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Comparing Groups of Brazilian Cattle Farmers with different levels of Intention to use Improved Natural Grassland

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Abstract

This study used the Theory of Planned Behavior (TPB) to analyze the intention of Brazilian farmers to use improved natural grassland. The TPB hypothesizes that the adoption of an innovation is driven by the intention to use it, which in turn is determined by three socio-psychological constructs: attitude, subjective norm, and perceived behavioral control. These constructs are derived from beliefs. The theoretical framework and model were applied to a sample of 214 Brazilian cattle farmers. Based on the socio-psychological constructs that influence intention, two groups of farmers were identified; farmers that were willing and farmers that were unwilling to use improved natural grassland. Results showed that compared to unwilling farmers, willing farmers evaluated the use of improved natural grassland on their farms more favorably (attitude), they felt a greater social pressure upon them to adopt this innovation (social norm), and they reported a higher capability (perceived behavioral control) to use improved natural grassland. Willing and unwilling farmers also differed in their behavioral beliefs concerning the outcomes of using improved natural grassland, their normative beliefs concerning important others, and their control beliefs concerning factors that could facilitate or inhibit the use of improved natural grassland. The two groups did not differ in most of their socioeconomic characteristics, but did differ in their goals and relative risk attitudes.

Keywords: Farmers' intention; Goals; Improved natural grassland; Relative risk attitude; Theory of Planned Behavior.

1. Introduction

Biome *Pampa*, the Brazilian part of the largest biome *Campos*, represents 90% of the natural grasslands in Rio Grande do Sul state. In this region, continuous and extensive grazing of natural grasslands is the main type of cattle production (Beretta et al., 2002; Da Trindade et al., 2012). Biome *Pampa* has been threatened by overgrazing and the expansion of agriculture (mainly cash crops, forestation, etc.), with negative consequences for the environment. These consequences include: landscape fragmentation, loss of biodiversity, biological invasion, soil erosion, water pollution, and land degradation (Carvalho and Batello, 2009). It is important that farmers in the Biome *Pampa*, who graze their cattle on natural grasslands, adopt innovations that increase productivity and reduce damage to the environment. Improved natural grassland[1] is an example of such an innovation that is currently available to these farmers. In the Brazilian context, improved natural grassland is defined as an innovation where one (or both) of the following practices is applied to natural grassland: use of fertilizers and introduction of new forage species (Nabinger et al., 2009). Although previous research has demonstrated that farmers in this region have the intention to adopt improved natural grassland (Borges, et al., 2014b), the actual adoption rate has remained low.

Developing an understanding of the factors influencing farmers' decisions to adopt is crucial to increase the adoption rate of sustainable innovations. Prior research has focused on the role of socio-demographic characteristics and economic considerations in the adoption of sustainable agricultural practices (Fielding et al., 2005). However, the literature on adoption is inconclusive about the determinants of adoption (Borges et al., 2014a; Knowler and Bradshaw, 2007; Prokopy et al., 2008), possibly due to the failure to appropriately account for the role of psychological factors. Indeed, Rehman et al. (2007) indicated that relatively little

[1] The concept of improved natural grassland as used in this paper was checked by two local specialists to assure that farmers in the region would understand it.

research has addressed the role of psychological factors in the adoption decision and Hansson et al. (2012) argued that there is little understanding of the psychological constructs underlying farmers' decisions and behaviors.

One approach to studying the role of psychological factors on human decisions is to use the Theory of Planned Behavior (TPB) (Ajzen, 1991) or its previous version, the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). Recently, these theories have been used to understand farmers' decisions (Beedell and Rehman, 2000; Beedell and Rehman, 1999; Bruijnis et al. 2013; de Lauwere et al., 2012; Garforth et al., 2006; Garforth et. al, 2004; Läpple and Kelley, 2013; Lynne et al., 1995; Yazdanpanah et al., 2014).

The TPB assumes that intention is the best predictor of behavior. Intention is determined by three socio-psychological constructs: attitude, subjective norm, and perceived behavioral control. These constructs, in turn, are determined by beliefs. In general, farmers have a higher intention to adopt an innovation when they evaluate the outcomes of adopting the innovation as favorable (attitude), when they perceive a lot of social pressure to adopt (social norm), and when they feel that they are capable of implementing the practice on their farms (perceived behavioral control) (Borges et al., 2014b). The TRA and TPB were previously used to explain the intention of farmers to use sustainable practices (Borges et al., 2014b; Fielding et al. 2005; Martínez-García et al., 2013). The studies of Borges et al. (2014b) and Martínez-García et al. (2013) correlated the psychological constructs attitude, subjective norm and perceived behavioral control with intention. The TRA does not consider the role of perceived behavioral control. Martínez-García et al. (2013) used the TRA and found a significant and positive correlation between the intention of farmers in Mexico to use improved natural grassland, and their attitude and subjective norm. Borges et al. (2014b) found a positive correlation between the intention of Brazilian cattle farmers to use improved natural grassland, and farmers'

attitude, subjective norm, and perceived behavioral control. The studies of Martinez-Garcia et al (2013) and Borges et al. (2014), however, assumed that farmers are a homogenous group in terms of their intention to use an innovation. That is, Martínez-García et al. (2013) and Borges et al. (2014b) did not investigate differences in the level of intention between farmers and the possible factors that could explain these differences. These factors include socio-psychological factors, socioeconomic characteristics, goals, and perceptions of relative risk attitude. An example of a study that investigated the difference in the level of farmers' intention to adopt a sustainable practice is Fielding et al. (2005). Using the TPB as a framework, they explained the differences between groups of farmers with a strong intention to manage riparian zones versus those with a weak intention. They found that the difference in intention between the groups were associated with differences in their attitudes, subjective norm, and perceived behavioral control. However, Fielding et al. (2005) used an arbitrary cut-off value to divide groups of farmers with different levels of intention. They divided farmers in groups with strong and weak intention to use a sustainable practice by using a median split. That is, farmers who had values for intention questions below the median were classified as farmers with weak intention and the farmers who had values for intention above the median were classified as farmers with strong intention.

The objective of this study was to examine whether differences in the level of farmers' intention to use improved natural grassland can be explained by socio-psychological factors from TPB, socioeconomic characteristics, goals, and relative risk attitude. A better understanding of the factors that influence farmers' intentions to adopt this innovation is useful for policy makers and extension agents, and can be used to develop policy initiatives to stimulate the adoption of improved natural grassland.

This paper contributes methodologically by using cluster analysis to group farmers with different levels of intention. The cluster analysis overcame the shortcoming of using an

arbitrary cut-off value by identifying homogenous groups of farmers, where objects (farmers) in a specific cluster share characteristics, but are very dissimilar to objects (farmers) not belonging to that cluster (Hair et al., 2010; Mooi and Sarstedt, 2011).

2. Methodology

2.1 Theoretical framework: The Theory of Planned Behavior (TPB)

The TPB assumes that human behavior originates from individuals' intentions to perform a specific behavior (Ajzen, 1991). Intention to act is the immediate determinant of behavior (Ajzen, 2005). In the TPB, intention is determined by three central socio-psychological constructs: attitude, subjective norm, and perceived behavioral control. According to Beedell and Rehman (2000) and Wauters et al. (2010), attitude is the degree to which execution of the behavior is positively or negatively evaluated, subjective norm refers to a person's perception of the social pressure upon them to perform or not perform the behavior, and perceived behavioral control is the perceived own capability to successfully perform the behavior. As a general rule, the intention to act is stronger when attitude and subjective norm are more favorable, and when perceived behavioral control is greater (Davis et al., 2002). Therefore we derived the following hypothesis:

H_1: farmers with more favorable attitude and subjective norm, and with greater perceived behavioral control, have a stronger intention to use improved natural grassland.

In the TPB, attitude is derived from behavioral beliefs ($b_i \times e_i$), where b_i is the belief about the likelihood of outcome i^{th} of the behavior, and e_i is the evaluation of the i^{th} outcome (Wauters et al., 2010). The subjective norm is derived from normative beliefs ($n_j \times m_j$), where n_j is the belief about the normative expectations of the j^{th} important other, and m_j is the motivation to comply with the opinion of the j^{th} important other (Wauters et al., 2010). Perceived behavioral control originates from control beliefs ($c_k \times p_k$), where c_k is the belief about the presence of the k^{th} factor that may facilitate or inhibit the performance of the

behavior, and p_k is the perceived power of the k^{th} factor to facilitate or inhibit the behavior (Wauters et al., 2010). Therefore behavioral, normative and control beliefs present a double function in the TPB. First, the sums of behavioral beliefs, normative beliefs, and control beliefs result in indirect measures of attitude, subjective norm, and perceived behavioral control, respectively. The indirect attitude, subjective norm and perceived behavioral control are also expected to influence farmers' intention to use improved natural grassland, as shown in Figure 1. Second, behavioral, normative, and control beliefs are expected to drive direct attitude, subjective norm and perceived behavioral control, respectively, as shown in Figure 1.

Although in the TPB there is not a direct relation between behavioral, normative, and control beliefs with intention, we assumed that the more positive behavioral, normative and control beliefs, the more positive the attitude, subjective norm and perceived behavioral control and therefore the intention. This same direct relation between beliefs and intention was used by Fielding et al. (2005) and Martínez-García et al. (2013). Therefore we derived the following hypotheses:

H_2: farmers with more positive behavioral beliefs have a stronger intention to use improved natural grassland.

H_3: farmers with more positive normative beliefs have a stronger intention to use improved natural grassland.

H_4: farmers with more positive control beliefs have a stronger intention to use improved natural grassland.

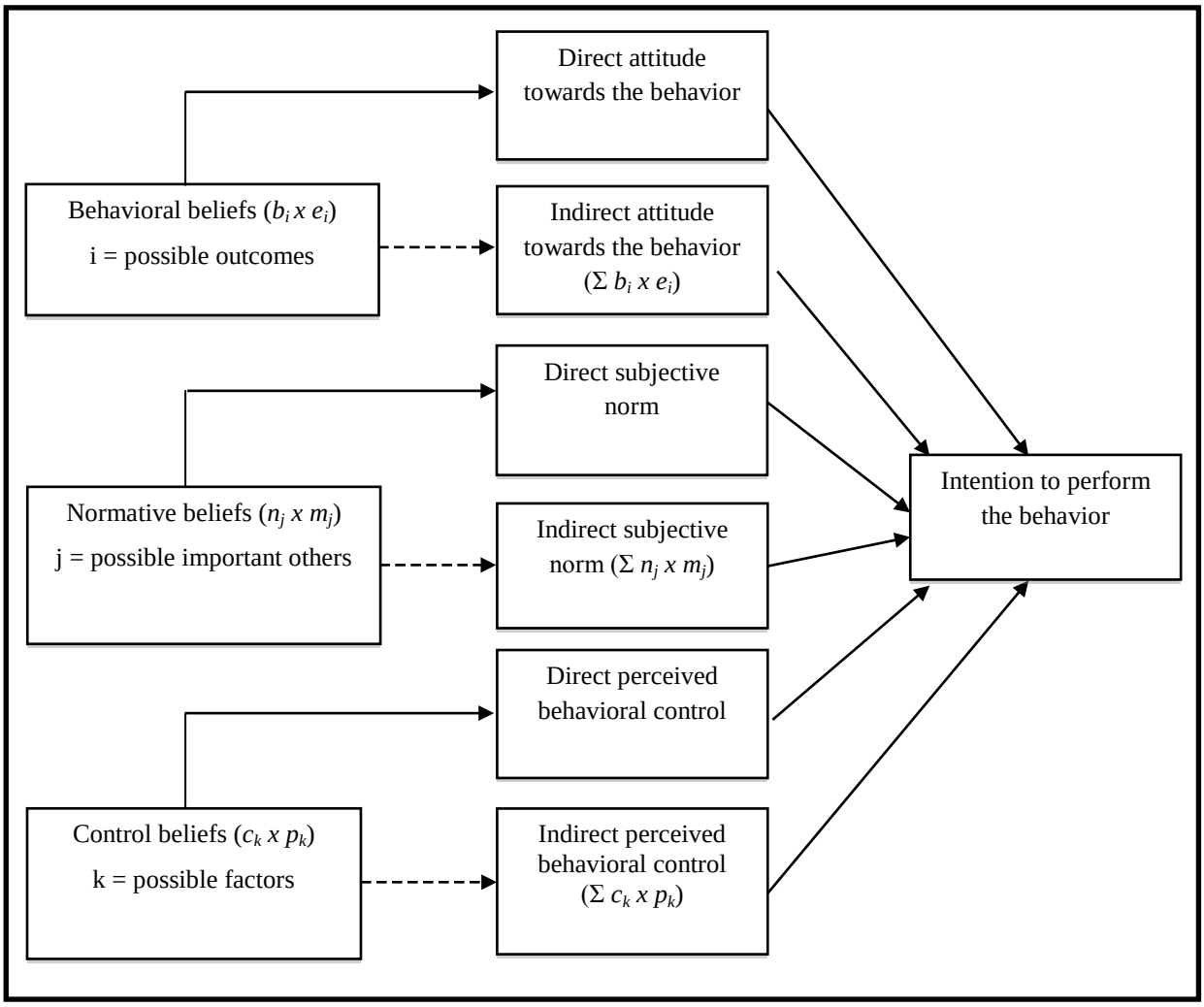

Figure 1: The TPB Model. Continuous arrows represent relationships with direct influence, and discontinuous arrows represent relationships where beliefs generate indirect measures (adapted from Ajzen, 1991; Borges et al., 2014b).

2.2 Farmers' goals, perceptions of relative risk attitude, and socioeconomic characteristics

In addition to socio-psychological factors from TPB, other characteristics and factors may explain differences in the intention to adopt improved natural grassland. Pannel et al. (2006) claimed that farmers adopt an innovation if it helps them to achieve their goals. Although not using the TPB as a framework, previous research has demonstrated that farmers' goals, such as social, status, lifestyle, economic, and environmental goals, play a significant role in explaining adoption decisions (Greiner et al., 2009; Greiner and Gregg, 2011; Maybery et al.,

2005; Pannel et al., 2006; Torkamani, 2005). Using the TPB as a main framework, other authors have addressed the role of goals in farmers' decisions and behavior (Bergevoet et al., 2004; Willock et al., 1999). Bergevoet et al. (2004) found that farmers' goals are important in explaining farmers' entrepreneurial behavior. Likewise, Willock et al. (1999) identified that farmers' objectives mediated the influence of attitude on farmers' business and environmental behaviors. Therefore, there is theoretical support for the inclusion of farmers' goals to explain farmers' intention to use improved natural grassland. As improved natural grassland is an innovation, which can increase production and profits, and reduce damage to the environment, we expect *a priori* that farmers who have economic and environmental goals will have a higher intention to use this innovation. We also expect that farmers with a status goal will have a higher intention to use improved natural grassland. This is because farmers who adopt sustainable innovations such as improved natural grassland are likely to be appreciated more highly by other people. In contrast, we expect that farmers with a lifestyle goal have a lower intention to use improved natural grassland, because farmers with this goal usually farm following traditional practices and rarely adopt innovations.

The role of risk in influencing people's decisions and behaviors has also been investigated by authors who use the TPB as a main framework (Horst et al., 2007; Lobb et al., 2007; Quintal et al., 2010). In the context of adoption of an innovation in agriculture, Marra et al. (2003) claimed that farmers' risk attitude are important in explaining farmers' adoption decision. Risk attitude describes an individual's tendency to take or avoid risks in their decision making (Pannell et al., 2006). The more risk-averse a farmer is, the greater the tendency to adopt an innovation that is perceived to reduce risk or to not adopt an innovation that is perceived to increase risk (Pannell et al., 2006). We expect that the more risk-averse a farmer is, the greater the intention to adopt improved natural grassland, as this innovation is expected to decrease risk at farm level.

In the TPB, socioeconomic characteristics are assumed to influence intention through attitude, subjective norm, perceived behavioral control and beliefs. However, the TPB has been criticized for not including socioeconomic characteristics explicitly (Beedell and Rehman, 2000). To overcome this shortcoming, some authors have explicitly included socioeconomic characteristics to explain farmers' decisions (Bruijnis et al., 2013; Martínez-García et al., 2013; Fielding et al., 2005; Rehman et al., 2007). We followed these authors, including farmers' socioeconomic characteristics as additional variables to explain farmers' intention to use improved natural grassland. Socioeconomic characteristics such as age, education, experience, farm size, income, and number of family members who depend on the farm income, are frequently used as variables that influence farmers' decisions on the adoption of innovations (Borges et al., 2014a). Based on the literature on the adoption of innovations, we expect that the following types of farmers will all have a higher intention to use improved natural grassland: (1) younger farmers, (2) higher educated farmers, (3) farmers with more experience, (4) farmers with larger farms, (5) farmers with a higher share of income coming from agriculture (Prokopy et al., 2008), and (6) farmers with more family members who depend on farm income (Jara-Rojas et al., 2012).

2.3 Measurements

2.3.1 TPB constructs

The statements used to measure the TPB constructs were based on the instructions of Fishbein and Ajzen (2010). The TPB constructs were measured using a seven-point scale, with one being the most negative answer and seven being the most positive answer (for example, very weak to very strong or strongly disagree to strongly agree). A seven-point scale was also used in other TPB studies (Borges et al., 2014b; de Lauwere et al., 2012; Wauters et al., 2010). Intention was measured by calculating the mean scores of four statements. Attitude, subjective norm, and perceived behavioral control can either be elicited directly, or

derived from beliefs (Läpple and Kelley, 2013). In this study we used both measures, as this allowed us to understand the intention of farmers in a more detailed way. The direct attitude of the farmers towards the use of improved natural grassland was measured as the mean of the scores for four statements. Similarly, the direct subjective norm and direct perceived behavioral control were measured as the means of the scores for three and five statements, respectively. The statements used to measure intention and the direct constructs are presented in Table A1 in the Appendix.

For indirect measures, the first step was to identify the possible outcomes from the use of improve natural grassland, possible important others, and the possible factors that facilitate or prevent the adoption of this innovation, that is, *i*, *j*, and *k* as shown in Figure 1. For this purpose, semi-structured interviews with 13 farmers were carried out in the study region, during the period from September 2013 until October 2013 (the questions used in this step of the analysis are presented in Table A2 in the Appendix). The possible outcomes, important others, and possible factors are presented in Table A3 in the Appendix. The results of these semi-structured interviews were then used to elicit the indirect measures.

For each outcome *i*, farmers were asked two questions (see Table A4 in the Appendix), which they answered using the seven-point scale. The two questions elicited b_i and e_i for each outcome *i*, as shown in Figure 1. For each outcome *i*, the product of b_i and e_i was calculated, resulting in eight behavioral beliefs ($b_i \times e_i$). The indirect attitude was calculated as the sum of these behavioral beliefs.

For each important other *j*, farmers were asked two questions (see Table A4 in the Appendix), which they answered using the seven-point scale. The two questions elicited n_j and m_j for each important other *j*, as shown in Figure 1. For each important other *j*, the product of n_j and m_j was calculated, resulting in seven normative beliefs ($n_j \times m_j$). The indirect subjective norm was calculated as the sum of these normative beliefs.

For each factor *k*, farmers were asked two questions (see Table A4 in the Appendix), which they answered using the seven-point scale. The two questions elicited c_k and p_k for each factor *k*, as shown in Figure 1. For each factor *k*, the product of c_k and p_k was calculated, resulting in seven control beliefs ($c_k \times p_k$). The indirect perceived behavioral control was calculated as the sum of these control beliefs.

The reliability of the scales measuring the TBP constructs was investigated using Cronbach's α coefficient. The Cronbach's α coefficients were: intention 0.92; direct attitude 0.88; direct subjective norm 0.81; direct perceived behavioral control 0.82; indirect attitude 0.80; indirect subjective norm 0.86; indirect perceived behavioral control 0.80.

2.3.2 Measurements of farmers goals

Farmers were asked to rate the importance of eighteen items/goals using a seven-point scale, with one being 'not at all important' and seven being 'extremely important'. The list of goals and scale was based on Greiner et al. (2009). The eighteen goals used in the questionnaire are shown in Table A5 in the Appendix.

Factor analysis was used to reduce the number of items used to represent farmers' goals. Principal component was used as the extraction method. The criterion to define the number of factors was an eigenvalue greater than one (Hair et al., 2010). Two items with communalities less than or equal to 0.4 were excluded from the analysis. Items were included in a factor when they presented factor loadings greater than 0.5. We excluded one item that loaded higher than 0.5 in multiple factors. Factors scores were generated for subsequent analysis.

2.3.3 Measurements of farmers relative risk attitude

There are different ways of measuring farmers' risk attitude (Bard and Barry, 2000). Given the focus of the questionnaire on psychometric scales, farmers were asked to rate their level of agreement with two statements about their perceptions of relative risk attitude: "In general, I am willing to take more risks than other farmers" and "Regarding the adoption of innovations

on my farm, I am willing to take more risks than other farmers". Both statements were measured using a seven-point scale, with one being the most negative answer and seven being the most positive one (strongly disagree to strongly agree). Similar statements were used by Meuwissen et al. (2001) and Greiner et al. (2009). The reliability of the scale measuring the relative risk attitude was investigated using Cronbach's α coefficient. The Cronbach's α coefficient was 0.84.

2.4 Sampling and survey

The population of farmers investigated in this study were small cattle farmers in the micro-region of *Campanha Central,* in Rio Grande do Sul state, Brazil. Four municipalities belong to this micro-region: Rosário do Sul, Santa Margarida do Sul, São Gabriel, and Santana do Livramento.

A list of small cattle farmers for each municipality was obtained from the governmental extension agency, which has a record of the majority of small cattle farmers in the micro-region. Using the farmers in the list as the target population, a random sample of 214 farmers was selected, representing 20% of the small cattle farmers in each municipality.

Before applying the survey, a pretest was carried out with ten farmers and two specialists, to ensure that the questions could be clearly understood. The final version of the survey consisted of five groups of questions: socioeconomic characteristics, questions based on the TPB, farmers' goals, relative risk attitude, and personality traits (the latter group is not further addressed in this paper). All the questions were translated from English to Portuguese by the first author, who is fluent in English and native Portuguese speaker.

The 214 farmers were contacted and invited to participate in the survey, either by telephone or during a visit to their farm. If the farmers were not found, or if they were unwilling to participate, then other farmers were contacted. Upon acceptance, farmers were invited to fill out the survey face-to-face with one interviewer. The first author was one of the

interviewers and he also trained four local interviewers to help in the data collection. The interviewer was necessary to increase the response rate by providing instructions and guidance to farmers. The data collection took place from December 2013 until February 2014.

2.5 Data analysis

Given the assumption that farmers would differ in their intention to use improved natural grassland, we used direct attitude, direct subjective norm, and direct perceived behavioral control as grouping variables (see Table 1). If this assumption was correct, farmers with different values for these direct measures would also have different levels of intention, which would allow us to test our hypotheses. Therefore, a two-stage cluster approach was used to group farmers according to the socio-psychological constructs that influence their intention to use improved natural grassland. First, an agglomerative procedure (Ward method) using Euclidean distance squared as the similarity measure was applied. Second, a non-hierarchical cluster procedure (K-means) was used. To define the number of clusters, we used the Calinski /Harabasz and Duda/Hart indices as stopping rules (Hair et al., 2010; Mooi and Sarstedt, 2011).

Differences between groups (clusters) were tested using a Mann-Whitney test for ordinal variables and an independent sample t-test for continuous variables.

Table 1 – Descriptive statistics for the TPB constructs used as clustering variables

TPB constructs	Mean	Median
Direct attitude	6.20	6.50
Direct subjective norm	4.96	5.33
Direct perceived behavioral control	4.76	5.00

354 ## 3. Results and Discussion

355 *3.1 Groups of farmers and the differences between them based on TPB variables*

356 Two clusters of farmers were identified; we termed these clusters as farmers who were
357 willing (n=141) or unwilling (n=73) to use improved natural grassland. Having identified
358 these groups, we examined whether differences in the level of farmers' intention to use
359 improved natural grassland could be explained by socio-psychological factors.

360 When performing a cluster analysis it is important to test whether the identified groups
361 differ in some criterion variables (Hair et al., 2010; Mooi and Sarstedt, 2011). That is, it was
362 important to test if the groups would differ in some theoretical sense. Based on the TPB, we
363 assumed that different values for the direct constructs would result in different levels of
364 intention to perform a behavior. The results presented in Table 2 confirm that the two groups
365 differed in their direct measures, with willing farmers having a higher score for direct attitude,
366 direct subjective norm, and direct perceived behavioral control than unwilling farmers. In
367 addition, willing farmers had significantly higher values for intention and indirect attitude,
368 indirect subjective norm, and indirect perceived behavioral control. Therefore we did not
369 reject H_1: farmers with more favorable attitude and subjective norm, and with greater
370 perceived behavioral control, have a stronger intention to use improved natural grassland.
371 These results suggest that, based on socio-psychological factors, there are two groups of
372 farmers with different levels of intentions; willing farmers with a high level of intention and
373 unwilling farmers with a low level of intention. A correlation matrix with intention, direct and
374 indirect measures is presented in Table A6 in the Appendix.

375 Compared to unwilling ones, willing farmers evaluated the use of improved natural
376 grassland on their farms more favorably (direct attitude), they perceived a greater social
377 pressure upon them to adopt this innovation (direct subjective norm), and they reported a
378 higher capability (direct perceived behavioral control) to use improved natural grassland.

Although the unwilling group of farmers had lower scores for all the constructs, results in Table 2 show that unwilling farmers had a positive attitude towards improved natural grassland, as this group also had a high score for direct attitude. In contrast, the scores for both the direct subjective norm and direct perceived behavioral control were low, indicating that unwilling farmers did not perceive lot of social pressure to adopt and that they perceived a low capability to use improved natural grassland.

Table 2 – Medians for the direct measures and indirect measures of TPB constructs for the two groups of farmers

TPB constructs[a]	Willing	Unwilling
Direct attitude	6.75	5.75
Direct subjective norm	5.66	3.33
Direct perceived behavioral control	5.60	3.60
Intention	5.50	3.75
Indirect attitude	252	192
Indirect subjective norm	203	110
Indirect perceived behavioral control	131	112

[a)] A significant difference ($P<0.05$) between the groups was found for all TBP constructs using the Mann-Whitney test.

Results in Table 3 show that willing and unwilling farmers differed in their behavioral beliefs. The two groups differed in their perceptions about the likelihood of the outcomes (*b*) and the evaluation of these outcomes (*e*). The only outcome where the perceived likelihood did not differ between the two groups of farmers was 'have to buy machines'. Compared to the unwilling group, willing farmers perceived it as more likely and more important that using improved natural grassland would result in the six positive outcomes. Although the scores

were higher for willing farmers, unwilling farmers also had high scores for the six positive outcomes, as all the medians were above or equal to five. It is often suggested that extension programs can increase the intention to adopt an innovation by emphasizing and reinforcing the positive outcomes to farmers (Borges et al., 2014b; Garforth et al., 2006; Martínez-García et al., 2013). This strategy may be less appropriate for farmers in this region, as the results in Table 3 show that they already have positive opinions about the outcomes of using improved natural grassland. For the two negative outcomes, 'have to buy machines' and 'have to hire employees', the interpretation is different, as these outcomes were recoded. Willing farmers perceived it as less likely that using improved natural grassland would result in 'have to hire employees' than unwilling farmers. Additionally, willing farmers perceived it as less important that using improved natural grassland would result in 'have to buy machines' and 'have to hire employees'. Given these results, we did not reject H_2: farmers with more positive behavioral beliefs have a stronger intention to use improved natural grassland. Our results are partially consistent with the literature on the adoption of sustainable innovations. Fielding et al. (2005) found that groups of farmers with a strong or weak intention to manage riparian zones in Australia significantly differed in their behavioral beliefs about the positive outcomes, but not in their beliefs about the negative outcomes.

Table 3 – Medians of the behavioral beliefs for the two groups of farmers

Outcomes	Likelihood of outcome (*b*)		Evaluation of outcome (*e*)	
	Willing	Unwilling	Willing	Unwilling
Increase number of animals per hectare[a]	6	5	7	5
Have pasture available throughout the year[a]	6	5	6	5
Increase pasture resistance[a]	6	5	6	5
Decrease feeding costs[a]	5	5	6	5
Prevent soil erosion[a]	6	5	7	5
Increase cattle weight gains[a]	7	5	7	6
Have to buy machines[bc]	4	3	5	3
Have to hire employees[ac]	4	3	5	3

[a)] Significant difference between groups for both *b* and *e* at P<0.05 using the Mann-Whitney test.

[b)] Significant difference between groups for *e* but not for *b* at P<0.05 using the Mann-Whitney test.

[c)] Variables were recoded as these were presented as a negative outcome in the questionnaire.

Results in Table 4 show that willing and unwilling farmers differed in their normative beliefs. The two groups differed in their normative expectations of important others (*n*) and in their motivation to comply with the opinion of these important others (*m*). Compared to unwilling farmers, the willing group perceived it as more likely that the important others would support them in their decision to use improved natural grassland and they also indicated a higher motivation to comply with the opinion of these important others. Therefore we did not reject H_3: farmers with more positive normative beliefs have a stronger intention to

use improved natural grassland. The results in Table 4 show that, in general, willing farmers perceived it as likely that the seven important others would support them in their decision to use improved natural grassland, as the median scores for this group were all greater or equal to five. Both groups of farmers thought that extension agents and workers in the place where inputs are purchased would be most likely to support the decision to use improved natural grassland, while willing farmers also thought that family would be most likely to support the decision. Both groups indicated a higher motivation to comply (*m* in Table 4) with the opinion of family compared to other important others. Willing farmers were motivated to comply with the opinion of different groups of people, as the median scores were greater or equal to five for all the important others. Compared to willing farmers, unwilling farmers were less motivated to comply with the opinion of others, especially with the opinions of government, friends, neighbor farmers, and workers in the place where they buy inputs. Differences in the degree to which farmers are motivated to comply with important others can suggest channels which are likely to have a greater impact on the intention of farmers (Garforth et al., 2004). In this study, family is the best channel to disseminate information about improved natural grassland, as both groups presented the highest median score for this important other. Extension agents are also an appropriate channel to disseminate information about improved natural grassland, as this important other had the second highest median score for both groups, together with cattle traders. Our results are consistent with those of Fielding et al. (2005), who found that farmers with different levels of intention differed in their normative beliefs.

459 **Table 4 – Medians of the normative beliefs for the two groups of farmers**

Important others	Normative expectations of important other (*n*)		Motivation to comply with important other (*m*)	
	Willing	Unwilling	Willing	Unwilling
Family[a]	6	4	6	5
Extension agents[a]	6	5	5	4
Government[a]	5	4	5	3
Friends[a]	5	4	5	3
Neighbor farmers[a]	5	4	5	3
Workers in the place where you buy your inputs[a]	6	5	5	3
Cattle traders[a]	6	5	5	4

460 [a)] Significant difference between groups for both *n* and *m* at P<0.05 using the Mann-Whitney
461 test.

462 Results in Table 5 show that willing and unwilling farmers differed in their control beliefs.
463 The two groups differed in their perception of the likelihood that each factor would be present
464 to facilitate or inhibit their adoption of improved natural grassland (*c*), and in the perceived
465 power of each factor to facilitate or inhibit their adoption (*p*). Compared to the unwilling
466 group, willing farmers perceived a higher likelihood of the four facilitating factors being
467 present and they also perceived that the power of these factors to facilitate adoption was
468 greater. The two groups differed in their perceptions about which was the stronger facilitating
469 factor; for willing farmers this was 'availability of qualified technical assistance' and for
470 unwilling farmers, 'availability of governmental credit'. For the three factors that would
471 inhibit the use of improved natural grassland, 'lack of information about the practice', 'lack of

money to invest', and 'difficulty to deal with weeds', the interpretation is different, as these factors were recoded. Compared to unwilling farmers, willing farmers perceived it as less likely that these three factors would be present to inhibit their use of improved natural grassland and the perceived power of these three factors to inhibit adoption was lower. Given these results, we did not reject H_4: farmers with more positive control beliefs have a stronger intention to use improved natural grassland. In contrast to this research, Fielding et al. (2005) did not consider the role of perceived power. However, they found that farmers with different levels of intention differed in their perception of the likelihood of factors being present that would inhibit the performance of the behavior (equivalent to *c* in Table 5).

Table 5 – Medians of the control beliefs for the two groups of farmers

Control factors	Perceived likelihood that factor is present (*c*)		Perceived power of factor (*p*)	
	Willing	Unwilling	Willing	Unwilling
Lack of information about the practice[ab]	6	4	5	4
Lack of money to invest[ab]	5	4	6	5
Availability of governmental credit[a]	5	4	5	5
Sufficient skills[a]	5	4	5	4
Sufficient knowledge[a]	5	4	5	4
Difficulty to deal with weeds[ab]	5	4	5	5
Availability of qualified technical assistance[a]	6	4	6	4

[a)] Significant difference between groups in *c* and *p* at P<0.05 using the Mann-Whitney test.

[b)] Variables recoded as were negative presented in the questionnaire.

3.2 Groups of farmers and the differences between them based on their socioeconomic characteristics, goals, and perceptions of relative risk attitude

The socioeconomic characteristics of willing and unwilling farmers were similar. Results in Table 6 show that a significant difference between the two groups was found for only two variables, 'experience' and 'number of family members who depend on farm income'. Contrary to our prior expectation, unwilling farmers had more farming experience than willing farmers. Confirming our prior expectation, willing farmers had more family members who depended on farm income than unwilling farmers. Our results are partially consistent with the literature. Martinez Garcia et al. (2013) found no significant correlation between the intention of farmers in Mexico to use improved natural grassland and the following socioeconomic characteristics: age, education, experience, and family members. However, they found a positive correlation between intention and farm variables, such as herd size and farm size (Martínez-García et al., 2013). Fielding et al. (2005) found no differences in socioeconomic characteristics between groups of farmers with strong or weak intentions to manage riparian zones in Australia. Finally, Bruijnis et al. (2013) also found no differences in socioeconomic characteristics between farmers with different levels of intention to improve the foot health of dairy cows in the Netherlands.

The list of goals was reduced to a three-factor model using factor analysis (see Table A5 in the Appendix), with each factor representing a combination of individual goals. We used the following terms for these three factors: economic/social goal, status goal, and lifestyle goal. Farmers who tended to have high ratings for the economic/social goal were driven by financial and family concerns, combined with a sense of obligation to others regarding the quality of their products and environmental issues. Farmers who tended to have a high score for the status goal were driven by a desire to be appreciated and recognized by society. Farmers who tended to have high ratings for the lifestyle goal were driven by a desire for

freedom, combined with a respect for family traditions. The list of goals that loaded in each factor is provided in Table A5 in the Appendix. Results in Table 6 show that willing and unwilling farmers differed for two of the three goals. Confirming our prior expectation, willing farmers tended to score higher than unwilling farmers for the economic/social and status goals. No differences were found between the two groups for the lifestyle goal. A possible explanation for this result is given by Pannel et al. (2006). They claimed that personal goals are one of the most important drivers for farmers' decisions about the adoption of innovations, and if farmers do not perceive that adoption will help them achieve their goals, then adoption will certainly not occur. Therefore willing farmers with a higher intention, who had higher 'economic/social' and 'status' goals in this study, could be intrinsically motivated to use improved natural grassland because they perceive that this innovation will help them to achieve these goals.

Willing and unwilling farmers differed in their relative risk attitude. Results in Table 6 show that the median relative risk attitude was lower for unwilling farmers; unwilling farmers perceived themselves as more risk-averse than willing farmers. This result contradicts our prior expectation. We expected improved natural grassland to be an innovation that would decrease risks at farm level, and therefore that the risk-averse farmers would be more willing to adopt this innovation. There are two possible explanations for this result. Firstly, risk-averse farmers may have perceived that the use of improved natural grassland would not decrease the risks at farm level. Secondly, the self-reported measure of relative risk attitude used in this study may not have been a sufficient risk descriptor in the absence of more quantifiable variables (Greiner et al., 2009).

Table 6 – Means and medians of the socioeconomic characteristics, goals, and perceptions of relative risk attitude for the two groups of farmers

Variables	Willing (Mean[a] or Median[b])	Unwilling (Mean[a] or Median[b])
Socioeconomic characteristics		
Age (years)[a]	56	56
Education[b] (levels[c])	2	2
Experience (years) [ad]	29	34
Farm size (number of hectares) [a]	73	83
Percentage of farm income from agriculture[a]	81	81
Number of family members who depend on farm income[bd]	3	2
Goals		
Economic/social[ad] (factor scores)	0.20	-0.39
Status[ad] (factor scores)	0.19	-0.36
Lifestyle[a] (factor scores)	0.02	-0.05
Risk attitude		
Relative risk attitude[bd]	5	4

[a)] Continuous variables (independent sample t-Test).

[b)] Ordinal variables (Mann-Whitney test).

[c)] Measured as: 1=illiterate, 2=incomplete elementary school, 3=complete elementary school, 4=incomplete high school, 5=complete high school, 6=incomplete bachelor degree, 7=complete bachelor degree, 8=post-graduate studies.

[d)] Significant difference between groups at $P<0.05$.

4. Conclusions

In this paper, socio-psychological factors from the TPB were used to explain differences in the level of farmers' intention to use improved natural grassland. In addition, this study explored differences in socioeconomic characteristics, goals, and relative risk attitude between groups of farmers with different levels of intention.

Results showed that cluster analysis is a suitable technique to group farmers with different levels of intention. Indeed, willing and unwilling farmers showed consistent differences in the psychological factors that explain their level of intention. As hypothesized by the TPB, willing and unwilling farmers differed in line with our *priori* expectations in terms of their direct and indirect measures of attitude, subjective norm, and perceived behavioral control, with the willing group presenting higher values for these constructs, compared to the unwilling group. Results also suggested that the differences in the level of intention are explained mainly by subjective norm and perceived behavioral control, as willing and unwilling farmers evaluated positively (attitude) the use of improved natural. This result can be explained by the behavioral beliefs findings. According to the TPB, the more positive people perceive the outcomes of performing a behavior, the more favorable is their attitude towards the behavior. Therefore, as willing and unwilling farmers already perceived the positive outcomes (benefits) of using improved natural grassland, farmers also have a positive attitude to use this innovation. Although it is not possible to confirm from our data, a reason that could explain why farmers already perceived the benefits of using improved natural grassland is that this innovation has been promoted to farmers by extension agents in the region. A strategy to promote the use of improved natural grassland by strengthening the benefits of this innovation is expected to be less successful for farmers located in Biome *Pampa*, as most farmers already perceived the benefits of using improved natural grassland and have a positive attitude to the use of this innovation.

Willing and unwilling farmers also differed in terms of their normative beliefs concerning important others, and their control beliefs concerning factors that could facilitate or inhibit the use of improved natural grassland. farmers. Results for the normative beliefs suggest that farmers' intention to use improved natural grassland could be increased by using extension agents to disseminate information about the practice to farmers and their families. We expect that this strategy would lead to a direct and indirect increase in farmers' intention to use improved natural grassland. The direct impact occurs because farmers in both groups are motivated to comply with the opinion of extension agents. The indirect impact occurs because if family members have more information about improved natural grassland, then they are then more likely to support farmers in their decision to adopt. Finally, our results for the control beliefs suggest the that intention of both groups could be increased by the governmental provision of qualified technical assistance and credit, as these factors were perceived by farmers to be the factors which most facilitated the use of improved natural grassland.

Farmers with different levels of intention to use improved natural grassland did not differ in most of their socioeconomic characteristics. However, they did differ in their goals and relative risk attitude. Willing farmers had higher economic/social and status goals, and seem to be intrinsically motivated to use improved natural grassland. Finally, unwilling farmers had a higher self-reported risk aversion than willing farmers. Therefore, farmers' goals and their relative risk attitudes could be added to future studies that use the TPB to test whether these findings are consistent.

A limitation of this study is that indirect and interaction effects were not tested. Indeed, we restricted our analysis to the direct impact of socioeconomic characteristics, goals and relative risk attitude on farmers' intention. However, it is not possible to guarantee that these variables do not have an indirect impact on intention, trough attitude, subjective norm, perceived

behavioral control and beliefs. In addition, it is not possible to assure that socioeconomic characteristics, goals and relative risk attitude do not present an interaction effect, influencing more than one TPB constructs and perhaps even in different directions.

Another potential limitation of this study concerns the use of intention to adopt instead of real adoption behavior. As farmers' intention to use improved natural grassland were measured for next year, the ideal approach would be to apply another survey one year later among the same farmers to analyze whether farmers who showed intention to adopt the innovation do really use it on their farms. On the other hand, measuring farmers' intention and the factors that influence their intention, could allow policy makers and extension agents to develop strategies to influence farmers to translate their intentions to use improved natural grassland into adoption.

Because our research focused on Biome *Pampa* in Rio Grande do Sul, Brazil, the implications for policy makers and extension agents do not necessarily apply to other regions. However, the approach used in our study can be applied to different regions to develop specific strategies to increase the adoption and use of sustainable innovations in agriculture.

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730 **Appendix**

731 **Table A1 – Statements used to measure intention, direct attitude, direct subjective norm, and direct behavioral control**

Statements	Scale (1 – 7)
Intention	
1) I intend to use improved natural grassland in at least part of my farm within the next year	definitely not-definitely yes
2) How strong is your intention to use improved natural grassland in at least part of your farm within the next year	very weak-very strong
3) How likely is it that you will use improved natural grassland in at least part of your farm within the next year	unlikely-likely
4) I plan to use improved natural grassland in at least part of my farm within the next year (I know where and how I will do this).	strongly disagree- strongly agree
Direct attitude	
1) Using improved natural grassland in at least part of my farm within the next year is:	bad-good
2) Using improved natural grassland in at least part of my farm within the next year is:	disadvantageous-advantageous
3) Using improved natural grassland in at least part of my farm within the next year is:	unnecessary-necessary
4) Using improved natural grassland in at least part of my farm within the next year is:	unimportant-important

Direct subjective norm	
1) Most people who are important to me think that I should use improved natural grassland in at least part of my farm within the next year.	strongly disagree-strongly agree
2) Most people whose opinion I value would approve that I use improved natural grassland in at least part of my farm within the next year.	improbable-probable
3) Most farmers like me will use improved natural grassland in at least part of his farm within the next year.	unlikely-likely
Direct perceived behavioral control	
1) If I want to use improved natural grassland in at least part of my farm within the next year, I have sufficient knowledge.	definitely not- definitely yes
2) If I want to use improved natural grassland in at least part of my farm within the next year, I have sufficient resources.	definitely not- definitely yes
3) How confident are you that you could overcome barriers that prevent you to use improved natural grassland in at least part of your farm within the next year?	completely unconfident-completely confident
4) Using improved natural grassland in at least part of my farm within the next year is completely up to me.	disagree-agree
5) For me to use improved natural grassland in at least part of my farm within the next year is under my	not at all-completely

control.

740 **Table A2 – Open questions posed to respondents during the semi-structured interviews**

741 **to identify outcomes (*i*), important others (*j*), and factors (*k*)**

TPB aspect	Open question
Outcomes (*i*)	What do you see as the advantages and disadvantages of using improved natural grassland in at least part of your farm for the next year?
Important others (*j*)	Please list the individuals or groups who would approve/disapprove or think you should/should not use improved natural grassland in at least part of your farm for the next year
Factors (*k*)	Please list any factors or circumstances that would make it easier/difficult or enable/prevent you to use improved natural grassland in at least part of your farm for the next year

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Table A3 – Outcomes (i), important others (j), and factors (k) identified in the semi-structured interviews

Outcomes (*i*)	Important others (*j*)	Factors (*k*)
Increase number of animals per hectare	Family	Lack of information about the practice
Have pasture available throughout the year	Extension agents	Lack of money to invest
Increase pasture resistance	Government	Availability of governmental credit
Decrease feeding costs	Friends	Sufficient skills
Prevent soil erosion	Neighbor farmers	Sufficient knowledge
Increase cattle weight gains	Workers in the place where you buy your inputs	Difficulty to deal with weeds
Have to buy machines	Cattle traders	Availability of qualified technical assistance
Have to hire employees		

Table A4 – Questions used to elicited behavioral, normative, and control beliefs

Beliefs	Questions	
	Likelihood of each outcome (b)	Evaluation of each outcome (e)
Behavioral beliefs	How likely is it that, if you use improved natural grassland in at least part of your farm within the next year, you would [*outcome i*], (unlikely – likely)	How important is it that, if you use improved natural grassland in at least part of your farm within the next year, you would [*outcome i*], (unimportant – important)
	Normative expectations of each important other (n)	Motivation to comply with each important other (m)
Normative beliefs	How likely is it that the individual/group [*important other j*] would think that you should use improved natural grassland in at least part of your farm for the next year, (unlikely – likely)	How much do you care what the individual/group [*important other j*] think you should do on your farm, for example to use improved natural grassland in at least part of your farm within the next year, (not at all – very much)
	Likelihood of the presence of each factor (c)	Perceived power of each factor (p)
Control beliefs	How likely is it that [*factor k*] would be present to facilitate, or to prevent you to use improved natural grassland in at least part of your farm within the next year, (unlikely – likely)	How strongly would [*factor k*] facilitate or prevent you to use improved natural grassland in at least part of your farm within the next year? (very weak – very strong)

Table A5 – Factor loading matrix for the goals, with factor loadings greater than 0.5 in bold

Item	Factor 1[a]	Factor 2[b]	Factor 3[c]
Belong to rural community	0.146	**0.764**	0.278
Be recognized as a top farmer	0.099	**0.813**	0.193
Be appreciated by society	0.161	**0.833**	-0.033
Avoid low/negative income	**0.556**	0.488	0.068
Guarantee land ownership/Maintain land ownership	**0.617**	0.368	0.083
Leave the business for the next generation	**0.718**	0.188	0.122
Improve the family and personal standard of living	**0.811**	0.151	0.130
Put children through school/university	**0.803**	0.138	0.011
Realize an income as high as possible	**0.717**	-0.088	0.146
Expand the business	**0.733**	0.033	0.107
Work in the countryside with animals and nature	**0.612**	0.267	0.338
Be your own boss	0.078	0.176	**0.893**
Continue family tradition	0.253	0.098	**0.835**
Conserve diversity of animals/plants and ecosystems on farm	**0.565**	0.276	0.428
Produce high quality food	**0.766**	0.255	0.182
Variance explained (%)	33.11	17.68	13.45
Invest in the farm without borrowing money[d]			
Farm to make money[d]			
Help to feed the world[d]			

[a)] Economic/social goal.

[b)] Status goal.

[c)] Lifestyle goal.

[d)] Items excluded either because of communalities ≤ 0.4 or because an item loaded higher than 0.5 in multiple factors.

Table A6 – Correlation[a] matrix with intention (INT), direct attitude (dATT), direct subjective norm (dSN), direct perceived behavioral control (dPBC), indirect attitude (iATT), indirect subjective norm (iSN) and indirect perceived behavioral control (iPBC)

	INT	dATT	dSN	dPBC	iATT	iSN	iPBC
INT	1						
dATT	0.47	1					
dSN	0.61	0.46	1				
dPBC	0.52	0.42	0.56	1			
iATT	0.56	0.63	0.46	0.40	1		
iSN	0.44	0.33	0.63	0.43	0.31	1	
iPBC	0.27	0.14	0.26	0.32	0.06	0.19	1

[a] spearman rank coefficient. All correlations were significant at $P<0.05$, except the correlation between iAtt and iPBC.