



Comparing groups of Brazilian cattle farmers with different levels of intention
to use improved natural grassland

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

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31 **Abstract**

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

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

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56 **1. Introduction**

57 Biome *Pampa*, the Brazilian part of the largest biome *Campos*, represents 90% of the
58 natural grasslands in Rio Grande do Sul state. In this region, continuous and extensive grazing
59 of natural grasslands is the main type of cattle production (Beretta et al., 2002; Da Trindade et
60 al., 2012). Biome *Pampa* has been threatened by overgrazing and the expansion of agriculture
61 (mainly cash crops, forestation, etc.), with negative consequences for the environment. These
62 consequences include: landscape fragmentation, loss of biodiversity, biological invasion, soil
63 erosion, water pollution, and land degradation (Carvalho and Batello, 2009). It is important
64 that farmers in the Biome *Pampa*, who graze their cattle on natural grasslands, adopt
65 innovations that increase productivity and reduce damage to the environment. Improved
66 natural grassland¹ is an example of such an innovation that is currently available to these
67 farmers. In the Brazilian context, improved natural grassland is defined as an innovation
68 where one (or both) of the following practices is applied to natural grassland: use of fertilizers
69 and introduction of new forage species (Nabinger et al., 2009). Although previous research
70 has demonstrated that farmers in this region have the intention to adopt improved natural
71 grassland (Borges, et al., 2014b), the actual adoption rate has remained low.

72 Developing an understanding of the factors influencing farmers' decisions to adopt is
73 crucial to increase the adoption rate of sustainable innovations. Prior research has focused on
74 the role of socio-demographic characteristics and economic considerations in the adoption of
75 sustainable agricultural practices (Fielding et al., 2005). However, the literature on adoption is
76 inconclusive about the determinants of adoption (Borges et al., 2014a; Knowler and
77 Bradshaw, 2007; Prokopy et al., 2008), possibly due to the failure to appropriately account for
78 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.

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

82 One approach to studying the role of psychological factors on human decisions is to use
83 the Theory of Planned Behavior (TPB) (Ajzen, 1991) or its previous version, the Theory of
84 Reasoned Action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). Recently,
85 these theories have been used to understand farmers' decisions (Beedell and Rehman, 2000;
86 Beedell and Rehman, 1999; Bruijnjs et al. 2013; de Lauwere et al., 2012; Garforth et al.,
87 2006; Garforth et. al, 2004; Läßple and Kelley, 2013; Lynne et al., 1995; Yazdanpanah et al.,
88 2014).

89 The TPB assumes that intention is the best predictor of behavior. Intention is determined
90 by three socio-psychological constructs: attitude, subjective norm, and perceived behavioral
91 control. These constructs, in turn, are determined by beliefs. In general, farmers have a higher
92 intention to adopt an innovation when they evaluate the outcomes of adopting the innovation
93 as favorable (attitude), when they perceive a lot of social pressure to adopt (social norm), and
94 when they feel that they are capable of implementing the practice on their farms (perceived
95 behavioral control) (Borges et al., 2014b). The TRA and TPB were previously used to explain
96 the intention of farmers to use sustainable practices (Borges et al., 2014b; Fielding et al. 2005;
97 Martínez-García et al., 2013). The studies of Borges et al. (2014b) and Martínez-García et al.
98 (2013) correlated the psychological constructs attitude, subjective norm and perceived
99 behavioral control with intention. The TRA does not consider the role of perceived behavioral
100 control. Martínez-García et al. (2013) used the TRA and found a significant and positive
101 correlation between the intention of farmers in Mexico to use improved natural grassland, and
102 their attitude and subjective norm. Borges et al. (2014b) found a positive correlation between
103 the intention of Brazilian cattle farmers to use improved natural grassland, and farmers'

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

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

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

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

132 **2. Methodology**

133 *2.1 Theoretical framework: The Theory of Planned Behavior (TPB)*

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

145 *H₁: farmers with more favorable attitude and subjective norm, and with greater perceived*
146 *behavioral control, have a stronger intention to use improved natural grassland.*

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

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

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

168 *H₂: farmers with more positive behavioral beliefs have a stronger intention to use improved*
169 *natural grassland.*

170 *H₃: farmers with more positive normative beliefs have a stronger intention to use improved*
171 *natural grassland.*

172 *H₄: farmers with more positive control beliefs have a stronger intention to use improved*
173 *natural grassland.*

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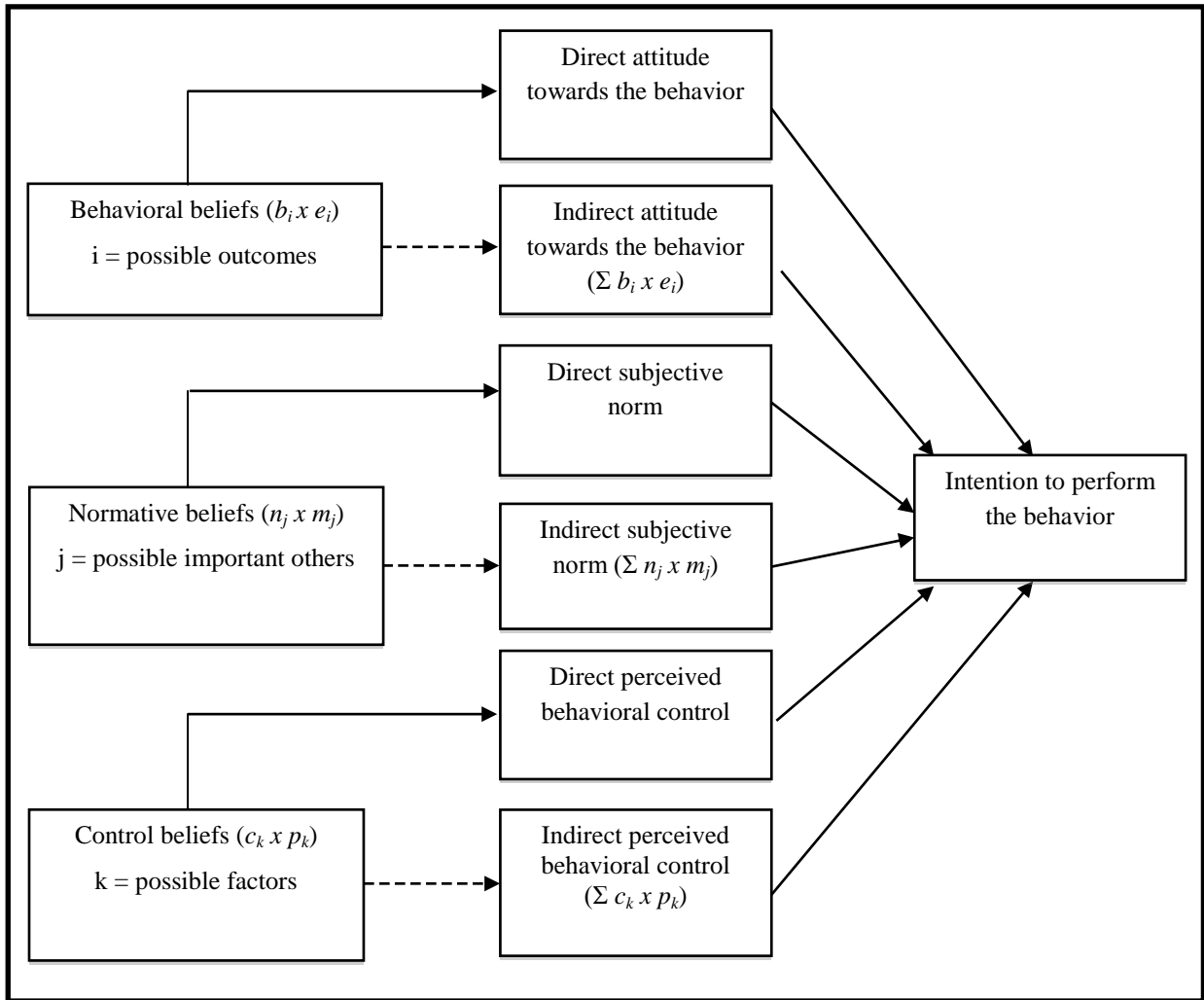
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197 Figure 1: The TPB Model. Continuous arrows represent relationships with direct influence, and discontinuous
198 arrows represent relationships where beliefs generate indirect measures (adapted from Ajzen, 1991; Borges et al.,
199 2014b).

200

201 2.2 Farmers' goals, perceptions of relative risk attitude, and socioeconomic characteristics

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

208 2005; Pannell et al., 2006; Torkamani, 2005). Using the TPB as a main framework, other
209 authors have addressed the role of goals in farmers' decisions and behavior (Bergevoet et al.,
210 2004; Willock et al., 1999). Bergevoet et al. (2004) found that farmers' goals are important in
211 explaining farmers' entrepreneurial behavior. Likewise, Willock et al. (1999) identified that
212 farmers' objectives mediated the influence of attitude on farmers' business and environmental
213 behaviors. Therefore, there is theoretical support for the inclusion of farmers' goals to explain
214 farmers' intention to use improved natural grassland. As improved natural grassland is an
215 innovation, which can increase production and profits, and reduce damage to the environment,
216 we expect *a priori* that farmers who have economic and environmental goals will have a
217 higher intention to use this innovation. We also expect that farmers with a status goal will
218 have a higher intention to use improved natural grassland. This is because farmers who adopt
219 sustainable innovations such as improved natural grassland are likely to be appreciated more
220 highly by other people. In contrast, we expect that farmers with a lifestyle goal have a lower
221 intention to use improved natural grassland, because farmers with this goal usually farm
222 following traditional practices and rarely adopt innovations.

223 The role of risk in influencing people's decisions and behaviors has also been investigated
224 by authors who use the TPB as a main framework (Horst et al., 2007; Lobb et al., 2007;
225 Quintal et al., 2010). In the context of adoption of an innovation in agriculture, Marra et al.
226 (2003) claimed that farmers' risk attitude are important in explaining farmers' adoption
227 decision. Risk attitude describes an individual's tendency to take or avoid risks in their
228 decision making (Pannell et al., 2006). The more risk-averse a farmer is, the greater the
229 tendency to adopt an innovation that is perceived to reduce risk or to not adopt an innovation
230 that is perceived to increase risk (Pannell et al., 2006). We expect that the more risk-averse a
231 farmer is, the greater the intention to adopt improved natural grassland, as this innovation is
232 expected to decrease risk at farm level.

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

249 *2.3 Measurements*

250 *2.3.1 TPB constructs*

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

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

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

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

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

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

288 The reliability of the scales measuring the TBP constructs was investigated using
289 Cronbach's α coefficient. The Cronbach's α coefficients were: intention 0.92; direct attitude
290 0.88; direct subjective norm 0.81; direct perceived behavioral control 0.82; indirect attitude
291 0.80; indirect subjective norm 0.86; indirect perceived behavioral control 0.80.

292 *2.3.2 Measurements of farmers goals*

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

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

303 *2.3.3 Measurements of farmers relative risk attitude*

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

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

314 *2.4 Sampling and survey*

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

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

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

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

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

336 *2.5 Data analysis*

337 Given the assumption that farmers would differ in their intention to use improved natural
338 grassland, we used direct attitude, direct subjective norm, and direct perceived behavioral
339 control as grouping variables (see Table 1). If this assumption was correct, farmers with
340 different values for these direct measures would also have different levels of intention, which
341 would allow us to test our hypotheses. Therefore, a two-stage cluster approach was used to
342 group farmers according to the socio-psychological constructs that influence their intention to
343 use improved natural grassland. First, an agglomerative procedure (Ward method) using
344 Euclidean distance squared as the similarity measure was applied. Second, a non-hierarchical
345 cluster procedure (K-means) was used. To define the number of clusters, we used the Calinski
346 /Harabasz and Duda/Hart indices as stopping rules (Hair et al., 2010; Mooi and Sarstedt,
347 2011).

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

350 **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

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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 H₁: 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.

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

385 **Table 2 – Medians for the direct measures and indirect measures of TPB constructs for**
 386 **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

387 ^{a)} A significant difference ($P < 0.05$) between the groups was found for all TBP constructs
 388 using the Mann-Whitney test.

389
 390 Results in Table 3 show that willing and unwilling farmers differed in their behavioral
 391 beliefs. The two groups differed in their perceptions about the likelihood of the outcomes (*b*)
 392 and the evaluation of these outcomes (*e*). The only outcome where the perceived likelihood
 393 did not differ between the two groups of farmers was 'have to buy machines'. Compared to
 394 the unwilling group, willing farmers perceived it as more likely and more important that using
 395 improved natural grassland would result in the six positive outcomes. Although the scores

396 were higher for willing farmers, unwilling farmers also had high scores for the six positive
397 outcomes, as all the medians were above or equal to five. It is often suggested that extension
398 programs can increase the intention to adopt an innovation by emphasizing and reinforcing
399 the positive outcomes to farmers (Borges et al., 2014b; Garforth et al., 2006; Martínez-García
400 et al., 2013). This strategy may be less appropriate for farmers in this region, as the results in
401 Table 3 show that they already have positive opinions about the outcomes of using improved
402 natural grassland. For the two negative outcomes, 'have to buy machines' and 'have to hire
403 employees', the interpretation is different, as these outcomes were recoded. Willing farmers
404 perceived it as less likely that using improved natural grassland would result in 'have to hire
405 employees' than unwilling farmers. Additionally, willing farmers perceived it as less
406 important that using improved natural grassland would result in 'have to buy machines' and
407 'have to hire employees'. Given these results, we did not reject H₂: farmers with more
408 positive behavioral beliefs have a stronger intention to use improved natural grassland. Our
409 results are partially consistent with the literature on the adoption of sustainable innovations.
410 Fielding et al. (2005) found that groups of farmers with a strong or weak intention to manage
411 riparian zones in Australia significantly differed in their behavioral beliefs about the positive
412 outcomes, but not in their beliefs about the negative outcomes.

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

Outcomes	Likelihood of outcome (<i>b</i>)		Evaluation of outcome (<i>e</i>)	
	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

422 ^{a)} Significant difference between groups for both *b* and *e* at $P < 0.05$ using the Mann-Whitney
 423 test.

424 ^{b)} Significant difference between groups for *e* but not for *b* at $P < 0.05$ using the Mann-Whitney
 425 test.

426 ^{c)} Variables were recoded as these were presented as a negative outcome in the questionnaire.

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

434 use improved natural grassland. The results in Table 4 show that, in general, willing farmers
435 perceived it as likely that the seven important others would support them in their decision to
436 use improved natural grassland, as the median scores for this group were all greater or equal
437 to five. Both groups of farmers thought that extension agents and workers in the place where
438 inputs are purchased would be most likely to support the decision to use improved natural
439 grassland, while willing farmers also thought that family would be most likely to support the
440 decision. Both groups indicated a higher motivation to comply (*m* in Table 4) with the opinion
441 of family compared to other important others. Willing farmers were motivated to comply with
442 the opinion of different groups of people, as the median scores were greater or equal to five
443 for all the important others. Compared to willing farmers, unwilling farmers were less
444 motivated to comply with the opinion of others, especially with the opinions of government,
445 friends, neighbor farmers, and workers in the place where they buy inputs. Differences in the
446 degree to which farmers are motivated to comply with important others can suggest channels
447 which are likely to have a greater impact on the intention of farmers (Garforth et al., 2004). In
448 this study, family is the best channel to disseminate information about improved natural
449 grassland, as both groups presented the highest median score for this important other.
450 Extension agents are also an appropriate channel to disseminate information about improved
451 natural grassland, as this important other had the second highest median score for both
452 groups, together with cattle traders. Our results are consistent with those of Fielding et al.
453 (2005), who found that farmers with different levels of intention differed in their normative
454 beliefs.

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

Important others	Normative expectations of		Motivation to comply with	
	important other (<i>n</i>)		important other (<i>m</i>)	
	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

472 money to invest’, and ‘difficulty to deal with weeds’, the interpretation is different, as these
 473 factors were recoded. Compared to unwilling farmers, willing farmers perceived it as less
 474 likely that these three factors would be present to inhibit their use of improved natural
 475 grassland and the perceived power of these three factors to inhibit adoption was lower. Given
 476 these results, we did not reject H₄: farmers with more positive control beliefs have a stronger
 477 intention to use improved natural grassland. In contrast to this research, Fielding et al. (2005)
 478 did not consider the role of perceived power. However, they found that farmers with different
 479 levels of intention differed in their perception of the likelihood of factors being present that
 480 would inhibit the performance of the behavior (equivalent to *c* in Table 5).

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

Control factors	Perceived likelihood		Perceived power of factor	
	that		<i>(p)</i>	
	factor is present (<i>c</i>)			
	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

482 ^{a)} Significant difference between groups in *c* and *p* at P<0.05 using the Mann-Whitney test.

483 ^{b)} Variables recoded as were negative presented in the questionnaire.

484 *3.2 Groups of farmers and the differences between them based on their socioeconomic*
485 *characteristics, goals, and perceptions of relative risk attitude*

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

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

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

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

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532

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

Variables	Willing (Mean ^a or Median ^b)	Unwilling (Mean ^a or Median ^b)
<i>Socioeconomic characteristics</i>		
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
<i>Goals</i>		
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
<i>Risk attitude</i>		
Relative risk attitude ^{bd}	5	4

535 ^{a)} Continuous variables (independent sample t-Test).

536 ^{b)} Ordinal variables (Mann-Whitney test).

537 ^{c)} Measured as: 1=illiterate, 2=incomplete elementary school, 3=complete elementary school,
538 4=incomplete high school, 5=complete high school, 6=incomplete bachelor degree,
539 7=complete bachelor degree, 8=post-graduate studies.

540 ^{d)} Significant difference between groups at P<0.05.

541 **4. Conclusions**

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

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

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

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

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

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

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

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

606

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609

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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)
<i>Intention</i>	
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
<i>Direct attitude</i>	
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

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|---|----------------------------------|
| 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

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|--|---|
| 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 |
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control.

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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>i</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 (<i>j</i>)	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 (<i>k</i>)	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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755 **Table A3 – Outcomes (i), important others (j), and factors (k) identified in the semi-**
 756 **structured interviews**

Outcomes (<i>i</i>)	Important others (<i>j</i>)	Factors (<i>k</i>)
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		

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

Beliefs	Questions
	<p>Likelihood of each outcome (b) Evaluation of each outcome (e)</p>
<i>Behavioral beliefs</i>	<p>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)</p> <p>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)</p>
	<p>Normative expectations of each important other (n) Motivation to comply with each important other (m)</p>
<i>Normative beliefs</i>	<p>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)</p> <p>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)</p>
	<p>Likelihood of the presence of each factor (c) Perceived power of each factor (p)</p>
<i>Control beliefs</i>	<p>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)</p> <p>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)</p>

768 **Table A5 – Factor loading matrix for the goals, with factor loadings greater than 0.5 in**
769 **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			

770 ^{a)} Economic/social goal.

771 ^{b)} Status goal.

772 ^{c)} Lifestyle goal.

773 ^{d)} Items excluded either because of communalities ≤ 0.4 or because an item loaded higher than
774 0.5 in multiple factors.

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797 **Table A6 – Correlation^a matrix with intention (INT), direct attitude (dATT), direct**
 798 **subjective norm (dSN), direct perceived behavioral control (dPBC), indirect attitude**
 799 **(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

800 ^a spearman rank coefficient. All correlations were significant at P<0.05, except the correlation
 801 between iAtt and iPBC.