188	15	5	10	5
13	2	7.56	4	soybean	11217	13	5	7	6
13	3	6.75	5	soybean	11217	13	6	8	5
13	4	7.77	8	soybean	11217	16	4	11	5
14	3	6.42	3	corn	11204	35	5	25	10
14	4	9.67	10	hay	11204	17	6	12	5
14	5	2.25	5	corn	11204	79	8	50	29
16	1	12.31	9	corn	11203	4	4	0	4
16	3	9.38	4	corn	11203	9	5	2	7
16	4	6.82	3	corn	11203	19	5	10	9
21	1	11.35	9	soybean	11210	19	6	6	13
21	3	12.54	12	soybean	11210	6	5	0	6
21	4	9.71	2	soybean	11210	8	4	0	8
23	2	7.88	14	soybean	11235	37	8	1	36

Appendix B Continued

23	3	8.00	10	soybean	11235	2	2	0	2
23	4	7.92	4	soybean	11235	23	4	7	16
25	4	10.18	0	soybean	11189	18	6	12	6
25	5	3.58	8	corn	11189	21	6	13	8
25	7	7.03	21	corn	11189	4	4	1	3
28	3	10.02	6	corn	11194	12	7	5	7
30	1	6.44	0	soybean	11211	31	11	11	20
30	3	11.03	0	corn	11211	44	10	14	30
30	4	11.38	9	legumes	11211	30	11	15	15
32	2	10.25	16	corn	11233	22	10	9	13
32	3	8.94	14	corn	11233	18	11	3	15
32	4	8.46	2	hay	11233	13	8	1	12
33	2	9.73	8	soybean	11234	24	6	18	6
33	3	12.36	13	soybean	11234	20	8	8	12
33	4	12.09	5	soybean	11234	9	5	3	6
37	1	10.11	12	corn	11235	15	6	9	6
37	4	6.26	12	hay	11235	20	5	14	6
43	1	10.29	9	soybean	11232	54	9	23	31
43	2	9.70	9	soybean	11232	21	10	5	16
43	4	12.30	12	soybean	11232	11	7	3	8
44	1	9.25	14	hay	11227	5	3	2	3
44	4	7.00	14	corn	11227	42	9	12	30
44	5	9.24	16	hay	11227	12	5	5	7
45	2	6.85	5	soybean	11238	12	5	5	7
45	3	8.50	5	hay	11238	11	4	7	4
45	4	7.94	10	soybean	11238	3	3	0	3
48	1	11.64	9	soybean	11197	19	7	6	13
48	3	11.66	11	corn	11197	54	6	31	23
51	1	13.08	8	corn	11194	17	8	1	16
51	6	11.68	5	corn	11194	0	0	0	0
53	2	8.50	5	soybean	11235	20	7	2	18
53	3	13.52	20	hay	11194	1	1	0	1
53	4	7.91	12	soybean	11235	10	3	8	2
56	1	8.56	10	corn	11218	39	4	36	3
56	5	12.18	3	legumes	11218	17	7	9	8
56	6	8.79	4	corn	11218	27	8	16	11
58	2	7.11	7	fallow	11228	13	4	10	3
58	3	10.05	16	corn	11228	24	5	19	5
58	4	8.14	17	soybean	11228	18	6	10	8
63	1	10.55	4	corn	11203	10	3	3	7
63	2	10.70	4	corn	11203	6	4	0	6

Appendix B Continued

65	4	11.47	6	legumes	11195	9	4	5	4
68	1	7.11	5	soybean	11189	15	5	5	10
68	3	5.77	11	corn	11189	26	7	13	13
69	3	9.91	9	soybean	11212	18	9	8	10
69	4	9.13	8	soybean	11186	6	3	0	6
69	5	6.46	9	soybean	11212	18	4	14	4
76	2	12.33	12	corn	11211	27	9	15	12
76	3	8.75	15	corn	11211	40	10	18	22
76	4	11.55	10	hay	11211	19	11	6	13
77	1	4.42	1	hay	11233	13	6	7	6
77	2	9.00	12	soybean	11233	18	7	6	12
77	3	5.40	1	corn	11233	17	7	8	9
78	1	12.36	6	soybean	11188	8	6	1	7
78	6	11.66	4	corn	11188	53	11	15	38
85	1	7.08	13	corn	11211	36	6	22	14
85	2	5.62	7	corn	11187	30	4	23	7
85	4	9.60	13	corn	11211	16	6	10	6
88	1	7.50	2	legumes	11227	7	4	3	4
88	4	9.23	7	hay	11227	17	6	2	15
88	7	10.33	10	corn	11227	12	4	4	8
96	1	13.33	33	hay	11187	28	7	11	17
96	6	12.19	7	hay	11187	3	3	0	3
97	2	4.80	15	hay	11219	7	3	5	2
97	3	5.50	10	soybean	11219	30	7	21	9
97	4	9.33	6	soybean	11219	14	5	9	5
98	2	8.81	11	hay	11210	13	3	11	2
98	5	12.66	9	hay	11210	38	13	17	21
98	6	12.46	3	corn	11210	27	9	12	15
100	1	7.64	15	corn	11228	19	6	13	6
101	1	7.93	4	hay	11204	64	11	17	47
101	2	8.72	1	soybean	11204	15	7	1	14
101	4	5.92	2	corn	11204	14	7	6	8
104	1	7.22	5	hay	11199	30	8	17	13
104	2	6.76	8	hay	11199	29	8	12	17
104	4	9.12	15	pasture	11199	85	7	75	10
106	3	6.18	9	corn	11195	11	6	4	7
107	3	11.78	13	hay	11197	12	7	3	9
107	4	7.40	7	hay	11197	10	5	6	4
107	6	10.10	14	hay	11197	11	4	7	4

Appendix B Continued

108	3	8.80	12	corn	11204	20	8	12	8
108	4	11.33	3	corn	11204	31	7	15	16
108	5	10.74	9	corn	11204	8	5	3	5
109	4	7.38	10	corn	11197	24	9	11	13
109	5	10.31	6	soybean	11197	15	7	8	7
109	6	11.40	6	corn	11197	35	8	22	13
110	2	7.39	6	corn mixed	11228	37	10	24	13
110	3	7.92	9	veg	11228	11	6	6	5
110	7	7.50	5	corn	11186	30	6	23	7

Appendix C1: 2012 Landscape level data for *B. rapa*, including the response variable (mean seed set/landscape), potential confounding variables (Julian date, Flowering plant index/transect, Proportion Soybean cover, Proportion crop cover (Ag Cover)) and farmland heterogeneity variables (Shannon diversity for crop types (SHDI) and mean field size). Landscape level predictors at three spatial scales are included (1km, 2km, 3km)

Landscape	Mean seed set/landscape	Julian Date	Flowering Plant Index	Soybean Cover (1km)	Soybean Cover (2km)	Soybean Cover (3km)	Ag Cover (1km)	Ag Cover (2km)	Ag Cover (3km)	MFS_1km	MFS_2km	MFS_3km	SHDI_1km	SHDI_2km	SHDI_3km
2	1.3	12172	25	0.29	0.18	0.15	0.74	0.68	0.62	38727.33	37074.74	36983.32	1.24	1.56	1.62
3	5.3	12190	23	0.74	0.43	0.29	0.8	0.56	0.54	73048.06	48687.76	49888.69	0.27	0.89	1.32
5	4.3	12182	9	0.71	0.52	0.37	0.94	0.85	0.82	85633.2	77141.13	76507.71	0.56	0.97	1.27
6	2.3	12181	4	0.3	0.14	0.14	0.87	0.7	0.72	45902.26	38452.82	51702.84	1.06	1.37	1.23
7	2.4	12171	0	0.06	0.06	0.07	0.71	0.75	0.68	47222.22	62317.38	53107.61	0.82	0.95	1.06
8	4.4	12203	27	0.15	0.24	0.3	0.79	0.71	0.71	43731.78	52481.68	63696.26	0.89	1.31	1.37
9	4.1	12189	21	0.41	0.2	0.17	0.92	0.82	0.8	101834.23	105312.06	92962.91	0.72	0.99	1.09
11	3.7	12189	26	0.04	0.11	0.22	0.67	0.74	0.79	33315.53	52638.5	58051.08	1	1.11	1.23
18	3.5	12181	8	0.38	0.27	0.23	0.84	0.76	0.78	64453.64	66214.75	62307.23	1.04	1.28	1.39
19	2.6	12190	11	0.15	0.26	0.22	0.71	0.69	0.69	54569.79	53937.08	52665.63	1.26	1.26	1.41
20	2.5	12196	11	0.64	0.31	0.27	0.9	0.87	0.84	47322.97	68458.59	76702.62	0.6	0.99	1.09
22	2.6	12180	23	0.36	0.21	0.18	0.94	0.81	0.77	52068.15	37635.65	40519.41	0.87	1.4	1.36
24	0	12172	10	0.36	0.19	0.14	0.83	0.77	0.73	37753.13	47421.17	46762.78	1.07	1.18	1.31
26	2.9	12172	27	0.09	0.28	0.28	0.62	0.71	0.71	23876.25	44117.47	60498.79	1.17	1	0.96
27	2.4	12198	13	0	0.1	0.09	0.84	0.72	0.65	92780.43	43124.74	44624.2	0.55	1.4	1.55
29	4.8	12188	11	0.05	0.3	0.3	0.87	0.82	0.79	79515.65	81679.4	76241.32	0.58	1.09	1.13

Appendix C1 Continued

31	6.2	12188	23	0.12	0.22	0.24	0.64	0.64	0.68	20148.67	31302.69	41794.58	1.18	1.41	1.27
35	4.9	12204	14	0.07	0.17	0.19	0.83	0.64	0.64	51792.98	43861.84	47760.21	0.42	0.95	1.17
36	2.1	12173	13	0.21	0.22	0.27	0.6	0.67	0.71	12867.71	22416.23	34715.5	1.54	1.53	1.44
39	1.7	12187	18	0.12	0.09	0.1	0.69	0.68	0.68	24750.42	31437.78	34337.19	1.46	1.69	1.55
40	2.1	12203	0	0	0.07	0.15	0.74	0.49	0.51	38882.47	32998.16	38336.34	0.97	1.59	1.57
59	0.2	12201	14	0.18	0.32	0.24	0.85	0.71	0.63	56444.08	58025.25	50646.72	1.07	1.2	1.32
72	5.7	12191	0	0.01	0.01	0.03	0.66	0.64	0.51	38582.94	34132.6	35870.51	0.86	1.25	1.39
73	2.7	12173	7	0.27	0.34	0.3	0.95	0.86	0.81	105495.64	138209.84	93447.58	0.89	1.05	1.16
74	3.7	12174	20	0.49	0.43	0.27	0.92	0.8	0.76	76735.6	57284.43	58265.71	0.95	1.16	1.25
75	4.3	12201	0	0.2	0.14	0.15	0.67	0.5	0.5	18193.58	22280.91	24295.88	1.23	1.58	1.49
79	2.1	12187	0	0.41	0.2	0.16	0.82	0.66	0.66	28233.8	33616.31	47060.49	1.17	1.34	1.17
80	3.8	12190	7	0.44	0.34	0.24	0.81	0.77	0.76	115333.66	146180.83	123695.19	0.69	0.7	0.65
82	3.5	12198	0	0.33	0.2	0.16	0.71	0.6	0.65	50851.07	46939.49	51711.87	1.05	1.51	1.66
87	6	12203	11	0.4	0.25	0.19	0.86	0.89	0.85	45062.49	74115.9	82552.93	1.32	1.51	1.5
91	5.9	12188	0	0.14	0.11	0.09	0.69	0.69	0.71	26504.8	41933.06	51218.24	1.04	1.07	1.1
92	2.7	12201	0	0.07	0.16	0.15	0.71	0.65	0.6	25237.98	23759.51	27533.6	1.35	1.76	1.8
93	1.3	12196	11	0.01	0.07	0.08	0.76	0.63	0.56	27018.99	42725.98	51346.09	1.05	1.34	1.43
102	3	12180	43	0.13	0.07	0.05	0.5	0.48	0.39	27588.33	34875.57	33171.4	0.58	1.03	1.29
105	2.2	12180	17	0.31	0.23	0.16	0.64	0.63	0.55	32009.65	40721.99	44455.31	0.69	0.91	1.15
118	2.6	12182	16	0.14	0.15	0.12	0.73	0.64	0.6	48954.78	40216.93	40691.13	0.86	1.17	1.34
202	2	12191	12	0.15	0.1	0.05	0.6	0.6	0.47	18267.11	20975.08	21510	1.09	1.47	1.62
203	4.2	12182	12	0.39	0.21	0.17	0.72	0.68	0.64	31239.9	49380.67	50841.83	1.17	1.37	1.59
204	3.5	12171	11	0.24	0.1	0.12	0.91	0.76	0.65	56999.86	78143.97	77107.74	1.12	0.93	1.14
207	1.2	12172	3	0.29	0.27	0.27	0.91	0.92	0.87	31472.38	52624.77	62382.33	0.81	1.01	1.21
208	3.5	12174	13	0.56	0.46	0.33	0.93	0.89	0.79	61850.07	72676.54	61211.07	0.72	0.93	1.11
211	6.3	12204	0	0.03	0.08	0.08	0.67	0.67	0.48	20926.63	21221.93	22839.85	1.25	1.7	1.77
214	1.6	12198	16	0.06	0.14	0.21	0.84	0.87	0.87	26380.67	53396.25	63432.24	1.6	1.54	1.41
215	2.9	12197	23	0	0.13	0.18	0.9	0.87	0.88	42983.41	51802.89	67468.66	1.23	1.48	1.5
216	3.2	12179	9	0.33	0.42	0.29	0.89	0.81	0.79	127085.36	70266.02	72853.39	1.06	1.17	1.35
217	3.3	12179	14	0.24	0.18	0.18	0.74	0.82	0.81	27368.32	51287.08	60836.05	1.6	1.65	1.6

Appendix C2: 2012 Landscape level data for *R. sativus*, including the response variable (mean seed set/landscape), potential confounding variables (Julian date, Flowering plant index/transect, Proportion Soybean cover, Proportion crop cover (Ag Cover)) and farmland heterogeneity variables (Shannon diversity for crop types (SHDI) and mean field size). Landscape level predictors at three spatial scales are included (1km, 2km, 3km)

Landscape	Mean seed set/landscape	Julian Date	Flowering Plant Index	Soybean Cover (1km)	Soybean Cover (2km)	Soybean Cover (3km)	Ag Cover (1km)	Ag Cover (2km)	Ag Cover (3km)	MFS_1km	MFS_2km	MFS_3km	SHDI_1km	SHDI_2km	SHDI_3km
2	0.14	12172	25	0.29	0.18	0.15	0.74	0.68	0.62	38727.33	37074.74	36983.32	1.24	1.56	1.62
3	2.00	12190	23	0.74	0.43	0.29	0.80	0.56	0.54	73048.06	48687.76	49888.69	0.27	0.89	1.32
5	1.90	12182	9	0.71	0.52	0.37	0.94	0.85	0.82	85633.20	77141.13	76507.71	0.56	0.97	1.27
6	0.33	12181	4	0.30	0.14	0.14	0.87	0.70	0.72	45902.26	38452.82	51702.84	1.06	1.37	1.23
7	0.39	12171	0	0.06	0.06	0.07	0.71	0.75	0.68	47222.22	62317.38	53107.61	0.82	0.95	1.06
8	0.77	12203	27	0.15	0.24	0.30	0.79	0.71	0.71	43731.78	52481.68	63696.26	0.89	1.31	1.37
9	0.67	12189	21	0.41	0.20	0.17	0.92	0.82	0.80	101834.23	105312.06	92962.91	0.72	0.99	1.09
11	0.29	12189	26	0.04	0.11	0.22	0.67	0.74	0.79	33315.53	52638.50	58051.08	1.00	1.11	1.23
18	0.47	12181	8	0.38	0.27	0.23	0.84	0.76	0.78	64453.64	66214.75	62307.23	1.04	1.28	1.39
20	0.40	12196	11	0.64	0.31	0.27	0.90	0.87	0.84	47322.97	68458.59	76702.62	0.60	0.99	1.09
22	0.38	12180	22.5	0.36	0.21	0.18	0.94	0.81	0.77	52068.15	37635.65	40519.41	0.87	1.40	1.36
24	0.29	12172	10	0.36	0.19	0.14	0.83	0.77	0.73	37753.13	47421.17	46762.78	1.07	1.18	1.31
26	0.43	12181	27	0.09	0.28	0.28	0.62	0.71	0.71	23876.25	44117.47	60498.79	1.17	1.00	0.96
27	0.78	12198	13	0.00	0.10	0.09	0.84	0.72	0.65	92780.43	43124.74	44624.20	0.55	1.40	1.55
29	1.25	12188	11	0.05	0.30	0.30	0.87	0.82	0.79	79515.65	81679.40	76241.32	0.58	1.09	1.13
31	1.29	12188	23	0.12	0.22	0.24	0.64	0.64	0.68	20148.67	31302.69	41794.58	1.18	1.41	1.27
35	0.61	12204	14	0.07	0.17	0.19	0.83	0.64	0.64	51792.98	43861.84	47760.21	0.42	0.95	1.17
36	0.20	12173	13	0.21	0.22	0.27	0.60	0.67	0.71	12867.71	22416.23	34715.50	1.54	1.53	1.44
39	1.00	12187	18	0.12	0.09	0.10	0.69	0.68	0.68	24750.42	31437.78	34337.19	1.46	1.69	1.55
40	0.38	12203	0	0.00	0.07	0.15	0.74	0.49	0.51	38882.47	32998.16	38336.34	0.97	1.59	1.57
59	0.54	12201	14	0.18	0.32	0.24	0.85	0.71	0.63	56444.08	58025.25	50646.72	1.07	1.20	1.32
72	0.61	12191	0	0.01	0.01	0.03	0.66	0.64	0.51	38582.94	34132.60	35870.51	0.86	1.25	1.39
73	0.54	12173	7	0.27	0.34	0.30	0.95	0.86	0.81	105495.64	138209.84	93447.58	0.89	1.05	1.16
74	0.90	12174	20	0.49	0.43	0.27	0.92	0.80	0.76	76735.60	57284.43	58265.71	0.95	1.16	1.25
75	0.78	12201	0	0.20	0.14	0.15	0.67	0.50	0.50	18193.58	22280.91	24295.88	1.23	1.58	1.49
79	1.37	12187	0	0.41	0.20	0.16	0.82	0.66	0.66	28233.80	33616.31	47060.49	1.17	1.34	1.17
80	1.44	12214	7	0.44	0.34	0.24	0.81	0.77	0.76	115333.66	146180.83	123695.19	0.69	0.70	0.65
82	0.50	12228	0	0.33	0.20	0.16	0.71	0.60	0.65	50851.07	46939.49	51711.87	1.05	1.51	1.66
87	0.67	12203	11	0.40	0.25	0.19	0.86	0.89	0.85	45062.49	74115.90	82552.93	1.32	1.51	1.50

Appendix C2 Continued

91	0.58	12188	0	0.14	0.11	0.09	0.69	0.69	0.71	26504.80	41933.06	51218.24	1.04	1.07	1.10
92	0.78	12201	0	0.07	0.16	0.15	0.71	0.65	0.60	25237.98	23759.51	27533.60	1.35	1.76	1.80
93	0.42	12196	11	0.01	0.07	0.08	0.76	0.63	0.56	27018.99	42725.98	51346.09	1.05	1.34	1.43
102	0.11	12180	43	0.13	0.07	0.05	0.50	0.48	0.39	27588.33	34875.57	33171.40	0.58	1.03	1.29
105	0.00	12180	17	0.31	0.23	0.16	0.64	0.63	0.55	32009.65	40721.99	44455.31	0.69	0.91	1.15
118	1.27	12227	16	0.14	0.15	0.12	0.73	0.64	0.60	48954.78	40216.93	40691.13	0.86	1.17	1.34
202	0.10	12191	12	0.15	0.10	0.05	0.60	0.60	0.47	18267.11	20975.08	21510.00	1.09	1.47	1.62
203	0.63	12182	12	0.39	0.21	0.17	0.72	0.68	0.64	31239.90	49380.67	50841.83	1.17	1.37	1.59
204	1.34	12171	11	0.24	0.10	0.12	0.91	0.76	0.65	56999.86	78143.97	77107.74	1.12	0.93	1.14
207	0.31	12172	3	0.29	0.27	0.27	0.91	0.92	0.87	31472.38	52624.77	62382.33	0.81	1.01	1.21
208	0.66	12174	13	0.56	0.46	0.33	0.93	0.89	0.79	61850.07	72676.54	61211.07	0.72	0.93	1.11
211	0.18	12204	0	0.03	0.08	0.08	0.67	0.67	0.48	20926.63	21221.93	22839.85	1.25	1.70	1.77
214	0.60	12198	16	0.06	0.14	0.21	0.84	0.87	0.87	26380.67	53396.25	63432.24	1.60	1.54	1.41
215	1.50	12197	23	0.00	0.13	0.18	0.90	0.87	0.88	42983.41	51802.89	67468.66	1.23	1.48	1.50
216	0.46	12179	9	0.33	0.42	0.29	0.89	0.81	0.79	127085.36	70266.02	72853.39	1.06	1.17	1.35
217	1.33	12179	14	0.24	0.18	0.18	0.74	0.82	0.81	27368.32	51287.08	60836.05	1.60	1.65	1.60

Appendix C3: 2012 Landscape level data for *D. grandiflorum*, including the response variable (mean seed set/landscape), potential confounding variables (Julian date, Flowering plant index/transect, Proportion Soybean cover, Proportion crop cover (Ag Cover)) and farmland heterogeneity variables (Shannon diversity for crop types (SHDI) and mean field size). Landscape level predictors at three spatial scales are included (1km, 2km, 3km)

Landscape	Mean seed set/landscape	Julian Date	Flowering Plant Index	Soybean Cover (1km)	Soybean Cover (2km)	Soybean Cover (3km)	Ag Cover (1km)	Ag Cover (2km)	Ag Cover (3km)	SHDI_1km	SHDI_2km	SHDI_3km	MFS_1km	MFS_2km	MFS_3km
3	2.41	12190	23	0.74	0.43	0.29	0.80	0.56	0.54	0.27	0.89	1.32	73048.06	48687.76	49888.69
6	1.06	12181	4	0.30	0.14	0.14	0.87	0.70	0.72	1.06	1.37	1.23	45902.26	38452.82	51702.84
7	0.26	12171	0	0.06	0.06	0.07	0.71	0.75	0.68	0.82	0.95	1.06	47222.22	62317.38	53107.61
8	0.42	12203	27	0.15	0.24	0.30	0.79	0.71	0.71	0.89	1.31	1.37	43731.78	52481.68	63696.26
9	1.45	12189	21	0.41	0.20	0.17	0.92	0.82	0.80	0.72	0.99	1.09	101834.23	105312.06	92962.91
11	1.38	12189	26	0.04	0.11	0.22	0.67	0.74	0.79	1.00	1.11	1.23	33315.53	52638.50	58051.08
19	1.29	12190	11	0.15	0.26	0.22	0.71	0.69	0.69	1.26	1.26	1.41	54569.79	53937.08	52665.63
20	1.05	12196	11	0.64	0.31	0.27	0.90	0.87	0.84	0.60	0.99	1.09	47322.97	68458.59	76702.62
26	0.00	12172	27	0.09	0.28	0.28	0.62	0.71	0.71	1.17	1.00	0.96	23876.25	44117.47	60498.79
27	0.38	12198	13	0.00	0.10	0.09	0.84	0.72	0.65	0.55	1.40	1.55	92780.43	43124.74	44624.20
31	0.49	12188	23	0.12	0.22	0.24	0.64	0.64	0.68	1.18	1.41	1.27	20148.67	31302.69	41794.58
35	0.23	12204	14	0.07	0.17	0.19	0.83	0.64	0.64	0.42	0.95	1.17	51792.98	43861.84	47760.21
36	0.00	12173	13	0.21	0.22	0.27	0.60	0.67	0.71	1.54	1.53	1.44	12867.71	22416.23	34715.50
39	1.02	12187	18	0.12	0.09	0.10	0.69	0.68	0.68	1.46	1.69	1.55	24750.42	31437.78	34337.19
59	0.43	12201	14	0.18	0.32	0.24	0.85	0.71	0.63	1.07	1.20	1.32	56444.08	58025.25	50646.72
72	0.64	12191	0	0.01	0.01	0.03	0.66	0.64	0.51	0.86	1.25	1.39	38582.94	34132.60	35870.51
75	0.36	12201	0	0.20	0.14	0.15	0.67	0.50	0.50	1.23	1.58	1.49	18193.58	22280.91	24295.88
79	0.92	12187	0	0.41	0.20	0.16	0.82	0.66	0.66	1.17	1.34	1.17	28233.80	33616.31	47060.49
80	1.35	12190	7	0.44	0.34	0.24	0.81	0.77	0.76	0.69	0.70	0.65	115333.66	146180.83	123695.19
82	2.32	12198	0	0.33	0.20	0.16	0.71	0.60	0.65	1.05	1.51	1.66	50851.07	46939.49	51711.87
87	0.14	12203	11	0.40	0.25	0.19	0.86	0.89	0.85	1.32	1.51	1.50	45062.49	74115.90	82552.93
92	0.44	12201	0	0.07	0.16	0.15	0.71	0.65	0.60	1.35	1.76	1.80	25237.98	23759.51	27533.60
93	0.70	12196	11	0.01	0.07	0.08	0.76	0.63	0.56	1.05	1.34	1.43	27018.99	42725.98	51346.09
202	1.20	12191	12	0.15	0.10	0.05	0.60	0.60	0.47	1.09	1.47	1.62	18267.11	20975.08	21510.00
204	1.72	12171	11	0.24	0.10	0.12	0.91	0.76	0.65	1.12	0.93	1.14	56999.86	78143.97	77107.74

Appendix C2 Continued

211	0.53	12204	0	0.03	0.08	0.08	0.67	0.67	0.48	1.25	1.70	1.77	20926.63	21221.93	22839.85
214	1.48	12198	16	0.06	0.14	0.21	0.84	0.87	0.87	1.60	1.54	1.41	26380.67	53396.25	63432.24
215	0.78	12197	23	0.00	0.13	0.18	0.90	0.87	0.88	1.23	1.48	1.50	42983.41	51802.89	67468.66
216	1.67	12179	9	0.33	0.42	0.29	0.89	0.81	0.79	1.06	1.17	1.35	127085.36	70266.02	72853.39
217	0.65	12179	14	0.24	0.18	0.18	0.74	0.82	0.81	1.60	1.65	1.60	27368.32	51287.08	60836.05

Appendix D: Analysis testing the effects of farmland heterogeneity on pollination potential of agricultural landscapes, using data collected at a transect scale. Rather than combining the results from each transect to generate a single pollination potential value for each landscape as presented in our results section, here we treated each transect as individual. In order to control for the pseudo-replication of using each transect as a data point, we included the random effect “landscape ID #”. Results from analysis at this scale were consistent with those presented in the results section of this study.

Appendix D1: Top models (within 2 AICc units of top model) relating combinations of potentially confounding variables (Julian date, flowering plant index, adjacent crop field type, proportion Soybean cover and proportion crop cover) to mean seed set/transect of *B. juncea*, *B. rapa*, *R. sativus* and *D. grandiflorum*. Models were ranked by lowest AICc values. We included a null model for comparison.

Response Variable	Models	df	AICc	delta AICc	Akaike Weight
<i>B. juncea</i> (2011) mean seed set per transect	Adj. Crop+Crop Cover +Soybean Cover	12	447.8	0	0.40
	Adj. Crop + Crop Cover	11	448.4	0.66	0.30
<i>B. rapa</i> (2012) mean seed set per transect	Adj. Crop + Crop Cover + Soybean Cover	12	838.5	0	0.62
<i>R. sativus</i> (2012) mean seed set per transect	Crop Cover	4	292.3	0	0.42
	Crop Cover+Soybean Cover	5	293.1	0.75	0.29
<i>D. grandiflorum</i> (2012) mean seed set per transect	Crop cover + Soybean Cover	5	171.0	0	0.36
	Soybean Cover	4	171.1	0.10	0.34

Appendix D2: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on the residual mean seed set/transect for *B. juncea* in 2011 (with “landscape ID #” as random effect to control for pseudoreplication), including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from the top model (delta AICc) and Akaike weights for each model.

Coefficients		AICc	Delta AICc	Akaike Weight
SHDI (2km)	log-MFS (1km)			
-	-	402.3	0	0.75
	0.04	406.0	3.75	0.12
-0.04		406.0	7.76	0.12
-0.02	0.03	409.6	7.36	0.02

Appendix D3: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on the residual mean seed set/transect for *B. rapa* (2012) (with “landscape ID #” as random effect to control for pseudoreplication), including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from the top model (delta AICc) and Akaike weights for each model.

Coefficients		AICc	Delta AICc	Akaike Weight
SHDI (2km)	log-MFS (1km)			
-	-	839.0	0	0.66
-0.12		841.8	2.87	0.16
	0.10	841.9	2.93	0.15
-0.10	0.07	844.8	5.81	0.04

Appendix D4: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on the residual mean seed set/transect for *R. sativus* (2012) (with “landscape ID #” as random effect to control for pseudoreplication), including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from the top model (delta AICc) and Akaike weights for each model.

Coefficients		AICc	Delta AICc	Akaike Weight
SHDI (2km)	log-MFS (1km)			
-	-	279.7	0	0.91
0.02	-	285.6	6.0	0.05
	-0.01	285.7	6.1	0.04
0.02	0.003	291.4	11.8	0.003

Appendix D5: Comparison of all possible models of Shannon diversity for crop types (SHDI) and log transformed mean field size (log-MFS) effect on the residual mean seed set/transect for *D. grandiflorum* (2012) (with “landscape ID #” as random effect to control for pseudoreplication), including a null model (highlighted in bold). Models were ranked by lowest AICc value. Variable coefficients showing direction of effect are included, as well as AICc values, distance from the top model (delta AICc) and Akaike weights for each model.

Coefficients		AICc	Delta AICc	Akaike Weight
SHDI (2km)	log-MFS (1km)			
-	-	160.7	0	0.85
-0.03	-	165.6	4.9	0.07
	0.03	165.6	4.9	0.07
-0.02	0.02	170.2	9.47	0.007

Appendix E: Total Number
of seeds counted, by
phytometer species

<i>B. juncea</i>	<i>B. rapa</i>	<i>R. sativus</i>	<i>D. grandiflorum</i>
34,543	21,925	1,271	8,870

Appendix F: Raw data collected in 2011 from *B. juncea*. Each row represents a single pod, and is defined by the plant number, transect number, and landscape number,. The number of mature seeds within that pod are included.

Landscape	Transect	Plant Number	Mature Seeds
1	1	1	7
1	1	1	10
1	1	1	11
1	1	1	11
1	1	1	11
1	1	1	12
1	1	1	13
1	1	1	13
1	1	1	15
1	1	1	15
1	1	1	15
1	1	1	0
1	1	1	3
1	1	1	4
1	1	2	0
1	1	2	1
1	1	2	1
1	1	2	5
1	1	3	0
1	1	3	0
1	1	3	5
1	1	3	7
1	1	3	9
1	1	3	10
1	1	3	11
1	1	3	11
1	1	3	13
1	1	3	14
1	1	3	14
1	1	3	15

1	1	3	15
1	1	3	15
1	1	3	16
1	2	1	7
1	2	1	8
1	2	1	8
1	2	1	9
1	2	1	10
1	2	1	10
1	2	1	11
1	2	1	11
1	2	1	12
1	2	1	12
1	2	1	12
1	2	1	12
1	2	1	13
1	2	1	13
1	2	1	14
1	2	1	14
1	2	1	15
1	2	1	16
1	2	1	16
1	2	1	16
1	2	2	4
1	2	2	7
1	2	2	9
1	2	2	11
1	2	2	12
1	2	3	9
1	2	3	12
1	2	3	13
1	2	3	13
1	2	3	14
1	2	3	14
1	2	3	14
1	2	3	14
1	2	3	15
1	2	3	15
1	3	1	7
1	3	1	12
1	3	1	14
1	3	1	14
1	3	1	14

1	3	1	14
1	3	1	14
1	3	1	14
1	3	1	15
1	3	1	15
1	3	1	20
1	3	2	0
1	3	2	3
1	3	2	8
1	3	2	9
1	3	2	10
1	3	2	11
1	3	2	12
1	3	2	12
1	3	2	13
1	3	3	7
1	3	3	9
1	3	3	13
1	3	3	2
1	3	3	10
1	3	3	13
1	3	3	6
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	0
4	1	1	10
4	1	1	10
4	1	1	12
4	1	1	15
4	1	1	15
4	1	1	16
4	1	1	16
4	1	2	0
4	1	2	0
4	1	2	0

4	1	2	0
4	1	2	0
4	1	2	0
4	1	2	6
4	1	3	0
4	1	3	0
4	1	3	0
4	1	3	0
4	1	3	2
4	1	3	2
4	1	3	4
4	1	3	7
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	0
4	5	1	10
4	5	1	12
4	5	1	13
4	5	1	14
4	5	1	15
4	5	1	15
4	5	1	16
4	5	1	16
4	5	3	6
4	5	3	11

4	5	3	11
4	5	3	12
4	6	1	0
4	6	1	9
4	6	1	9
4	6	1	9
4	6	1	13
4	6	1	13
4	6	1	10
4	6	1	12
4	6	1	13
4	6	1	13
4	6	1	14
4	6	1	14
4	6	3	5
4	6	3	8
4	6	3	9
4	6	3	10
4	6	3	0
4	6	3	12
4	6	3	12
4	6	3	13
10	1	1	0
10	1	1	10
10	1	1	15
10	1	2	1
10	1	2	2
10	1	2	4
10	1	2	5
10	1	2	6
10	1	2	8
10	1	2	8
10	1	2	10
10	1	2	10
10	1	3	2
10	1	3	6
10	1	3	11
10	1	3	13
10	1	3	15
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110	7	3	6

Appendix G: Raw data collected in 2012 from *B. rapa*. Each row represents a single pod, and is defined by the plant number, transect number, and landscape number,. The number of mature seeds within that pod are included.

Landscape	Transect	Round	Plant Number	Mature Seeds
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217	1	2	1	4
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217	1	2	1	19
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217	1	2	1	5
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217	1	2	1	1
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217	1	2	1	8
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217	2	1	1	5
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217	3	1	2	9
217	3	1	2	10
217	3	1	2	8
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217	3	1	2	8
217	3	1	2	8
217	3	1	2	8
217	3	2	1	1
217	3	2	1	3

Appendix H: Raw data collected in 2012 from *R. sativus*. Each row represents a single pod, and is defined by the plant number, transect number, and landscape number. The number of mature seeds within that pod are included.

Landscape	Transect	Round	Plantnum	Mature Seeds
2	3	1	1	1
2	3	1	1	1
2	3	1	1	0
2	6	1	1	1
2	6	2	1	2
2	6	2	1	3
3	3	1	1	3
3	3	1	1	1
3	3	1	1	1
3	3	1	1	3
5	2	1	1	3
5	2	1	1	5
5	2	1	1	4
5	2	1	1	2
5	2	1	1	2
5	4	1	1	7
5	4	1	1	2
5	4	1	1	4
5	4	1	1	0
5	4	1	1	3
5	4	1	1	6
5	4	1	1	4
5	4	1	1	3
5	4	1	1	5
5	4	1	1	8
5	4	2	1	1
5	4	2	1	5
5	4	2	1	3
5	4	2	1	1
5	4	2	1	4
5	4	2	1	1

5	5	1	1	1
6	6	1	1	1
7	1	1	1	2
7	1	1	1	0
7	1	1	1	2
7	1	1	1	1
7	1	1	1	1
7	1	1	2	1
7	1	1	2	2
7	1	1	2	2
7	1	1	2	1
7	1	1	2	2
7	1	2	1	1
7	4	1	1	1
7	4	1	1	2
7	4	1	1	1
7	4	1	2	2
8	1	1	1	2
8	1	1	1	2
8	1	1	1	1
8	1	1	1	4
8	1	1	2	0
8	1	1	2	0
8	1	1	2	0
8	1	1	2	0
8	1	1	2	0
8	1	1	2	0
8	1	1	2	1
8	1	1	2	4
8	1	1	2	1
8	1	1	2	1
8	2	1	1	2
8	2	1	1	2
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8	2	1	1	2
8	2	1	1	3
8	2	1	1	1
8	4	1	1	1
8	4	1	1	0
8	4	1	1	1
8	4	1	1	1
8	4	1	1	1
8	4	1	1	2

8	4	1	1	0
8	4	1	1	3
8	4	1	1	1
9	4	1	1	1
9	4	1	1	0
9	4	1	1	2
9	4	1	1	1
9	4	1	1	3
9	5	1	1	1
9	5	1	1	3
9	5	1	1	3
9	5	1	1	4
9	5	2	1	1
9	5	2	1	2
9	5	2	1	1
9	5	2	1	3
9	5	2	1	0
11	2	1	1	2
11	2	1	1	0
11	2	1	1	1
11	5	1	1	1
18	1	1	1	1
18	1	1	1	1
18	1	2	1	0
18	3	1	1	2
18	3	1	1	2
18	3	2	1	0
18	3	2	2	2
18	5	1	1	1
18	5	1	1	2
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20	1	1	1	5
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20	1	1	1	2
20	1	1	2	3
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20	1	1	2	0
20	1	1	2	2
20	1	1	2	1
20	1	1	2	1
20	2	1	1	0
20	2	1	1	1

20	2	2	1	1
20	3	1	1	0
22	2	2	1	9
22	2	2	1	8
22	2	2	1	5
22	2	2	1	7
22	3	2	1	5
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22	3	2	1	5
22	3	2	1	2
22	3	2	1	1
22	3	2	1	1
22	4	1	1	0
22	4	1	1	1
22	4	1	1	2
22	4	1	1	1
22	4	1	1	1
22	4	1	1	0
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22	4	1	1	1
22	4	2	1	0
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22	4	2	1	2
22	4	2	1	4
22	4	2	1	4
22	4	2	1	2
22	4	2	1	3
22	4	2	1	4
24	1	1	1	2
24	1	1	1	1
24	4	1	1	1
24	4	1	1	1
24	4	1	1	1
26	2	2	1	1
26	2	2	1	2
26	2	2	1	7
26	2	2	1	3
26	4	1	1	2
26	4	1	1	1
26	4	2	1	3
27	5	1	1	0

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27	5	1	1	1
27	5	1	1	0
27	5	1	1	4
27	5	1	2	3
27	6	1	1	3
27	6	1	1	0
27	6	1	1	0
27	6	1	1	6
29	2	1	1	5
29	2	2	1	6
29	2	2	1	7
29	2	2	2	1
29	2	2	2	0
29	2	2	2	1
29	2	2	2	1
29	4	2	1	0
29	4	2	1	0
29	4	2	1	1
29	4	2	1	6
29	4	2	1	6
31	2	1	1	1
31	4	1	1	2
31	5	1	1	1
31	5	1	1	0
31	5	1	1	6
31	5	1	1	5
31	5	1	1	1
31	5	1	1	3
31	5	1	1	3
31	5	1	1	0
31	5	1	1	3
31	5	1	1	5
31	5	1	1	6
35	1	1	2	2
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35	1	2	1	4
35	1	2	1	1
35	1	2	1	3
35	1	2	1	2

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35	3	2	1	3
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35	3	2	1	6
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35	4	2	1	2
36	4	1	1	2
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39	6	2	1	1
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40	1	1	1	1
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40	1	1	2	4
40	5	1	1	2
40	5	1	1	1
40	6	1	1	1
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59	2	1	1	0
59	4	1	1	1
59	4	1	2	3
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59	4	1	2	3
72	5	1	2	2
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72	5	1	2	4

72	7	1	1	5
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73	1	1	1	4
73	1	1	1	5
73	1	1	1	3
73	2	1	1	1
73	2	2	1	3
73	3	1	1	0
73	3	2	1	1
74	1	1	1	1
74	1	1	1	1
74	1	1	1	0
74	1	2	1	2
74	1	2	1	1
74	1	2	1	0
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74	1	2	1	1
74	1	2	1	2
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75	2	1	1	4
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75	4	1	1	6
75	4	1	1	5
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79	1	1	1	9
79	1	1	1	4
79	1	1	1	5
79	1	1	2	0
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79	1	1	2	2
79	1	1	2	3
79	1	1	2	1
79	1	1	2	1
79	1	1	2	1
79	1	1	2	2

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79	1	2	1	3
79	1	2	1	2
79	1	2	1	2
79	1	2	1	1
79	2	1	1	0
79	2	1	1	5
79	2	1	1	4
79	2	1	1	4
79	2	1	2	1
79	2	1	2	1
79	2	1	2	2
79	2	1	2	2
79	2	1	2	0
79	2	1	2	2
79	2	1	2	4
79	2	1	2	2
79	2	1	2	2
79	2	1	2	1
79	4	2	1	5
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80	5	2	1	2
80	5	2	1	1
80	5	2	1	2
80	5	2	2	4
80	5	2	2	2

80	5	2	2	2
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80	5	2	2	3
80	5	2	2	2
82	2	2	1	2
82	2	2	1	4
82	3	2	1	2
82	3	2	1	1
82	4	2	1	1
87	1	1	1	5
87	1	1	1	2
87	1	1	1	1
87	1	1	1	4
87	1	1	1	2
87	1	2	1	6
87	1	2	1	3
87	1	2	1	5
87	1	2	1	4
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87	1	2	1	4
87	1	2	1	1
87	1	2	1	4
87	1	2	1	3
87	1	2	1	1
87	1	2	1	5
87	1	2	1	2
87	1	2	1	5
87	2	2	1	1
87	2	2	1	1
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87	3	1	1	1
87	3	2	1	3
87	3	2	1	3
87	3	2	1	2
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91	5	1	1	1
92	1	1	1	1
92	1	1	1	1
92	1	1	1	0

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92	1	1	1	3
92	2	1	2	0
92	2	1	2	1
92	2	1	2	2
92	2	1	2	2
92	2	1	2	8
92	2	1	2	5
92	4	1	1	1
92	4	1	1	1
92	4	1	1	2
92	4	1	1	1
93	2	1	1	3
93	2	1	1	2
93	2	1	1	0
93	2	1	2	2
93	2	1	2	1
93	2	1	2	2
93	3	1	1	2
93	3	1	1	1
93	3	1	1	0
93	3	1	1	1
93	3	1	1	1
93	4	1	1	1
93	4	1	1	3
93	4	1	1	2
93	4	1	1	1
93	4	1	1	2
93	4	1	1	1
93	4	1	1	2
93	4	1	1	1
102	2	1	1	1
102	2	1	1	0
102	3	1	1	0
102	3	1	1	0
102	3	1	1	0
102	3	1	1	1
105	2	2	1	1
105	2	2	1	2
105	2	2	2	1
105	2	2	2	2
105	2	2	2	2

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105	2	2	2	1
105	4	1	1	0
105	4	2	1	0
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105	4	2	1	1
105	4	2	1	2
105	4	2	1	1
107	4	1	1	1
107	4	1	1	2
107	4	1	1	1
107	4	1	1	3
107	4	1	1	2
118	1	2	1	0
118	1	2	1	5
118	1	2	1	1
118	1	2	1	7
118	1	2	1	2
118	1	2	1	7
118	1	2	1	1
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118	1	2	1	5
118	1	2	1	2
118	1	2	1	8
118	1	2	1	2
118	1	2	1	5
118	1	2	1	1
118	1	2	1	4
118	5	2	1	1
202	1	1	1	1
202	1	2	1	0
202	3	1	1	1
202	3	1	1	2
202	3	1	2	1
203	1	1	1	1
203	1	1	1	3
203	1	2	1	1
203	1	2	1	1
203	2	1	1	5
203	2	1	1	5
203	2	1	1	1

203	2	2	1	0
203	2	2	1	1
203	2	2	1	0
203	2	2	1	1
203	4	1	1	0
203	4	1	1	0
203	4	1	1	0
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203	4	1	1	0
203	4	1	1	0
203	4	1	1	0
203	4	1	1	2
203	4	1	1	0
203	4	1	1	1
204	2	1	2	4
204	2	1	2	3
204	2	1	2	4
204	2	1	2	3
204	2	1	3	1
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204	3	1	2	3
204	3	1	2	4
204	3	1	2	6
204	3	1	2	7
204	4	1	1	4
204	4	1	1	0
204	4	1	1	2
204	4	1	1	5
204	4	1	2	0
204	4	1	2	2
204	4	1	2	1
204	4	1	2	0
204	4	1	2	3
207	1	1	1	2
207	2	1	1	0
207	2	1	1	1

207	2	1	1	0
207	2	1	1	2
208	1	1	1	0
208	1	1	1	0
208	1	1	1	0
208	1	1	1	2
208	2	1	1	3
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208	3	1	2	1
211	3	1	1	3
211	3	1	1	2
211	3	1	1	1
211	6	1	1	0
214	1	2	1	1
214	2	1	1	2
214	2	2	1	3
214	2	2	1	1
214	3	1	1	0
214	3	1	1	4
214	3	1	1	2
214	3	1	1	1
214	3	2	1	1
215	1	1	1	2
215	1	1	1	1
215	1	1	1	2
215	1	1	2	6
215	1	1	2	7
215	1	1	2	2
215	1	1	2	5
215	1	1	2	1
215	1	1	2	2
215	4	1	1	1
215	4	1	1	2
215	4	1	1	1

215	4	1	2	0
215	4	1	2	3
215	4	1	2	0
215	4	1	2	4
216	2	1	1	1
216	4	1	1	0
216	4	1	1	0
216	4	1	1	1
216	4	1	1	3
216	4	1	1	1
216	4	1	1	0
216	4	1	1	7
216	4	1	1	0
216	4	1	1	0
216	4	2	1	3
216	4	2	1	4
216	4	2	1	1
216	4	2	1	2
216	6	2	1	7
216	6	2	1	5
216	6	2	1	3
217	1	1	1	1
217	1	1	1	0
217	1	1	1	0
217	1	1	2	1
217	1	1	2	1
217	2	1	1	7
217	2	2	1	1
217	2	2	1	2
217	2	2	1	3
217	3	1	1	6
217	3	1	1	1
217	3	1	1	0
217	3	1	1	3

Appendix I: Raw data collected in 2012 from *D. grandiflorum*. Each row represents results from a collection of pods, and number of pods with number of mature seeds are included. These are defined by plant number, transect number and landscape number.

Landscape	Transect	Round	Total Successful Pods	Mature Seeds
3	3	1	0	0
3	3	1	3	5
3	3	1	0	0
3	3	1	0	0
3	3	1	0	0
3	3	1	0	0
3	3	1	3	1
3	3	1	0	0
3	1	1	31	235
3	3	1	4	17
3	3	1	44	308
3	1	1	28	149
3	3	1	7	3
6	2	1	16	52
6	6	1	46	40
6	2	1	12	30
6	2	1	6	16
6	6	1	10	62
7	1	1	10	6
8	2	1	2	3
8	2	1	0	0
8	2	1	3	13
8	2	1	0	0
8	2	1	0	0
8	2	1	0	0
8	2	1	1	1
8	2	1	1	5
8	2	1	0	0
8	2	1	3	6
8	2	1	6	26
8	2	1	0	0
8	2	1	0	0
8	2	1	1	0

8	4	1	4	5
8	4	1	14	76
9	1	1	7	73
9	1	1	8	19
9	1	1	9	36
9	4	1	7	30
9	1	1	13	40
9	5	1	10	20
9	5	1	22	48
9	5	1	8	12
11	2	1	8	25
11	5	1	6	22
19	1	1	3	9
19	5	1	4	4
19	5	1	5	20
19	5	1	0	0
19	5	1	12	60
19	1	1	6	8
19	1	1	8	33
19	5	1	3	44
19	5	1	2	0
19	5	1	9	47
19	5	1	11	53
19	5	1	12	47
19	1	1	5	22
19	5	1	8	25
20	1	1	15	42
20	2	1	0	0
20	3	1	0	0
20	3	1	0	0
20	2	1	2	0
20	3	1	5	4
20	3	1	4	4
20	1	1	12	43
20	1	1	6	55
20	2	1	0	0
20	2	1	0	0
20	1	1	0	0
20	2	1	0	0
20	1	1	6	18
20	2	1	0	0
20	2	1	0	0
20	1	1	12	92

20	2	1	12	6
20	2	1	0	0
20	3	1	6	30
20	1	1	9	16
20	2	1	0	0
20	2	1	0	0
20	1	1	3	5
20	2	1	6	2
20	3	1	0	0
20	2	1	0	0
20	1	1	0	0
20	2	1	0	0
20	2	1	0	0
20	3	1	0	0
20	1	1	6	64
20	1	1	11	78
20	2	1	0	0
20	1	1	6	19
20	3	1	3	28
20	3	1	0	0
20	1	1	7	49
20	1	1	3	17
20	1	1	21	195
20	1	1	4	8
20	2	1	10	53
20	2	1	6	18
20	1	1	17	29
26	4	1	0	0
27	6	1	0	0
27	6	1	0	0
27	6	1	0	0
27	6	1	0	0
27	6	1	0	0
27	6	1	0	0
27	6	1	3	3
27	6	1	0	0
27	6	1	2	4
27	6	1	0	0
27	3	1	15	38
27	6	1	17	34
27	5	1		
27	3	1	3	19
27	6	1	3	4

31	1	1	1	3
31	1	1	4	14
31	1	1	3	4
35	3	1	0	0
35	1	1	0	0
35	1	1	9	4
35	3	1	5	10
35	1	1	0	0
35	1	1	0	0
35	1	1	2	2
35	3	1	0	0
35	1	1	0	0
35	3	1	0	0
35	3	1	1	2
35	3	1	1	3
35	3	1	0	0
35	3	1	0	0
35	3	1	1	2
35	1	1	7	26
35	1	1	3	6
35	4	1	0	0
36	6	1	0	0
39	1	1	6	6
39	6	1	0	0
39	1	1	0	0
39	6	1	0	0
39	1	1	4	6
39	6	1	0	0
39	1	1	0	0
39	1	1	0	0
39	6	1	0	0
39	1	1	3	5
39	1	1	20	152
39	1	1	0	0
39	6	1	0	0
39	1	1	6	24
39	2	1	10	47
39	1	1	6	6
39	1	1	5	75
59	2	1	3	2
59	2	1	3	3
59	4	1	9	29
59	2	1	0	0

59	1	1	1	0
59	2	1	0	3
59	2	1	9	7
59	1	1	0	0
59	2	1	3	6
59	1	1	3	2
59	4	1	2	1
59	4	1	0	0
59	4	1	4	3
59	4	1	0	0
59	4	1	4	3
59	1	1	9	24
59	1	1	6	9
59	4	1	0	0
59	4	1	0	0
59	4	1	0	0
59	4	1	1	2
59	4	1	3	13
59	1	1	0:00	0
59	1	1	2	0
59	4	1	12	23
59	2	1	2	0
59	2	1	3	1
59	4	1	0	0
59	2	1	7	10
59	1	1	9	36
59	2	1	5	5
59	4	1	0	0
59	2	1	0	0
59	4	1	4	19
59	2	1	0	0
59	4	1	0	0
72	8	1	3	4
72	8	1	0	0
72	8	1	0	0
72	8	1	0	0
72	8	1	3	21
72	8	1	0	0
72	8	1	1	2
72	5	1	6	12
72	8	1	0	0
72	8	1	0	0
72	8	1	0	0

72	5	1	3	5
72	8	1	6	33
72	8	1	4	2
72	8	1	0	0
72	5	1	0	0
72	8	1	0	0
72	8	1	0	0
72	5	1	0	0
72	8	1	0	0
72	8	1	0	0
72	8	1	0	0
72	8	1	0	0
72	8	1	5	12
72	8	1	1	1
72	8	1	0	0
72	8	1	0	0
72	8	1	0	0
72	5	1	3	1
72	5	1	0	0
72	8	1	0	0
72	8	1	0	0
72	5	1	2	2
72	8	1	0	0
72	5	1	9	39
72	5	1	6	27
72	5	1	30	160
72	5	1	15	110
75	3	1	0	0
75	2	1	5	8
75	3	1	0	0
75	2	1	4	7
75	3	1	3	1
75	2	1	3	5
75	3	1	0	0
75	3	1	0	0
75	2	1	3	10
75	3	1	0	0
75	2	1	0	0
75	2	1	0	0
75	2	1	0	0
75	3	1	1	2
75	3	1	1	4
75	3	1	0	0

75	2	1	3	4
75	2	1	0	0
75	2	1	0	0
75	2	1	1	4
75	2	1	0	0
75	3	1	0	0
75	3	1	0	0
75	3	1	0	0
75	2	1	5	11
75	2	1	0	0
75	3	1	0	0
75	2	1	3	14
75	2	1	0	0
75	3	1	2	5
75	3	1	0	0
75	3	1	6	32
75	3	1	2	5
75	3	1	5	4
75	3	1	6	23
75	2	1	0	0
75	3	1	0	0
75	3	1	0	0
75	3	1	1	2
75	2	1	6	25
75	2	1	0	0
75	2	1	2	5
75	2	1	0	0
75	3	1	0	0
75	3	1	1	1
75	2	1	9	15
75	2	1	9	10
75	2	1	10	14
75	3	1	9	3
79	6	1	1	1
79	6	1	8	4
79	1	1	18	85
80	5	1	8	29
80	2	1	39	103
82	2	1	42	287
82	3	1	80	263
82	3	1	14	19
82	2	1	32	119
82	4	1	10	6

82	4	1	6	24
87	2	1	3	5
87	2	1	3	5
92	2	1	0	0
92	1	1	9	29
92	2	1	0	0
92	1	1	3	3
92	2	1	0	0
92	2	1	0	0
92	4	1	0	0
92	4	1	3	6
92	4	1	0	0
92	4	1	0	0
92	1	1	3	10
92	4	1	6	3
92	1	1	7	42
92	2	1	0	0
92	2	1	4	6
92	1	1	1	2
92	1	1	3	8
92	4	1	3	14
92	4	1	0	0
92	4	1	0	0
92	4	1	0	0
92	4	1	0	0
92	4	1	0	0
92	1	1	6	13
92	2	1	10	0
92	4	1	0	0
92	4	1	0	0
92	1	1	3	1
92	4	1	0	0
92	1	1	7	36
92	2	1	0	0
92	4	1	3	3
92	1	1	3	2
92	2	1	0	0
92	2	1	0	0
92	4	1	0	0
92	2	1	9	2
93	4	1	0	0
93	4	1	0	0
93	4	1	0	0

93	4	1	0	0
93	4	1	0	0
93	4	1	0	0
93	4	1	0	0
93	4	1	0	0
93	3	1	0	0
93	4	1	0	0
93	3	1	0	0
93	3	1	0	0
93	3	1	0	0
93	4	1	3	38
93	4	1	0	0
93	4	1	15	26
93	4	1	1	0
93	3	1	6	16
93	4	1	26	32
93	3	1	0	0
93	4	1	0	0
93	3	1	0	0
93	3	1	0	0
93	3	1	14	127
93	4	1	8	34
93	4	1	12	2
93	2	1	6	23
93	4	1	17	53
93	3	1	30	99
202	1	1	0	0
202	3	1	14	97
202	1	1	6	19
202	2	1	4	18
202	1	1	0	0
202	2	1	1	2
202	1	1	0	0
202	2	1	1	1
202	2	1	3	20
202	1	1	5	17
202	2	1	1	2
202	3	1	3	5
202	2	1	0	0
202	1	1	5	22
202	3	1	5	13
202	3	1	0	0
202	1	1	0	0

202	1	1	9	81
202	1	1	3	2
202	3	1	12	0
202	3	1	0	0
202	3	1	0	0
202	3	1	3	0
202	3	1	0	0
202	2	1	9	2
202	2	1	0	0
202	2	1	4	17
202	3	1	12	32
202	2	1	7	45
202	2	1	1	2
202	3	1	0	0
202	3	1	13	49
202	3	1	0	0
202	2	1	1	3
202	3	1	0	0
202	2	1	0	0
202	2	1	2	3
202	2	1	1	0
202	1	1	0	0
202	2	1	2	0
202	3	1	0	0
202	2	1	1	4
202	1	1	1	1
202	3	1	1	4
202	1	1	15	148
202	3	1	18	0
202	1	1	12	147
202	1	1	12	155
202	2	1	16	132
202	3	1	15	49
202	2	1	21	86
202	3	1	15	12
202	3	1	16	72
202	2	1	17	127
202	3	1	18	0
202	3	1	11	31
202	3	1	9	1
202	2	1	25	41
204	4	1	9	35
204	4	1	10	30

204	2	1	9	44
204	3	1	8	26
204	4	1	4	6
204	4	1	9	32
204	4	1	9	64
211	3	1	3	17
211	3	1	5	5
211	3	1	1	2
211	3	1	2	3
211	3	1	2	0
211	3	1	0	0
211	3	1	0	0
211	3	1	25	117
211	3	1	0	0
211	3	1	5	2
211	6	1	0	0
211	6	1	0	0
211	3	1	0	0
214	2	1	10	51
214	1	1	0	0
214	1	1	16	91
214	2	1	6	26
214	1	1	4	6
214	1	1	3	7
214	2	1	3	3
214	2	1	0	0
214	1	1	0	0
214	1	1	2	0
214	1	1	0	0
214	1	1	0	0
214	1	1	3	4
214	1	1	0	0
214	1	1	0	0
214	2	1	12	32
214	2	1	0	0
214	3	1	0	0
214	2	1	1	5
214	2	1	8	39
214	2	1	12	75
214	1	1	7	15
214	2	1	0	0
214	1	1	9	38
214	2	1	2	4

214	2	1	9	38
214	2	1	8	13
214	2	1	6	20
214	1	1	4	16
214	3	1	33	290
214	2	1	12	55
214	3	1	10	13
214	1	1	12	92
214	2	1	6	17
214	1	1	10	52
214	2	1	15	27
214	1	1	7	7
214	2	1	12	71
215	4	1	8	13
215	4	1	11	54
215	4	1	17	28
216	1	1	36	193
216	4	1	11	0
216	1	1	12	11
217	2	1	5	8
217	2	1	0	0
217	2	1	0	0
217	3	1	13	39
217	2	1	9	8
217	2	1	0	0
217	2	1	5	8

Appendix J: Native bee abundance collected from pan traps in 2012. Data was unavailable at the time of analysis to include in this study. Each row corresponds to results from pan traps at a given transect. Two sampling rounds were conducted at each transect (date).

Landscape	Transect	Date	Year	Native bee abundance
2	2	20.06.2012	2012	13
2	2	25.08.2012	2012	18
2	3	20.06.2012	2012	21
2	3	25.08.2012	2012	13
2	6	20.06.2012	2012	38
2	6	25.08.2012	2012	6
3	1	08.07.2012	2012	18
3	1	22.08.2012	2012	6
3	2	08.07.2012	2012	11

3	2	31.08.2012	2012	4
3	2	22.08.2012	2012	4
3	3	08.07.2012	2012	18
3	3	22.08.2012	2012	1
3	3	31.08.2012	2012	2
5	2	30.06.2012	2012	37
5	2	24.08.2012	2012	18
5	4	30.06.2012	2012	25
5	4	24.08.2012	2012	6
5	5	30.06.2012	2012	1
5	5	24.08.2012	2012	5
5	5	30.06.2012	2012	16
5	5	30.06.2012	2012	1
6	1	08.08.2012	2012	8
6	2	29.06.2012	2012	89
6	2	08.08.2012	2012	17
6	6	29.06.2012	2012	32
6	6	08.08.2012	2012	22
7	1	19.06.2012	2012	6
7	1	09.08.2012	2012	1
7	3	19.06.2012	2012	2
7	3	09.08.2012	2012	3
7	4	19.06.2012	2012	2
7	4	09.08.2012	2012	6
8	1	21.07.2012	2012	10
8	1	30.08.2012	2012	5
8	2	21.07.2012	2012	13
8	2	21.07.2012	2012	13
8	2	30.08.2012	2012	14
8	4	21.07.2012	2012	11
8	4	30.08.2012	2012	4
9	1	07.07.2012	2012	20
9	1	31.07.2012	2012	11
9	1	07.07.2012	2012	18
9	1	07.07.2012	2012	5
9	4	07.07.2012	2012	25
9	4	31.07.2012	2012	13
9	5	07.07.2012	2012	10
9	5	31.07.2012	2012	9
9	5	07.07.2012	2012	8
9	5	31.07.2012	2012	11
9	5	07.07.2012	2012	1
9	5	31.07.2012	2012	0

11	1	07.07.2012	2012	3
11	1	17.08.2012	2012	4
11	2	07.07.2012	2012	8
11	2	17.08.2012	2012	1
11	5	07.07.2012	2012	0
11	5	17.08.2012	2012	3
11	5	07.07.2012	2012	3
11	5	07.07.2012	2012	0
18	1	29.06.2012	2012	13
18	1	01.08.2012	2012	21
18	3	29.06.2012	2012	27
18	3	01.08.2012	2012	9
18	4	29.06.2012	2012	29
18	4	01.08.2012	2012	15
19	1	08.07.2012	2012	36
19	1	08.08.2012	2012	3
19	3	08.07.2012	2012	60
19	5	08.07.2012	2012	39
19	6	17.08.2012	2012	16
19	7	17.08.2012	2012	6
20	1	14.07.2012	2012	11
20	1	23.08.2012	2012	3
20	2	14.07.2012	2012	14
20	2	23.08.2012	2012	3
20	3	14.07.2012	2012	16
20	3	23.08.2012	2012	20
22	2	28.06.2012	2012	3
22	2	22.08.2012	2012	4
22	3	28.06.2012	2012	3
22	3	22.08.2012	2012	4
22	4	28.06.2012	2012	7
22	4	22.08.2012	2012	6
24	1	20.06.2012	2012	21
24	1	09.08.2012	2012	8
24	3	20.06.2012	2012	35
24	3	09.08.2012	2012	8
24	4	20.06.2012	2012	17
24	4	09.08.2012	2012	7
26	1	31.07.2012	2012	32
26	2	29.06.2012	2012	19
26	2	31.07.2012	2012	48
26	3	29.06.2012	2012	28
26	4	29.06.2012	2012	50

26	4	31.07.2012	2012	21
27	3	16.07.2012	2012	7
27	3	15.08.2012	2012	8
27	5	16.07.2012	2012	15
27	5	15.08.2012	2012	6
27	6	16.07.2012	2012	29
27	6	15.08.2012	2012	8
27	6	15.08.2012	2012	8
29	2	06.07.2012	2012	14
29	2	30.07.2012	2012	40
29	3	30.07.2012	2012	22
29	3	06.07.2012	2012	21
29	3	30.07.2012	2012	23
29	4	06.07.2012	2012	11
29	4	30.07.2012	2012	60
31	2	06.07.2012	2012	8
31	2	07.08.2012	2012	22
31	2	06.07.2012	2012	7
31	2	06.07.2012	2012	1
31	4	06.07.2012	2012	10
31	4	07.08.2012	2012	13
31	5	06.07.2012	2012	23
31	5	07.08.2012	2012	25
35	1	22.07.2012	2012	20
35	1	23.08.2012	2012	14
35	3	22.07.2012	2012	6
35	3	23.08.2012	2012	6
35	4	22.07.2012	2012	10
35	4	22.07.2012	2012	53
35	4	23.08.2012	2012	2
35	4	22.07.2012	2012	22
35	4	22.07.2012	2012	1
36	1	21.06.2012	2012	18
36	1	08.08.2012	2012	15
36	3	21.06.2012	2012	2
36	3	08.08.2012	2012	21
36	3	21.06.2012	2012	13
36	3	21.06.2012	2012	2
36	4	21.06.2012	2012	22
36	4	08.08.2012	2012	14
39	1	05.07.2012	2012	31
39	1	14.08.2012	2012	8
39	2	05.07.2012	2012	18

39	2	14.08.2012	2012	8
39	6	05.07.2012	2012	91
39	6	14.08.2012	2012	9
39	6	14.08.2012	2012	9
40	1	21.07.2012	2012	13
40	1	17.08.2012	2012	1
40	5	21.07.2012	2012	5
40	5	17.08.2012	2012	2
40	6	21.07.2012	2012	6
40	6	17.08.2012	2012	1
59	1	23.07.2012	2012	17
59	1	16.08.2012	2012	7
59	2	23.07.2012	2012	53
59	2	16.08.2012	2012	4
59	4	23.07.2012	2012	23
59	4	16.08.2012	2012	16
72	5	13.07.2012	2012	18
72	5	06.08.2012	2012	14
72	5	13.07.2012	2012	6
72	5	13.07.2012	2012	1
72	7	13.07.2012	2012	23
72	7	06.08.2012	2012	5
72	8	13.07.2012	2012	11
72	8	06.08.2012	2012	17
73	1	21.06.2012	2012	11
73	1	01.08.2012	2012	4
73	2	01.08.2012	2012	2
73	2	21.06.2012	2012	8
73	3	01.08.2012	2012	25
73	3	21.06.2012	2012	15
74	1	22.06.2012	2012	11
74	1	07.08.2012	2012	11
74	2	22.06.2012	2012	22
74	2	07.08.2012	2012	12
74	4	22.06.2012	2012	17
74	4	07.08.2012	2012	10
75	2	23.07.2012	2012	3
75	2	31.08.2012	2012	12
75	3	23.07.2012	2012	15
75	3	31.08.2012	2012	14
75	4	23.07.2012	2012	12
75	4	31.08.2012	2012	4
75	4	23.07.2012	2012	4

75	4	23.07.2012	2012	2
79	1	05.07.2012	2012	36
79	1	14.08.2012	2012	24
79	2	05.07.2012	2012	45
79	2	14.08.2012	2012	7
79	4	05.07.2012	2012	53
79	4	14.08.2012	2012	18
79	4	25.08.2012	2012	9
80	2	08.07.2012	2012	2
80	2	01.08.2012	2012	9
80	4	08.07.2012	2012	19
80	4	01.08.2012	2012	34
80	5	01.08.2012	2012	11
80	5	08.07.2012	2012	24
80	5	01.08.2012	2012	4
80	5	01.08.2012	2012	0
82	2	16.07.2012	2012	5
82	2	15.08.2012	2012	3
82	2	16.07.2012	2012	5
82	2	16.07.2012	2012	3
82	3	16.07.2012	2012	8
82	3	23.08.2012	2012	5
82	3	15.08.2012	2012	12
82	4	15.08.2012	2012	11
82	4	23.08.2012	2012	6
82	4	16.07.2012	2012	7
87	1	21.07.2012	2012	24
87	1	22.08.2012	2012	12
87	2	21.07.2012	2012	22
87	2	22.08.2012	2012	6
87	2	21.07.2012	2012	1
87	2	21.07.2012	2012	2
87	3	21.07.2012	2012	16
87	3	22.08.2012	2012	5
91	1	06.07.2012	2012	38
91	1	09.08.2012	2012	19
91	1	24.08.2012	2012	22
91	5	06.07.2012	2012	35
91	5	09.08.2012	2012	3
91	6	06.07.2012	2012	8
91	6	09.08.2012	2012	6
92	1	23.07.2012	2012	66
92	1	24.08.2012	2012	3

92	2	23.07.2012	2012	10
92	4	23.07.2012	2012	630
92	4	24.08.2012	2012	13
93	2	14.07.2012	2012	13
93	2	25.08.2012	2012	6
93	2	14.07.2012	2012	10
93	2	14.07.2012	2012	5
93	3	14.07.2012	2012	54
93	4	14.07.2012	2012	29
93	4	25.08.2012	2012	15
93	5	25.08.2012	2012	5
102	2	28.06.2012	2012	12
102	2	31.08.2012	2012	7
102	3	28.06.2012	2012	8
102	3	31.08.2012	2012	7
102	4	28.06.2012	2012	11
102	4	31.08.2012	2012	2
102	4	28.06.2012	2012	6
102	4	28.06.2012	2012	5
105	1	29.07.2012	2012	5
105	1	28.06.2012	2012	23
105	1	29.07.2012	2012	3
105	1	29.07.2012	2012	0
105	2	28.06.2012	2012	10
105	2	29.07.2012	2012	6
105	4	29.07.2012	2012	5
105	4	28.06.2012	2012	7
105	4	29.07.2012	2012	2
105	4	29.07.2012	2012	0
118	1	30.06.2012	2012	45
118	1	14.08.2012	2012	5
118	2	30.06.2012	2012	17
118	2	14.08.2012	2012	17
118	2	30.06.2012	2012	10
118	2	30.06.2012	2012	0
118	5	30.06.2012	2012	26
118	5	14.08.2012	2012	9
202	1	06.08.2012	2012	3
202	2	13.07.2012	2012	21
202	2	06.08.2012	2012	4
202	3	13.07.2012	2012	16
202	3	06.08.2012	2012	8
203	1	30.06.2012	2012	43

203	2	30.07.2012	2012	21
203	2	30.06.2012	2012	65
203	2	30.07.2012	2012	20
203	2	30.07.2012	2012	7
203	4	30.06.2012	2012	32
203	4	30.07.2012	2012	23
204	2	19.06.2012	2012	7
204	2	16.08.2012	2012	5
204	2	19.06.2012	2012	7
204	2	19.06.2012	2012	0
204	3	19.06.2012	2012	8
204	3	16.08.2012	2012	7
204	4	19.06.2012	2012	10
204	4	16.08.2012	2012	13
207	1	20.06.2012	2012	13
207	1	24.08.2012	2012	3
207	2	20.06.2012	2012	29
207	2	24.08.2012	2012	10
207	4	20.06.2012	2012	35
207	4	24.08.2012	2012	4
208	1	22.06.2012	2012	20
208	1	30.07.2012	2012	56
208	2	22.06.2012	2012	13
208	2	30.07.2012	2012	29
208	3	22.06.2012	2012	12
208	3	30.07.2012	2012	68
211	3	22.07.2012	2012	35
211	4	22.07.2012	2012	14
211	4	22.07.2012	2012	26
211	4	22.07.2012	2012	1
211	6	22.07.2012	2012	3
211	6	23.08.2012	2012	2
214	1	16.07.2012	2012	4
214	1	15.08.2012	2012	10
214	2	16.07.2012	2012	12
214	2	15.08.2012	2012	8
214	3	16.07.2012	2012	5
214	3	15.08.2012	2012	6
215	1	15.07.2012	2012	5
215	3	30.08.2012	2012	5
215	3	15.07.2012	2012	3
215	4	15.07.2012	2012	4
215	4	30.08.2012	2012	17

216	1	27.06.2012	2012	7
216	1	29.07.2012	2012	18
216	2	27.06.2012	2012	27
216	2	29.07.2012	2012	9
216	4	27.06.2012	2012	11
216	4	29.07.2012	2012	10
217	1	27.06.2012	2012	2
217	1	30.08.2012	2012	2
217	2	27.06.2012	2012	4
217	2	30.08.2012	2012	6
217	3	27.06.2012	2012	15
217	3	30.08.2012	2012	10

Appendix K: The abundance and diversity of other potential pollinators (butterflies and syrphids), sampled on our study transects in 2011 and 2012. Sampling occurred on the same transects as our project, albeit at different days. Butterflies were observed along our study transects in a 5m x 5m x 5m area centered on each transect, walking at a rate of 10 min/50 m. Syrphids were spotted and netted while walking along each transect at a rate of 10 min/50 m.

Landscape	Transect	Day	Month	Year	Syrphid abundance	Syrphid richness	Butterfly Abundance	Butterfly Richness
1	1	19	7	2011	1	1	5	1
1	1	23	8	2011	1	2	12	4
1	2	19	7	2011	38	6	1	1
1	2	23	8	2011	1	2	9	2
1	3	19	7	2011	74	8	0	0
1	3	23	8	2011	0	1	0	0
4	1	18	7	2011	6	2	4	3
4	1	10	8	2011	4	5	2	5
4	5	18	7	2011	3	2	3	1
4	5	10	8	2011	4	2	6	4
4	6	18	7	2011	3	2	4	2
4	6	10	8	2011	1	2	6	2
10	1	21	7	2011	0	1	0	0
10	1	12	8	2011	0	1	5	3
10	2	21	7	2011	0	1	0	0
10	2	12	8	2011	0	1	6	4
10	4	21	7	2011	13	3	3	1
10	4	12	8	2011	0	1	12	3
12	3	13	7	2011	15	7	2	3
12	3	24	8	2011	1	2	9	6
12	4	13	7	2011	9	5	3	2
12	4	24	8	2011	1	2	14	5

12	6	13	7	2011	17	10	1	1
12	6	24	8	2011	6	3	27	3
13	1	5	7	2011	2	2	1	1
13	2	5	7	2011	0	1	17	5
13	2	4	8	2011	7	3	2	3
13	3	5	7	2011	0	1	2	1
13	3	4	8	2011	1	2	1	1
13	4	5	7	2011	3	2	2	2
13	4	4	8	2011	4	2	0	0
14	3	7	7	2011	5	4	9	2
14	3	16	8	2011	1	2	19	7
14	4	7	7	2011	5	3	1	1
14	4	16	8	2011	2	3	36	7
14	5	7	7	2011	2	3	10	5
14	5	16	8	2011	12	4	12	6
16	1	10	7	2011	34	6	2	2
16	1	12	8	2011	6	6	7	4
16	3	10	7	2011	3	3	3	1
16	3	12	8	2011	7	4	2	3
16	4	10	7	2011	1	2	1	4
16	4	12	8	2011	0	1	3	3
21	1	8	7	2011	24	6	2	2
21	1	23	8	2011	1	2	5	2
21	3	8	7	2011	9	5	2	2
21	3	23	8	2011	0	1	2	2
21	4	8	7	2011	13	4	1	1
21	4	23	8	2011	1	1	0	0
23	1	22	7	2011	9	3	1	2
23	2	22	7	2011	23	6	3	3
23	2	18	8	2011	4	4	10	3
23	3	18	8	2011	3	2	3	1
23	4	22	7	2011	20	3	0	0
23	4	18	8	2011	0	1	5	1
25	4	14	7	2011	10	3	0	4
25	4	4	8	2011	0	1	5	3
25	5	14	7	2011	3	3	1	1
25	5	4	8	2011	2	3	7	10
25	7	14	7	2011	47	7	7	6
25	7	4	8	2011	0	1	22	7
28	1	12	7	2011	5	3	2	1
28	1	17	8	2011	3	2	1	1
28	3	12	7	2011	30	3	3	3
28	3	17	8	2011	10	4	9	5

28	4	12	7	2011	3	3	5	3
28	4	17	8	2011	3	2	0	0
30	1	17	7	2011	0	1	4	2
30	1	25	8	2011	11	4	0	0
30	3	17	7	2011	0	1	3	2
30	3	25	8	2011	4	4	0	0
30	4	17	7	2011	3	2	3	2
30	4	25	8	2011	10	2	2	4
32	2	22	7	2011	26	6	4	5
32	2	9	8	2011	13	4	11	8
32	3	22	7	2011	19	5	3	3
32	3	9	8	2011	20	4	3	3
32	4	22	7	2011	4	3	3	3
32	4	9	8	2011	1	2	2	2
33	2	14	7	2011	5	4	3	2
33	2	22	8	2011	3	4	0	2
33	3	14	7	2011	8	5	5	2
33	3	22	8	2011	1	2	3	3
33	4	14	7	2011	1	2	1	2
33	4	22	8	2011	1	2	0	0
37	1	30	6	2011	7	5	2	2
37	1	29	8	2011	1	2	10	2
37	2	30	6	2011	8	6	2	2
37	2	29	8	2011	6	3	0	2
37	3	30	6	2011	0	1	17	2
37	4	30	6	2011	11	5	0	0
37	4	29	8	2011	4	4	21	4
43	1	12	7	2011	3	2	10	4
43	1	19	8	2011	1	2	10	4
43	2	12	7	2011	0	1	10	4
43	2	19	8	2011	0	1	10	5
43	3	12	7	2011	4	3	11	2
43	3	19	8	2011	3	2	17	7
44	1	18	7	2011	12	2	1	6
44	1	29	8	2011	3	4	2	1
44	4	18	7	2011	54	6	0	1
44	4	29	8	2011	16	8	1	1
44	5	18	7	2011	9	5	0	0
44	5	29	8	2011	6	6	9	3
45	1	15	7	2011	1	2	3	3
45	2	15	7	2011	14	3	3	2
45	2	11	8	2011	3	3	0	0
45	3	15	7	2011	11	2	2	2

45	3	11	8	2011	1	2	0	2
45	4	11	8	2011	3	4	0	1
48	1	15	7	2011	7	3	7	5
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215	1	2	8	2012	1	2	3	3
215	1	13	8	2012	8	3	10	3
215	3	2	8	2012	0	1	1	6
215	3	13	8	2012	9	3	6	7
215	4	2	8	2012	7	4	5	6
215	4	13	8	2012	8	4	20	6
216	1	10	7	2012	1	2	8	4
216	1	9	8	2012	0	1	0	0
216	2	10	7	2012	16	4	11	6
216	2	9	8	2012	6	4	5	6
216	4	10	7	2012	1	2	17	5
216	4	9	8	2012	5	5	5	5
217	1	10	7	2012	1	2	3	2
217	1	13	8	2012	0	1	1	1
217	2	10	7	2012	2	2	5	3
217	2	13	8	2012	0	1	17	7
217	3	10	7	2012	0	1	5	4
217	3	13	8	2012	0	1	19	3

Appendix L: Transect locations, closest crop type and days sampled for each landscape from 2011 and 2012

Landscape	Transect	Date	GPS_Border East	GPS_Border North	Survey_Field Crop_Type
1	1	24.06.2011	468929	5030184	Unknown
1	1	25.07.2011	468922	5030193	Alfalfa
1	2	24.06.2011	469154	5030425	Hay
1	2	25.07.2011	469153	5030420	Cereal
1	3	24.06.2011	469214	5030024	Corn
1	3	25.07.2011	469205	5030035	Corn
2	2	16.06.2012	472153	4992051	Wheat
2	2	21.08.2012	472153	4992048	Cereal
2	3	16.06.2012	471665	4991692	Wheat
2	3	21.08.2012	471658	4991698	Cereal
2	6	16.06.2012	471549	4991885	Soybean
2	6	21.08.2012	471547	4991882	Soybean
3	1	04.07.2012	464101	5018246	Hay
3	1	18.08.2012	NA	NA	NA
3	2	04.07.2012	464407	5018450	Soybean
3	2	27.08.2012	464404	5018462	Soybean
3	3	04.07.2012	464332	5018027	Soybean
3	3	27.08.2012	464330	5018027	Soybean
4	1	23.06.2011	469594	5015060	Hay

4	1	11.08.2011	469593	5015058	Hay
4	5	23.06.2011	470130	5015502	Corn
4	5	11.08.2011	470133	5015512	Corn
4	6	23.06.2011	470423	5014884	Soybean
4	6	11.08.2011	470426	5014888	Soybean
5	2	26.06.2012	474959	4980662	Soybean
5	2	20.08.2012	474967	4980651	Soybean
5	4	26.06.2012	475428	4980425	Soybean
5	4	20.08.2012	475428	4980423	Soybean
5	5	26.06.2012	474629	4980990	Corn
5	5	20.08.2012	474641	4980997	Corn
6	1	25.06.2012	485407	5009671	Soybean
6	1	04.08.2012	485414	5009658	Soybean
6	2	25.06.2012	484916	5010224	Soybean
6	2	04.08.2012	484912	5010226	Soybean
6	6	25.06.2012	485118	5010375	Soybean
6	6	04.08.2012	485107	5010396	Soybean
7	1	15.06.2012	435244	5011663	Corn
7	1	05.08.2012	435245	5011662	Corn
7	3	15.06.2012	435051	5011923	Corn
7	3	05.08.2012	435046	5011928	Corn
7	4	15.06.2012	435129	5011366	Corn
7	4	05.08.2012	435134	5011370	Corn
8	1	17.07.2012	506622	5024463	Soybean
8	1	26.08.2012	506633	5024438	Soybean
8	2	17.07.2012	507074	5024167	Corn
8	2	26.08.2012	507077	5024165	Corn
8	4	17.07.2012	507295	5023779	Corn
8	4	26.08.2012	507302	502378	Corn
9	1	03.07.2012	488410	5005559	Soybean
9	1	27.07.2012	488411	5005560	Soybean
9	4	03.07.2012	488260	5006060	Soybean
9	4	27.07.2012	488268	5006062	Soybean
9	5	03.07.2012	488661	5005683	Soybean
9	5	27.07.2012	488658	5005684	Soybean
10	1	18.07.2011	443766	4999677	Corn
10	1	10.08.2011	443767	4999682	Corn
10	2	18.07.2011	443846	4999496	Corn
10	2	10.08.2011	443841	4999503	Corn
10	4	18.07.2011	444491	4999400	Soybean
10	4	10.08.2011	444485	4999397	Soybean
11	1	03.07.2012	489485	5011190	Corn
11	1	13.08.2012	489486	5011181	Corn

11	2	03.07.2012	489814	5011354	Corn
11	2	13.08.2012	489810	5011349	Corn
11	5	03.07.2012	489616	5011514	Corn
11	5	13.08.2012	489617	5011511	Corn
12	3	03.07.2011	466336	5000515	Soybean
12	3	04.08.2011	466341	5000525	Soybean
12	4	03.07.2011	466725	5000591	Soybean
12	4	04.08.2011	466729	5000596	Soybean
12	6	03.07.2011	466547	5000488	Soybean
12	6	04.08.2011	466548	5000490	Soybean
13	2	16.06.2011	464072	4997609	Soybean
13	2	31.07.2011	464093	4997621	Soybean
13	3	16.06.2011	464214	4997364	Soybean
13	3	31.07.2011	464214	4997364	Soybean
13	4	16.06.2011	464754	4997163	Soybean
13	4	31.07.2011	464743	4997141	Soybean
14	3	19.07.2011	463685	4992352	Corn
14	3	13.08.2011	463683	4992351	Corn
14	4	19.07.2011	464109	4992169	Hay
14	4	13.08.2011	464116	4992167	Alfalfa
14	5	19.07.2011	463983	4992527	Corn
14	5	13.08.2011	463988	4992525	Corn
16	1	10.08.2011	441619	5003307	Corn
16	1	18.07.2011	441611	5003297	Corn
16	3	18.07.2011	442202	5003231	Corn
16	3	18.08.2011	442204	5003233	Corn
16	4	18.07.2011	441799	5003189	Corn
16	4	10.08.2011	441811	5003191	Corn
18	1	25.06.2012	476850	5005542	Soybean
18	1	28.07.2012	476851	5005541	Soybean
18	3	25.06.2012	476952	5004769	Soybean
18	3	28.07.2012	476951	5004769	Soybean
18	4	25.06.2012	476701	5005200	Soybean
18	4	28.07.2012	476690	5005208	Soybean
19	1	04.07.2012	469620	5011044	Corn
19	1	04.08.2012	469624	5011042	Corn
19	3	04.07.2012	469825	5011643	Soybean
19	3	04.08.2012	469826	5011642	Soybean
19	5	04.07.2012	469194	5011584	Corn
19	5	04.08.2012	469195	5011579	Corn
19	6	13.08.2012	469600	5011423	Corn
19	7	13.08.2012	469672	5011241	Soybean
20	1	10.07.2012	483146	4998139	Soybean

20	1	19.08.2012	483144	4998135	Soybean
20	2	10.07.2012	482741	4998213	Soybean
20	2	19.08.2012	482790	4998217	Soybean
20	3	10.07.2012	482644	4998661	Soybean
20	3	19.08.2012	482641	4998660	Soybean
21	1	15.06.2011	468105	5020640	Soybean
21	1	25.07.2011	468097	5020636	Soybean
21	3	15.06.2011	468411	5020733	Soybean
21	3	25.07.2011	468412	5020737	Soybean
21	4	15.06.2011	468492	5020509	Soybean
21	4	25.07.2011	468493	5020513	Soybean
22	2	24.06.2012	471678	5033031	Corn
22	2	18.08.2012	471676	5033042	Corn
22	3	24.06.2012	472081	5032888	Soybean
22	3	18.08.2012	472085	5032893	Soybean
22	4	24.06.2012	472300	5033756	Soybean
22	4	18.08.2012	472302	5033759	Soybean
23	1	20.07.2011	490317	5015908	Cereal
23	2	20.07.2011	489975	5015441	Soybean
23	2	19.08.2011	489972	5015438	Soybean
23	3	19.08.2011	489712	5015878	Soybean
23	4	20.07.2011	489802	5015673	Soybean
23	4	19.08.2011	489824	5015832	Soybean
24	1	16.06.2012	458699	4996066	Soybean
24	1	05.08.2012	458693	4996067	Soybean
24	3	16.06.2012	458862	4996482	Soybean
24	3	05.08.2012	458867	4996486	Soybean
24	4	16.06.2012	458875	4996728	Corn
24	4	05.08.2012	458891	4996740	Corn
25	4	04.07.2011	476425	4984638	Soybean
25	4	18.08.2011	476425	4984848	Soybean
25	5	04.07.2011	476426	4985727	Corn
25	5	18.08.2011	476427	4985711	Corn
25	7	04.07.2011	476780	4984992	Corn
25	7	18.08.2011	476782	4984985	Corn
26	1	27.07.2012	483792	5005888	Hay
26	2	25.06.2012	483438	5005973	Hay
26	2	27.07.2012	483437	5005974	Hay
26	3	25.06.2012	483744	5006134	Hay
26	4	25.06.2012	483471	5005372	Soybean
26	4	27.07.2012	483455	5005365	Soybean
27	3	12.07.2012	461246	5000130	Corn
27	3	11.08.2012	461234	5000130	Corn

27	5	12.07.2012	461386	5000314	Hay
27	5	11.08.2012	461382	5000322	Hay
27	6	12.07.2012	460813	4999634	Corn
27	6	11.08.2012	460805	4999636	Corn
28	1	09.07.2011	498236	5023389	Corn
28	1	02.08.2011	498240	5023390	Corn
28	3	09.07.2011	498377	5023087	Corn
28	3	02.08.2011	498372	5023083	Corn
28	4	09.07.2011	498045	5023437	Soybean
28	4	02.08.2011	498050	5023455	Soybean
29	2	02.07.2012	469295	4983548	Corn
29	2	26.07.2012	469292	4983547	Corn
29	3	02.07.2012	469040	4983825	Corn
29	3	26.07.2012	469040	4983824	Corn
29	4	02.07.2012	468849	4984149	Corn
29	4	26.07.2012	468850	4984150	Corn
30	1	16.06.2011	481630	4983999	Soybean
30	1	26.07.2011	481625	4983984	Soybean
30	3	16.06.2011	481004	4983639	Corn
30	3	26.07.2011	481014	4983645	Corn
30	4	16.06.2011	481664	4983206	Alfalfa
30	4	26.07.2011	481668	4983261	Alfalfa
31	2	02.07.2012	464370	4986807	None
31	2	03.08.2012	464366	4986806	Unknown
31	4	02.07.2012	464784	4987263	Corn
31	4	03.08.2012	464780	4987269	Corn
31	5	02.07.2012	464376	4987046	Soybean
31	5	03.08.2012	464376	4987047	Soybean
32	2	17.06.2011	504125	5016885	Corn
32	2	21.08.2011	504137	5016880	Corn
32	3	17.06.2011	504229	5016711	Corn
32	3	21.08.2011	504230	5016698	Corn
32	4	17.06.2011	504582	5016956	Hay
32	4	21.08.2011	NA	NA	Hay
33	2	11.07.2011	483766	4986462	Soybean
33	2	18.08.2011	483765	4986463	Soybean
33	3	11.07.2011	483233	4986380	Soybean
33	3	18.08.2011	483231	4986581	Soybean
33	4	11.07.2011	483100	4986260	Soybean
33	4	18.08.2011	483104	4986261	Soybean
35	1	18.07.2012	499604	4998731	Corn
35	1	19.08.2012	499595	4998732	Corn
35	3	18.07.2012	499632	4998944	Corn

35	3	19.08.2012	499632	4998945	Corn
35	4	18.07.2012	499595	4999269	Corn
35	4	19.08.2012	499594	4999275	Corn
36	1	17.06.2012	480517	5005063	Hay
36	1	04.08.2012	480515	5005059	Hay
36	3	17.06.2012	480169	5004820	Hay
36	3	04.08.2012	480161	5004818	Hay
36	4	17.06.2012	480216	5004578	Corn
36	4	04.08.2012	480210	5004584	Corn
37	1	17.07.2011	470187	5026575	Corn
37	1	19.08.2011	470188	5026585	Corn
37	2	17.07.2011	470445	5026558	Soybean
37	2	19.08.2011	470446	5026569	Soybean
37	4	17.07.2011	470664	5026012	Hay
37	4	19.08.2011	470665	5025998	Hay
39	1	01.07.2012	477698	4972070	Corn
39	1	10.08.2012	477702	4972062	Corn
39	2	01.07.2012	477693	4972272	NA
39	2	10.08.2012	477702	4972258	Corn
39	6	01.07.2012	477272	4972748	Soybean
39	6	10.08.2012	477264	4972743	Soybean
40	1	17.07.2012	485765	5016390	Hay
40	1	13.08.2012	485757	5016400	Alfalfa
40	5	17.07.2012	486057	5015835	Hay
40	5	13.08.2012	486053	5015841	Alfalfa
40	6	17.07.2012	485865	5016222	Hay
40	6	13.08.2012	485862	5016226	Alfalfa
43	1	17.06.2011	504527	5008387	Soybean
43	1	20.08.2011	504522	5008342	Soybean
43	2	17.06.2011	504694	5008441	Soybean
43	2	20.08.2011	504695	5008439	Soybean
43	4	17.06.2011	503791	5008629	Soybean
43	4	20.08.2011	503792	5008633	Soybean
44	1	17.07.2011	466493	5014252	Hay
44	1	11.08.2011	466520	5014269	Hay
44	4	17.07.2011	465857	5013614	Corn
44	4	11.08.2011	465886	5013612	Corn
44	5	17.07.2011	466689	5014376	Hay
44	5	11.08.2011	466687	5014377	Hay
45	1	11.07.2011	500263	5003079	Cereal
45	2	11.07.2011	499926	5003287	Soybean
45	2	26.08.2011	499921	5003290	Soybean
45	3	11.07.2011	499867	5002991	Hay

45	3	26.08.2011	499867	5002997	Hay
45	4	26.08.2011	499811	5002811	Soybean
48	1	12.07.2011	490984	4996526	Soybean
48	1	26.08.2011	490985	4996542	Soybean
48	2	12.07.2011	491576	4996303	Corn
48	2	26.08.2011	491575	4996294	Corn
48	3	12.07.2011	491118	4996188	Corn
48	3	26.08.2011	491118	4996193	Corn
51	1	09.07.2011	497166	5017276	Corn
51	1	02.08.2011	497135	5017303	Corn
51	2	09.07.2011	497373	5017165	Soybean
51	2	02.08.2011	497367	5017172	Clover
51	3	02.08.2011	497178	5016843	Wheat
51	6	09.07.2011	496846	5016978	Corn
52	1	03.08.2011	463522	5003441	Corn
52	1	25.06.2011	463525	5003440	Corn
52	2	25.06.2011	463619	5003244	Alfalfa
52	2	03.08.2011	463616	5003246	Alfalfa
52	4	25.06.2011	463366	5003132	Corn
52	4	03.08.2011	463363	5003141	Corn
53	2	20.07.2011	481701	5015739	Soybean
53	2	19.08.2011	481695	5015745	Soybean
53	3	09.07.2011	482333	5015603	Unknown
53	3	19.08.2011	482332	5015607	Hay
53	4	20.07.2011	481821	5015328	Soybean
53	4	19.08.2011	481825	5015314	Soybean
56	1	26.06.2011	511645	5017438	Corn
56	1	02.08.2011	511641	5017445	Corn
56	5	26.06.2011	511240	5017202	Alfalfa
56	5	02.08.2011	511235	5017203	Alfalfa
56	6	26.06.2011	511481	5017716	Corn
56	6	02.08.2011	511481	5017732	Corn
58	2	17.07.2011	462555	5015294	None
58	2	12.08.2011	462552	5015293	Fallow
58	3	17.07.2011	462842	5014397	Corn
58	3	12.08.2011	462860	5014417	Corn
58	4	17.07.2011	462576	5014833	Soybean
58	4	12.08.2011	462562	5014858	Soybean
59	1	19.07.2012	440822	4993663	Soybean
59	1	12.08.2012	440816	4993667	Soybean
59	2	19.07.2012	441017	4993592	Soybean
59	2	12.08.2012	441017	4993595	Soybean
59	4	19.07.2012	441486	4993943	Wheat

59	4	12.08.2012	441484	4993944	Wheat
63	1	18.07.2011	451377	5000239	Corn
63	1	10.08.2011	451379	5000242	Corn
63	2	18.07.2011	451587	4999893	Corn
63	2	10.08.2011	451601	4999900	Corn
63	3	18.07.2011	451336	4999746	Corn
63	3	10.08.2011	451322	4999769	Corn
65	1	10.07.2011	466950	4974980	Corn
65	1	27.08.2011	466958	4974979	Corn
65	3	10.07.2011	466541	4974501	Corn
65	3	27.08.2011	466593	4974503	Corn
65	4	10.07.2011	466882	4975209	Hay
65	4	27.08.2011	466901	4975203	Alfalfa
67	2	18.06.2011	465755	5024581	Clover
67	2	03.08.2011	465756	5024584	Alfalfa
67	4	18.06.2011	466462	5024115	Soybean
67	4	03.08.2011	466462	5024112	Soybean
67	5	18.06.2011	466069	5024093	Soybean
67	5	03.08.2011	466087	5024093	Soybean
68	1	04.07.2011	481218	4993135	Soybean
68	1	05.08.2011	481220	4993141	Soybean
68	3	04.07.2011	480794	4993327	Corn
68	3	05.08.2011	480799	4993321	Corn
68	4	04.07.2011	480834	4992871	Soybean
68	4	05.08.2011	480833	4992867	Soybean
69	3	01.07.2011	469980	5006064	Soybean
69	3	27.07.2011	469979	5006065	Soybean
69	4	01.07.2011	469737	5006134	Soybean
69	4	27.07.2011	469729	5006126	Soybean
69	5	01.07.2011	469876	5006303	Soybean
69	5	27.07.2011	469879	5006302	Soybean
72	5	09.07.2012	441110	4983635	Corn
72	5	02.08.2012	441118	4983627	Corn
72	7	09.07.2012	440485	4983041	Corn
72	7	02.08.2012	440485	4983035	Corn
72	8	09.07.2012	441059	4982953	Hay
72	8	02.08.2012	441052	4982957	Alfalfa
73	1	17.06.2012	475659	4999499	Corn
73	1	28.07.2012	475657	4999482	Corn
73	2	17.06.2012	475517	4999644	Soybean
73	2	28.07.2012	475511	4999649	Soybean
73	3	17.06.2012	475736	5000371	Soybean
73	3	28.07.2012	475740	5000370	Soybean

74	1	18.06.2012	472319	4975308	Corn
74	1	03.08.2012	472315	4975309	Corn
74	2	18.06.2012	472921	4975716	Corn
74	2	03.08.2012	472917	4975719	Corn
74	4	18.06.2012	472683	4975527	Soybean
74	4	03.08.2012	472682	4975533	Soybean
75	2	19.07.2012	447732	5011848	Soybean
75	2	27.08.2012	447727	5011846	Soybean
75	3	19.07.2012	448140	5012133	Hay
75	3	27.08.2012	448139	5012138	Hay
75	4	19.07.2012	448562	5012323	Soybean
75	4	27.08.2012	448560	5012325	Soybean
76	2	17.06.2011	483488	4990660	Corn
76	2	05.08.2011	483480	4990668	Corn
76	3	17.06.2011	483580	4990470	Corn
76	3	26.07.2011	483587	4990465	Corn
76	4	17.06.2011	482867	4990530	Legumes
76	4	26.07.2011	482865	4990530	Hay
77	1	26.06.2011	495430	5012985	Hay
77	1	21.08.2011	495422	5012981	Hay
77	2	26.06.2011	495452	5012761	Soybean
77	2	21.08.2011	495454	5012773	Soybean
77	3	26.06.2011	495494	5012299	Corn
77	3	21.08.2011	495503	5012209	Corn
78	1	03.07.2011	468990	5001010	Soybean
78	1	05.08.2011	468988	5001001	Soybean
78	4	11.07.2011	469280	5000296	Soybean
78	4	05.08.2011	469276	5000294	Soybean
78	6	03.07.2011	468893	5000153	Corn
78	6	05.08.2011	468891	5000150	Corn
79	1	01.07.2012	473196	4971816	Soybean
79	1	10.08.2012	473200	4971813	Soybean
79	2	01.07.2012	473072	4972071	Corn
79	2	10.08.2012	473068	4972070	Corn
79	4	01.07.2012	472664	4971881	Corn
79	4	10.08.2012	472657	4971879	Corn
79	4	21.08.2012	472661	4971881	Corn
80	2	04.07.2012	477289	5017106	Corn
80	2	28.07.2012	477296	5017111	Corn
80	4	04.07.2012	477707	5016765	Corn
80	4	28.07.2012	477708	5016769	Corn
80	5	04.07.2012	477466	5016837	Soybean
80	5	28.07.2012	477460	5016842	Soybean

82	2	12.07.2012	468797	4996945	Hay
82	2	11.08.2012	468795	4996942	Hay
82	3	12.07.2012	468343	4996888	Corn
82	3	11.08.2012	468337	4996885	Corn
82	3	19.08.2012	468337	4996885	Corn
82	4	12.07.2012	468559	4997061	Corn
82	4	11.08.2012	468562	4997064	Corn
82	4	19.08.2012	468561	4997059	Corn
85	1	02.07.2011	476468	4994353	Corn
85	1	05.08.2011	476465	4994355	Corn
85	2	02.07.2011	476532	4994556	Corn
85	2	26.07.2011	476531	4994555	Corn
85	4	02.07.2011	476224	4994149	Corn
85	4	05.08.2011	476226	4994152	Corn
86	2	23.06.2011	NA	NA	Corn
86	2	03.08.2011	476964	5032333	Corn
86	3	23.06.2011	476741	5032105	Corn
86	3	03.08.2011	476744	5032104	Corn
86	4	23.06.2011	476937	5032572	Corn
86	4	03.08.2011	476943	5032567	Corn
87	1	17.07.2012	467636	5032946	Soybean
87	1	18.08.2012	467636	5032950	Soybean
87	2	17.07.2012	467500	5033298	Corn
87	2	18.08.2012	467504	5033303	Corn
87	3	17.07.2012	467221	5033340	Hay
87	3	18.08.2012	467237	5033346	Hay
88	1	25.06.2011	475136	5013740	Hay
88	1	11.08.2011	475141	5013725	Hay
88	4	25.06.2011	474688	5013265	Hay
88	4	11.08.2011	474679	5013263	Clover
88	7	25.06.2011	474774	5013140	Corn
88	7	11.08.2011	474774	5013142	Corn
91	1	02.07.2012	453343	4991423	Corn
91	1	05.08.2012	453341	4991422	Corn
91	1	20.08.2012	453351	4991418	Corn
91	5	02.07.2012	453611	4991354	Corn
91	5	05.08.2012	453609	4991357	Corn
91	6	02.07.2012	453462	4992152	Soybean
91	6	05.08.2012	453457	4992149	Soybean
92	1	19.07.2012	458632	4979474	Corn
92	1	20.08.2012	458631	4979471	Corn
92	2	19.07.2012	458725	4979027	Corn
92	2	20.08.2012	458723	4979026	Corn

92	4	19.07.2012	458012	4979298	Alfalfa
92	4	20.08.2012	458011	4979296	Alfalfa
93	2	10.07.2012	489022	4993102	Corn
93	2	21.08.2012	489016	4993097	Corn
93	3	10.07.2012	489181	4992636	Wheat
93	4	10.07.2012	489536	4992662	Corn
93	4	21.08.2012	489533	4992666	Corn
93	5	21.08.2012	489372	4993274	Corn
96	1	02.07.2011	506914	5005931	Clover
96	1	26.08.2011	506923	5005447	Alfalfa
96	2	02.07.2011	507036	5005251	Clover
96	2	26.08.2011	507027	5005269	Clover
96	6	02.07.2011	506914	5004878	Hay
97	2	25.06.2011	459689	5007249	Hay
97	2	04.08.2011	459687	5007249	Alfalfa
97	3	25.06.2011	460335	5006997	Soybean
97	3	04.08.2011	460340	5006999	Soybean
97	4	25.06.2011	459851	5006917	Soybean
97	4	04.08.2011	459852	5006918	Soybean
98	2	24.06.2011	475605	5025422	Hay
98	2	25.07.2011	475632	5025426	Clover
98	5	24.06.2011	475511	5025214	Hay
98	5	03.08.2011	475514	5025215	Oats
98	6	24.06.2011	475754	5025180	Corn
98	6	25.07.2011	475731	5025174	Corn
100	1	12.08.2011	464086	5007688	Corn
100	1	01.07.2011	464090	5007682	Corn
100	3	12.08.2011	463869	5007287	Hay
100	3	01.07.2011	463874	5007291	Hay
100	4	01.07.2011	464286	5006969	Legumes
100	4	21.08.2011	464288	5006978	Hay
101	1	19.07.2011	457553	4993028	Hay
101	1	13.08.2011	457550	4993029	Pasture
101	2	19.07.2011	456859	4992564	Soybean
101	2	13.08.2011	456956	4992560	Soybean
101	4	19.07.2011	457401	4992467	Corn
101	4	13.08.2011	457401	4992467	Corn
102	2	24.06.2012	456154	5026115	Fallow
102	2	27.08.2012	456154	5026114	Fallow
102	3	24.06.2012	456600	5026086	Fallow
102	3	27.08.2012	456595	5026100	Fallow
102	4	24.06.2012	456354	5026147	Fallow
102	4	27.08.2012	456354	2056153	Fallow

104	1	14.07.2011	463080	4974363	Hay
104	1	27.08.2011	463061	4974928	Hay
104	2	14.07.2011	463167	4974752	Hay
104	2	27.08.2011	463151	4974796	Hay
104	4	14.07.2011	463736	4974337	Hay
104	4	27.08.2011	463738	4974333	Hay
105	1	24.06.2012	481895	5028513	Corn
105	1	25.07.2012	481892	5028524	Corn
105	2	24.06.2012	481364	5028510	Soybean
105	2	25.07.2012	481316	5028513	Soybean
105	4	24.06.2012	481548	5028771	Soybean
105	4	25.07.2012	481551	5028767	Soybean
106	3	10.07.2011	459462	4988605	Corn
106	3	04.08.2011	459476	4988591	Corn
106	4	10.07.2011	459232	4989218	Unknown
106	4	04.08.2011	459215	4989228	Hay
106	7	10.07.2011	459808	4989349	Soybean
106	7	04.08.2011	459814	4989342	Soybean
107	3	12.07.2011	497403	4995418	Hay
107	4	12.07.2011	497247	4995184	Hay
107	4	20.08.2011	497249	4995195	Hay
107	5	20.08.2011	497606	4995516	Hay
107	6	12.07.2011	497575	4995295	Hay
107	6	20.08.2011	497576	4995291	Hay
108	3	19.07.2011	453502	4995153	Corn
108	3	13.08.2011	NA	NA	Corn
108	4	19.07.2011	453000	4995113	Corn
108	4	13.08.2011	452998	4995111	Corn
108	5	19.07.2011	452768	4995709	Corn
108	5	13.08.2011	452768	4995711	Corn
109	4	12.07.2011	503478	4999504	Corn
109	4	20.08.2011	503484	4999509	Corn
109	5	12.07.2011	503753	4999775	Soybean
109	5	20.08.2011	503743	4999784	Soybean
109	6	12.07.2011	503143	4999291	Corn
109	6	20.08.2011	503146	4999286	Corn
110	2	01.07.2011	457713	5013031	Corn
110	2	12.08.2011	457714	5013043	Corn
110	3	01.07.2011	458054	5013371	Cabbage
110	3	12.08.2011	458052	5013372	Hay
110	7	01.07.2011	458139	5013165	Corn
110	7	12.08.2011	458137	5013160	Corn
118	1	26.06.2012	481045	4978317	Corn

118	1	10.08.2012	481040	4978310	Corn
118	2	26.06.2012	481272	4978569	Corn
118	2	10.08.2012	481275	4975564	Corn
118	5	26.06.2012	481480	4978698	Corn
118	5	10.08.2012	481478	4975698	Corn
202	1	09.07.2012	445552	4978066	Hay
202	1	02.08.2012	445555	4978059	Fallow
202	2	09.07.2012	445540	4977826	Hay
202	2	02.08.2012	445539	4977829	Fallow
202	3	09.07.2012	445117	4978066	Abandoned
202	3	02.08.2012	445123	4978067	Abandoned
203	1	26.06.2012	477669	4976199	Soybean
203	1	26.07.2012	477656	4976197	Soybean
203	2	26.06.2012	478179	4976536	Fallow
203	2	26.07.2012	478174	4976532	Fallow
203	4	26.06.2012	477973	4976689	Fallow
203	4	26.07.2012	477972	4976685	Fallow
204	2	15.06.2012	437822	5007601	Corn
204	2	12.08.2012	437816	5007604	Corn
204	3	15.06.2012	438292	5007645	Corn
204	3	12.08.2012	438297	5007648	Corn
204	4	15.06.2012	437819	5007958	Alfalfa
204	4	12.08.2012	437816	5007957	Hay
207	1	16.06.2012	472648	4986841	Corn
207	1	20.08.2012	472646	4986838	Corn
207	2	16.06.2012	472471	4987146	Corn
207	2	20.08.2012	472469	4987147	Corn
207	4	16.06.2012	472786	4987638	Hay
207	4	20.08.2012	472466	4987633	Hay
208	1	18.06.2012	468484	4978719	Corn
208	1	26.07.2012	468690	4978716	Corn
208	2	18.06.2012	469032	4978730	Soybean
208	2	26.07.2012	469029	4978733	Soybean
208	3	18.06.2012	468930	4978343	Corn
208	3	26.07.2012	468940	4978344	Corn
211	3	18.07.2012	502168	4990479	Hay
211	4	18.07.2012	502595	4990158	Pasture
211	6	18.07.2012	502347	4990203	Hay
211	6	19.08.2012	502342	4990213	Hay
214	1	12.07.2012	478301	4988530	Hay
214	1	11.08.2012	478299	4988529	Alfalfa
214	2	12.07.2012	478184	4988923	Soybean
214	2	11.08.2012	472172	4988944	Soybean

214	3	12.07.2012	478339	4988190	Hay
214	3	11.08.2012	478332	4988188	Hay
215	1	11.07.2012	503016	5021477	Corn
215	1	26.08.2012	503017	5021469	Corn
215	3	11.07.2012	503084	5021827	Hay
215	3	26.08.2012	503084	5021830	Hay
215	4	11.07.2012	502709	5022231	Alfalfa
215	4	26.08.2012	502714	5022225	Hay
216	1	23.06.2012	514731	5029309	Corn
216	1	25.07.2012	514730	5029305	Corn
216	2	23.06.2012	515205	5029418	Soybean
216	2	25.07.2012	515200	5029413	Soybean
216	4	23.06.2012	514617	5029695	Alfalfa
216	4	25.07.2012	514629	5029699	Alfalfa
217	1	23.06.2012	508845	5019915	Wheat
217	1	26.08.2012	508840	5019917	Cereal
217	2	23.06.2012	509493	5019999	Legumes
217	2	26.08.2012	509498	5020003	Hay
217	3	23.06.2012	509387	5020621	Soybean
217	3	26.08.2012	509388	5020619	Soybean

Appendix M: Farmland heterogeneity variables (SHDI- Shannon Diversity for crop types, MFS- mean field size) calculated at 3 scales for each landscape in 2011 and 2012.

Landscape	MFS_1km	MFS_2km	MFS_3km	SHDI_1km	SHDI_2km	SHDI_3km
1	29086.08	46482.71	48707.44	1.378635	1.624104	1.635865
2	38727.33	37074.74	36983.32	1.243637	1.563475	1.623528
3	73048.06	48687.76	49888.69	0.273998	0.886672	1.316683
4	49673.71	45187.21	42860.2	1.051063	1.190732	1.36973
5	85633.2	77141.13	76507.71	0.563313	0.973837	1.265854
6	45902.26	38452.82	51702.84	1.058282	1.372089	1.23203
7	47222.22	62317.38	53107.61	0.821627	0.952531	1.055526
8	43731.78	52481.68	63696.26	0.893614	1.306441	1.371442
9	101834.2	105312.1	92962.91	0.718648	0.990394	1.093357
10	25004.41	34784.99	33945.23	1.157355	1.404836	1.505966
11	33315.53	52638.5	58051.08	0.995052	1.110955	1.228151
12	38583.62	66735.41	60333.87	0.996485	0.967691	1.011403
13	120211.8	112978.2	72398.5	0.3139	0.923304	1.254304
14	38601.36	58119.69	69490.97	1.090279	1.029934	1.114299
16	39900.01	45392.09	49850.53	0.208171	0.785311	0.836936
18	64453.64	66214.75	62307.23	1.039843	1.276255	1.386605
19	54569.79	53937.08	52665.63	1.260027	1.256651	1.405052

20	47322.97	68458.59	76702.62	0.604416	0.989046	1.08839
21	99295.96	148127.7	106541.9	0	0.085835	0.333516
22	52068.15	37635.65	40519.41	0.874274	1.404763	1.355574
23	33955.12	47953.53	53092.16	1.4316	1.41584	1.332
24	37753.13	47421.17	46762.78	1.065839	1.179135	1.314393
25	44060.42	52176.25	49598.69	0.94371	0.960126	1.137911
26	23876.25	44117.47	60498.79	1.171848	0.996306	0.955415
27	92780.43	43124.74	44624.2	0.550885	1.396135	1.554716
28	50178.81	66074.78	67899.05	1.063391	1.319802	1.451674
29	79515.65	81679.4	76241.32	0.577825	1.085706	1.129523
30	28832.37	44696.45	48000.71	1.38998	1.356811	1.350673
31	20148.67	31302.69	41794.58	1.18378	1.409364	1.26761
32	52623.08	50044.52	51648.23	1.02433	1.254601	1.353763
33	15238.19	21907.71	32420.3	0.901861	1.076498	1.489627
35	51792.98	43861.84	47760.21	0.424014	0.954901	1.174226
36	12867.71	22416.23	34715.5	1.542627	1.529252	1.439121
37	42572.97	37213.65	50095.61	1.481804	1.323741	1.262982
39	24750.42	31437.78	34337.19	1.45594	1.689813	1.552707
40	38882.47	32998.16	38336.34	0.971146	1.588039	1.566436
43	81145.28	99352.46	83436.61	0.72325	1.100768	1.1951
44	42335.93	44238.32	45656.57	1.750447	1.738801	1.60426
45	39264.82	41260.64	37518.16	1.398635	1.401718	1.389162
48	19915.67	35337.46	42458.77	1.474086	1.331918	1.446325
51	63470.76	67857.46	69828.81	0.953733	1.147907	1.152195
52	23582.14	37901.88	42661.6	1.667256	1.663716	1.560277
53	25015.47	33456.67	42544.96	0.916965	1.410073	1.285028
56	57966.49	62486.24	59693.16	1.560338	1.623446	1.569894
58	51903.5	58648.24	68727.2	0.770494	1.192326	1.359684
59	56444.08	58025.25	50646.72	1.074825	1.198757	1.323934
63	45618.14	44828.35	52296.63	1.281624	1.612697	1.501072
65	41086.24	52115.97	60640.64	1.307097	1.520271	1.238998
67	32556.6	55018.87	67095.31	1.072228	1.593212	1.679024
68	35564.21	52094.22	55407.51	1.026002	1.252544	1.290661
69	57097.74	54840.27	61550.1	0.547712	0.936815	1.062707
72	38582.94	34132.6	35870.51	0.858722	1.253189	1.391561
73	105495.6	138209.8	93447.58	0.885006	1.048764	1.155317
74	76735.6	57284.43	58265.71	0.953944	1.162511	1.249219
75	18193.58	22280.91	24295.88	1.226912	1.583973	1.490457
76	32719.33	42261.05	52057.86	1.074291	1.28023	1.350166
77	37162.13	36668.79	44685.41	1.397507	1.6427	1.495176
78	23379.23	30335.44	39941.73	0.587332	1.03056	1.195898
79	28233.8	33616.31	47060.49	1.166847	1.338578	1.166632
80	115333.7	146180.8	123695.2	0.688767	0.703229	0.65361

82	50851.07	46939.49	51711.87	1.04591	1.513365	1.66477
85	46729.89	51120.96	52772.34	0.694105	0.877627	1.18196
86	39979.26	25783.16	31158.62	1.127245	1.696398	1.710085
87	45062.49	74115.9	82552.93	1.321728	1.507613	1.499374
88	26005.74	37531.74	47460.23	1.29033	1.410129	1.498149
91	26504.8	41933.06	51218.24	1.04384	1.065667	1.098599
92	25237.98	23759.51	27533.6	1.347521	1.756523	1.799598
93	27018.99	42725.98	51346.09	1.04974	1.340143	1.425456
96	19748.13	24704.57	28138.34	1.117294	1.345582	1.49509
97	22860.48	29844.61	36977.81	1.481766	1.449271	1.457664
98	21906.7	36121.51	35788.23	1.095514	1.419278	1.414151
100	9888.896	22596.1	27106.42	0.786714	0.780862	1.011942
101	27161.65	35215.76	47526.86	1.470119	1.541877	1.602154
102	27588.33	34875.57	33171.4	0.579126	1.033286	1.287831
104	27470.8	52546.95	59771.51	0.90481	1.405463	1.329975
105	32009.65	40721.99	44455.31	0.692514	0.910252	1.152409
106	21874.48	30397.67	29950.91	1.142065	1.296838	1.33
107	14909.08	24187.14	31947.73	0.747939	1.793596	1.758213
108	34864.25	38093.65	55481.84	1.070983	1.407482	1.453622
109	24030.4	24478.97	29028.3	1.381887	1.47372	1.587433
110	45580.76	52843.98	48351.14	1.034036	1.296461	1.333179
118	48954.78	40216.93	40691.13	0.859727	1.167521	1.343922
202	18267.11	20975.08	21510	1.09393	1.468906	1.616162
203	31239.9	49380.67	50841.83	1.168163	1.372919	1.592075
204	56999.86	78143.97	77107.74	1.116572	0.933971	1.139651
205	22702.54	20771.4	22465.97	0.740989	1.414378	1.496468
207	31472.38	52624.77	62382.33	0.81166	1.013566	1.211484
208	61850.07	72676.54	61211.07	0.722966	0.934882	1.114711
211	20926.63	21221.93	22839.85	1.253464	1.704404	1.769719
214	26380.67	53396.25	63432.24	1.59658	1.541763	1.406503
215	42983.41	51802.89	67468.66	1.234699	1.484553	1.499651
216	127085.4	70266.02	72853.39	1.056708	1.174361	1.351471
217	27368.32	51287.08	60836.05	1.600239	1.646375	1.600292

Appendix N: Potentially confounding landscape variables (AG_Cover – proportion of the landscape cover that is agricultural (pasture+crop cover), Soy_Cover – proportion of landscape that is Soybean cover) calculated at 1km, 2km and 3km scales for each landscape in 2011 and 2012

Landscape	Soy_Cover 1km	Soy Cover 2km	Soy cover 3km	AG_Cover 1km	AG_Cover 2km	AG_Cover 3km
1	0.077563	0.100136	0.110806	0.785324	0.68562	0.514134
2	0.28951	0.175764	0.15018	0.735819	0.676614	0.624607
3	0.742846	0.428023	0.293046	0.803529	0.559909	0.537689
4	0.130241	0.186389	0.17094	0.745106	0.677808	0.647665
5	0.705634	0.51929	0.365372	0.941965	0.848552	0.824583
6	0.300165	0.137129	0.142215	0.872143	0.701764	0.718095
7	0.061182	0.060874	0.068703	0.708333	0.747809	0.684498
8	0.147466	0.24146	0.304612	0.787172	0.708503	0.714814
9	0.405969	0.202604	0.165608	0.916508	0.816168	0.795349
10	0.154514	0.104611	0.10447	0.525093	0.521775	0.580841
11	0.035251	0.108616	0.215211	0.666311	0.736939	0.793365
12	0.302775	0.35631	0.270302	0.617338	0.667354	0.690488
13	0.754948	0.322042	0.207893	0.841482	0.734358	0.651587
14	0.305242	0.266711	0.161535	0.810629	0.682906	0.617698
16	0	0.052449	0.08576	0.5985	0.476617	0.520661
18	0.381961	0.266576	0.227876	0.837897	0.76147	0.782302
19	0.154521	0.258236	0.220142	0.709407	0.687698	0.690505
20	0.636097	0.313497	0.272607	0.899136	0.872847	0.843729
21	0.695072	0.52941	0.32796	0.695072	0.555479	0.449843
22	0.355765	0.211017	0.182467	0.937227	0.809166	0.769869
23	0.246793	0.222245	0.19705	0.645147	0.671349	0.60761
24	0.360746	0.193433	0.144343	0.830569	0.770594	0.732617
25	0.377296	0.311148	0.175562	0.793088	0.730467	0.655805
26	0.088412	0.276596	0.279898	0.620782	0.705879	0.712541
27	0.002212	0.103382	0.09058	0.835024	0.722339	0.654488
28	0.136888	0.177085	0.145486	0.752682	0.710304	0.686535
29	0.049674	0.302226	0.296417	0.874672	0.816794	0.787827
30	0.199268	0.204106	0.223539	0.749642	0.737491	0.677343
31	0.122957	0.219741	0.237825	0.644758	0.641705	0.682645
32	0.308714	0.165581	0.091099	0.789346	0.613045	0.585347
33	0.304533	0.248877	0.154269	0.67048	0.514831	0.500713
35	0.0717	0.174031	0.19466	0.828688	0.635997	0.636803
36	0.213224	0.22207	0.27162	0.604783	0.666883	0.713596
37	0.241414	0.158137	0.148687	0.681168	0.400047	0.406331
39	0.115807	0.09376	0.102015	0.693012	0.675912	0.679113
40	0	0.068578	0.145742	0.738767	0.486723	0.511151

43	0.46867	0.2681	0.172426	0.649162	0.645791	0.50062
44	0.10232	0.101482	0.129785	0.677375	0.674634	0.623973
45	0.125601	0.117898	0.113359	0.667502	0.484812	0.425206
48	0.063044	0.178533	0.173489	0.537723	0.618406	0.636882
51	0.003184	0.110685	0.145143	0.761649	0.627682	0.612942
52	0.034717	0.103842	0.077671	0.683882	0.568528	0.474018
53	0.20105	0.067449	0.050704	0.525325	0.418208	0.463267
56	0.037464	0.070491	0.105014	0.811531	0.656105	0.676522
58	0.487235	0.143548	0.063799	0.674745	0.439862	0.381818
59	0.177772	0.321291	0.24089	0.846661	0.710809	0.63027
63	0.217132	0.205475	0.114368	0.72989	0.650011	0.528777
65	0.257373	0.08911	0.059339	0.65738	0.560247	0.606406
67	0.381078	0.197786	0.101213	0.618575	0.605208	0.514397
68	0.190935	0.235568	0.195797	0.782413	0.703272	0.683359
69	0.576602	0.282647	0.231047	0.799368	0.740344	0.752279
72	0.006322	0.009958	0.026677	0.65591	0.639986	0.506173
73	0.270562	0.337044	0.302341	0.949461	0.863811	0.809879
74	0.487782	0.431522	0.265331	0.920827	0.801982	0.763928
75	0.198088	0.138121	0.149747	0.673163	0.49575	0.502115
76	0.191358	0.145175	0.173546	0.687106	0.707873	0.711457
77	0.219163	0.090763	0.100163	0.780405	0.650871	0.734827
78	0.388439	0.227809	0.23484	0.584481	0.659796	0.701199
79	0.414422	0.196378	0.161679	0.81878	0.655518	0.658847
80	0.441424	0.339581	0.235343	0.807336	0.767449	0.755915
82	0.331208	0.199942	0.163473	0.711915	0.598478	0.649271
85	0.229598	0.107259	0.086249	0.654218	0.54955	0.527723
86	0.009269	0.063461	0.087656	0.719627	0.438314	0.495076
87	0.40373	0.248077	0.193423	0.856187	0.889391	0.853047
88	0.027489	0.10272	0.103267	0.702155	0.694337	0.664443
91	0.143715	0.108323	0.091512	0.689125	0.691895	0.705674
92	0.072579	0.163241	0.150083	0.706663	0.647447	0.599621
93	0.012617	0.067861	0.076982	0.756532	0.630208	0.564807
96	0	0.032215	0.034547	0.513451	0.457034	0.450213
97	0.26233	0.186005	0.143009	0.640094	0.45513	0.447842
98	0.453716	0.222535	0.183726	0.679108	0.614066	0.516941
100	0	0	0.015989	0.435111	0.525359	0.460809
101	0.119782	0.155836	0.104105	0.597556	0.53704	0.506953
102	0.131527	0.070458	0.045773	0.49659	0.479539	0.394371
104	0.029807	0.126881	0.073186	0.604358	0.525469	0.458248
105	0.311813	0.232962	0.160952	0.640193	0.631191	0.548282
106	0.28933	0.169087	0.109215	0.63436	0.440766	0.356083
107	0	0.041804	0.089479	0.551636	0.544211	0.514713
108	0.0426	0.097266	0.115673	0.697285	0.695209	0.70277

109	0.199235	0.1598	0.108988	0.696882	0.538537	0.445101
110	0.201254	0.164854	0.087983	0.820454	0.594495	0.376064
118	0.144514	0.147451	0.115759	0.734322	0.643471	0.596803
202	0.153326	0.097432	0.050931	0.602815	0.59779	0.47322
203	0.393096	0.205528	0.165443	0.718518	0.678984	0.643997
204	0.235914	0.104657	0.115225	0.911998	0.761904	0.651132
205	0	0	0.00258	0.771886	0.649106	0.609078
207	0.285369	0.268867	0.26871	0.912699	0.920934	0.873353
208	0.562266	0.460096	0.331661	0.927751	0.890288	0.788943
211	0.026955	0.077157	0.084081	0.669652	0.673796	0.477099
214	0.059931	0.139352	0.207358	0.844181	0.867689	0.866907
215	0	0.131285	0.178815	0.902652	0.867698	0.884589
216	0.326987	0.417414	0.293002	0.889597	0.808059	0.793292
217	0.235072	0.175676	0.176554	0.738945	0.820593	0.811147