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# The effects of agricultural management on the reproductive activity of female rodents in Argentina

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## Abstract

The aim of this study was to test if female rodents in border habitats of organic farms have higher reproductive activity than those of conventional farms in south-east Córdoba province, Argentina. The study was conducted in field borders of organic and conventional farms in 2012 and 2013 during the summer months, the time of the year when reproductive activity is more likely. We sampled field borders through a CMR trapping session and recorded vegetation cover, plant litter, vegetation volume, bare ground cover and land use of the field on both sides of the border (crop/crop or crop/pasture). We recorded the number of reproductive females and the rate of postpartum estrus. Green vegetation cover was higher in organic borders whereas plant litter was higher in borders of conventional farms. We used Generalized Linear Mixed Models (GLMM) to determine the factors that influence the number of reproductive females in borders of organic and conventional farms. The number of reproductive females was mainly determined by agriculture management and field type. There were more reproductive females in organic than in conventional borders, and borders associated with crop fields at both sides supported the highest number of reproductive females. The rate of postpartum estrus was higher in organic than in conventional borders. Our results showed that in border habitats of farms under organic management reproductive activity of female rodents was higher than in borders of conventional farms. Organic farm borders may provide high quality habitats that provide resources for reproduction and persistence of rodent populations.

## Zusammenfassung

Das Ziel dieser Untersuchung war zu überprüfen, ob Kleinsäugerweibchen in Saumhabitaten biologischer Betriebe höhere reproduktive Aktivität zeigten als in jenen von konventionellen Betrieben. Die Untersuchung wurde in Saumhabitaten von biologischen und konventionellen Betrieben in der südöstlichen Córdoba-Provinz (Argentinien) durchgeführt, und zwar in den Sommermonaten 2012 und 2013, der Jahreszeit, zu der reproduktive Aktivität wahrscheinlicher ist. Wir beprobten die Feldsäume mit der Fang-Wiederfang-Methode und registrierten die Vegetationsbedeckung, Pflanzenstreu, Vegetationsvolumen, Kahlstellen und die Landnutzung auf beiden Seiten des Saumhabitats (Feld/Feld oder Feld/Weide). Wir registrierten die Zahl reproduktiver Weibchen und das Auftreten von Post-partum-Östrus. Die grüne Vegetationsschicht der Saumhabitate war höher bei biologischen Betrieben, während es bei den konventionellen Betrieben mehr Pflanzenstreu in den Saumhabitaten gab. Wir nutzten Generalisierte lineare gemischte Modelle (GLMM), um die Faktoren zu bestimmen, die die Anzahl der reproduktiven Weibchen in Saumhabitaten von biologischen und konventionellen Betrieben beeinflussten. Die Zahl der reproduktiven Weibchen wurde hauptsächlich von der Bewirtschaftungsform und dem Feldtyp beeinflusst. Es gab mehr

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reproduktive Weibchen auf biologischen als auf konventionellen Betrieben, und Saumhabitate mit Feldern auf beiden Seiten beherbergten die meisten reproduktiven Weibchen. Post-partum-Östrus trat in biologischen Saumhabitate häufiger auf als in konventionellen Saumhabitaten. Unsere Ergebnisse zeigten, dass die reproduktive Aktivität der Kleinsäugerweibchen in Saumhabitaten von biologischen Betrieben höher war als in denen von konventionellen Betrieben. Die Saumhabitate von biologischen Betrieben sind vermutlich qualitativ hochwertige Lebensräume, die den Kleinsäugerpopulationen Ressourcen für die Reproduktion und das Überleben bieten.


***Keywords:*** Organic vs. conventional farms; Border habitat; Habitat quality; Rodent populations; Reproductive activity; Postpartum estrus; Vegetation volume; GLMM

## Introduction

Agricultural intensification is one of the key causes of habitat destruction and subsequent biodiversity loss, due mainly to the increasing use of pesticides and fertilizers at local scales (Bengtsson et al. 2003; Hole et al. 2005) and the loss of natural habitats at landscape scales (Roschewitz, Gabriel, Tscharntke, & Thies 2005; Tscharntke, Klein, Kruess, Steffan-Dewenter, & Thies 2005). Organic farming practices are more environmental friendly than conventional agriculture, which is dependent on the routine use of herbicides, pesticides and inorganic nutrient applications in the production of crops and animals (Bengtsson, Ahnström, & Weibull 2005). Studies conducted in plants, insects, birds and mammals have shown that organic farming practices can counteract the negative effects of agriculture intensification in Europe (Beecher, Johnson, Brandle, Case, & Young 2002; Roschewitz et al. 2005; Holzschuh, Steffan-Dewenter, Kleijn, & Tscharntke 2007; Macdonald, Tattersall, Service, Firbank, & Feber 2007; Fischer, Thies, & Tscharntke 2011). However, some studies about the effects of organic agriculture on biodiversity have shown that complexity at the farm and landscape scale, independent of farming system, explain biodiversity differences between organic and conventional farms (Weibull, Ostman, & Granqvist 2003; Clough, Kruess, Kleijn, & Tscharntke 2005). The introduction of organic farming practices would make a difference for biodiversity in simple landscapes (Batáry, Matthiesen, & Tscharntke 2010; Fischer et al. 2011).

Argentina agricultural systems differ from the well-studied European systems (D'Acunto, Semmartin, & Ghersa 2014). They consist of a homogeneous cropland mosaic made of large arable fields and a sparse network of linear habitats such as field borders, roadsides and railways that maintain high plant cover of native flora and introduced weeds throughout the year. The linear habitats frequently receive intentional or unintentional spraying of total herbicides from the neighbouring crops (Ghersa et al. 2002; de la Fuente, Perelman, & Ghersa 2010; Poggio, Chaneton, & Ghersa 2010). In spite of the large structural and functional differences between Argentina and Europe agricultural systems, linear habitats can also attenuate the effects of agricultural intensification by providing suitable habitats for conservation of species biodiversity in modified environments (Simone, Cagnacci, Provensal, & Polop 2010; Gomez, Sommaro, Steinmann, Chiapero, & Priotto 2011).

In the last decades the rate of agricultural expansion in Argentina has increased considerably due to technological changes (e.g., no-tillage techniques, genetically modified crops) and market conditions (e.g., global increase in soybean demand) (Baldi & Paruelo 2008). The farming area dedicated to no-tillage cropping systems increased from 2 Mha in 1992–1993 to 27 Mha in 2010–2011 (Aapresid 2012). During this process, many field borders were removed to enlarge crop areas (Aizen, Garibaldi, & Dondo 2009). In Argentina, the area of organic farmland relative to conventional is small; currently there are 3.6 Mha under organic practices, only 240,000 of them are intended to crop production, whereas the rest is dedicated to pastures for cattle production (SENASA 2013).

The south-east area of the Córdoba province (Juárez Celman, Union and Marcos Juárez Departments) has not been free from agricultural intensification with approximately 1,879,900 ha under crop production, and only 7344 ha of these are under organic management (MAGyA 2013; SENASA 2013). In this region, the small mammal assemblage is mainly represented by the sigmodontine rodents *Calomys musculinus*, *Calomys venustus*, *Calomys laucha*, *Akodon azarae*, *Akodon dolores*, *Oxymycterus rufus* and *Oligoryzomys flavescens* (Simone et al. 2010). In agricultural systems, all species use more stable linear habitats like field borders (Priotto & Polop 1997; Polop & Suárez 2010). Besides *C. musculinus* and *C. laucha* are considered habitat generalists since they occasionally use highly modified habitats such as crop fields (Mills, Ellis, McKee, Maiztegui, & Childs 1992).

Organic farms have higher levels of habitat heterogeneity, and contain greater densities of uncropped habitats compared with conventional farms (Fuller et al. 2005). Organic practices recognize the importance of providing uncropped border habitats for wildlife. The lack of pesticides and inorganic fertilized treatment promote well maintained and more suitable border habitats (Norton et al. 2009) providing important corridors for movement of small mammals (Gelling, Macdonald, & Mathews 2007; Sommaro et al. 2010; Gomez et al. 2011) and nesting and feeding sites for birds (Chamberlain, Fuller,