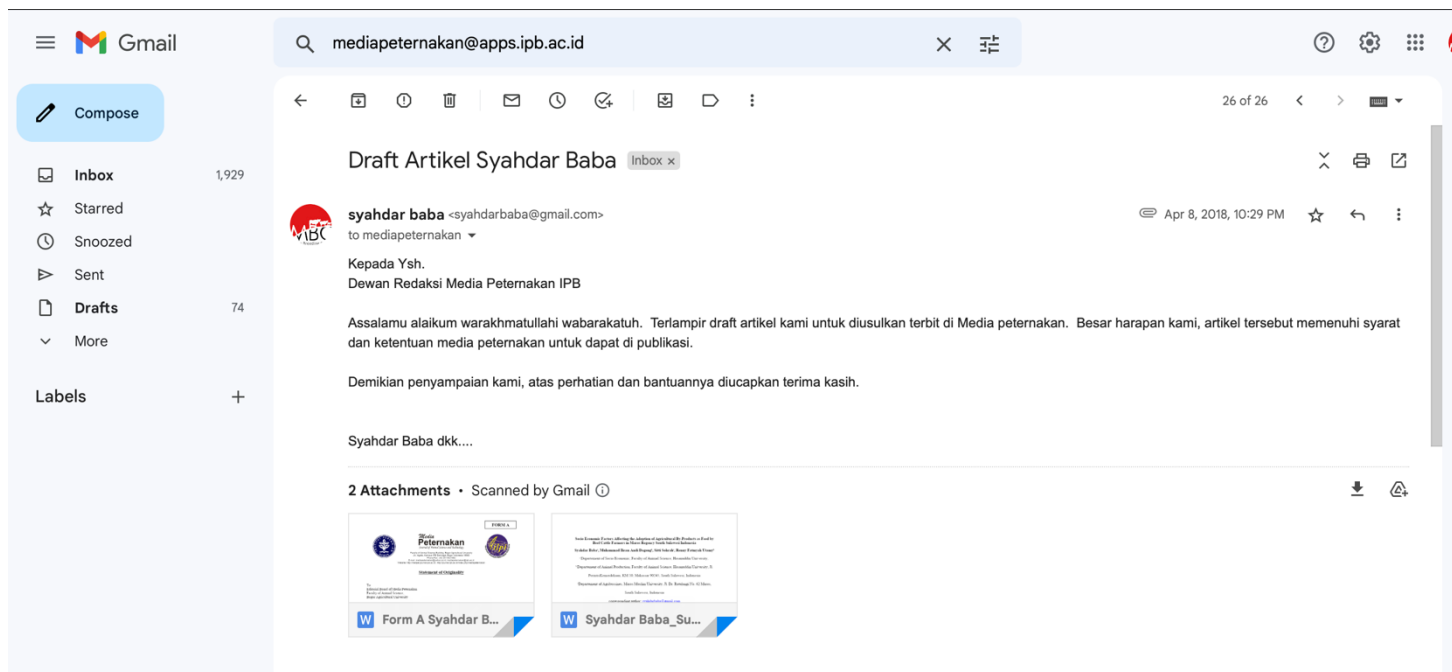
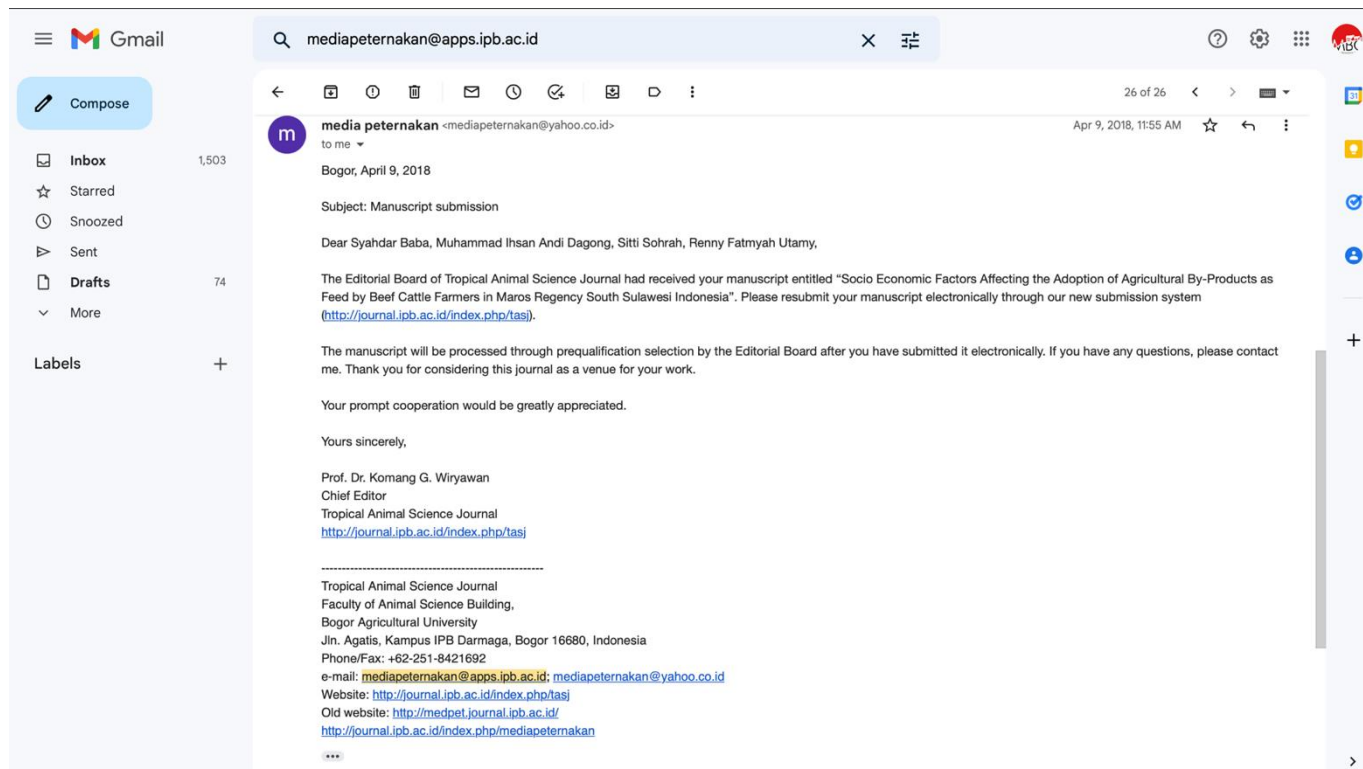


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Gambar 1. Bukti Submit Artikel pada tanggal 8 April 2018



Gambar 2. Balasan dari Penerbit bahwa artikel sedang di proses, tanggal 9 April 2018

Gmail interface showing an email from Tropical Animal Science Journal regarding authorship confirmation. The email is dated April 18, 2018, 3:57 PM. The subject is "Authorship confirmation".

Authorship confirmation Inbox x

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to me, iccangdagong, sittihsrah72, rfusat

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Thank you for submitting manuscript, "Socio Economic Factors Affecting the Adoption of Agricultural By-Products as Feed by Beef Cattle Farmers in Maros Regency South Sulawesi Indonesia" to Tropical Animal Science Journal. I would like to confirm about your approval as a co-author of the attached manuscript. If you disagree with the authorship, please send your confirmation in three days. Otherwise, manuscript will be further processed according to the journal system.

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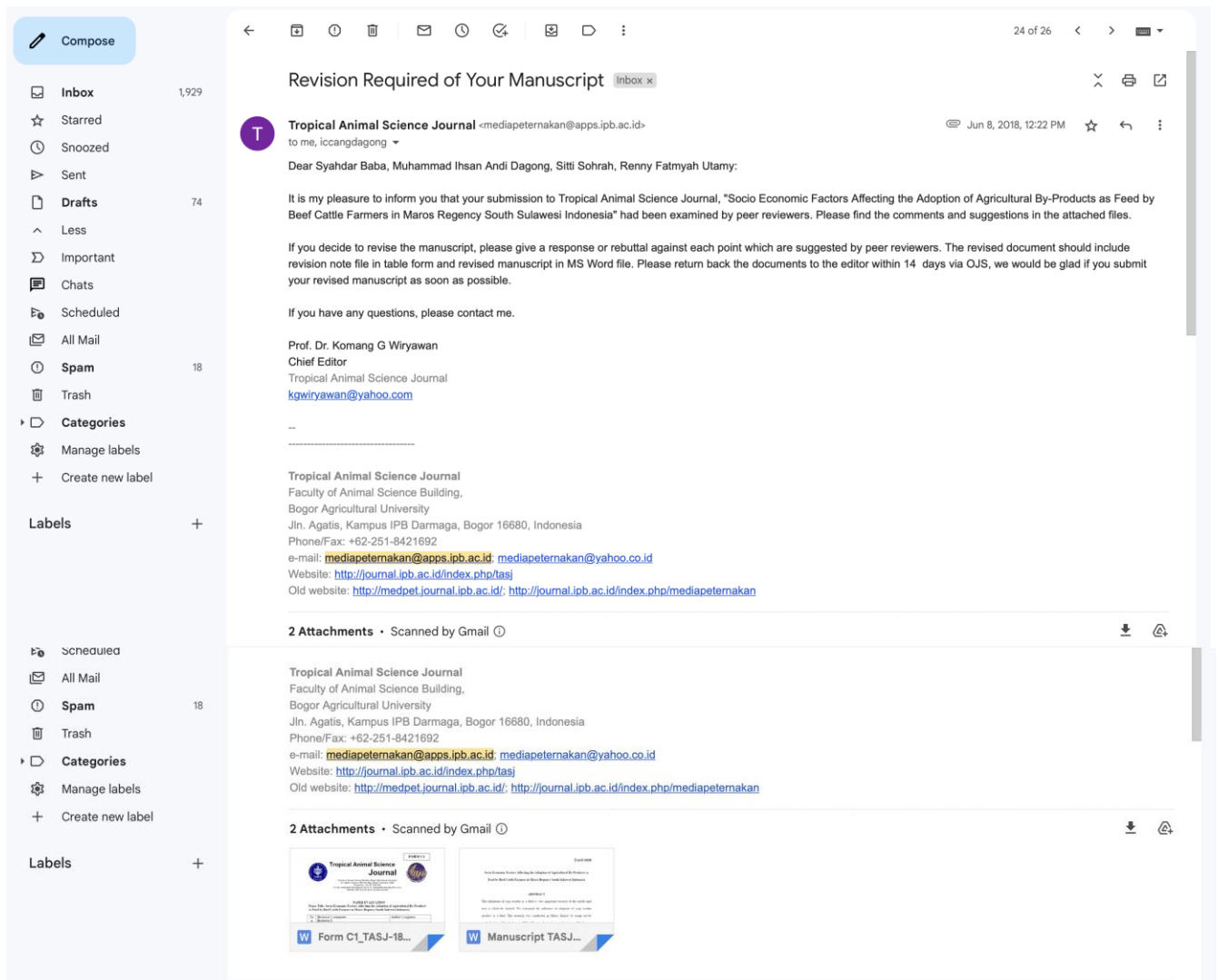
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Gambar 3. Bukti konfirmasi ke semua penulis tentang authorship dari publikasi, tanggal 18 April 2018



Gambar 4. Permintaan revisi artikel sesuai dengan saran dari reviewer sebagaimana terlampir, tgl 8 Juni 2018



PAPER EVALUATION

Paper Title: Socio Economic Factors Affecting the Adoption of Agricultural By-Products as Feed by Beef Cattle Farmers in Maros Regency South Sulawesi Indonesia

No	Reviewer's comments	Author's response
A	Reviewer I	
1	I will use Bahasa in my comments	
2	Baris 34: literature <u>tidak relevan</u> (cereal is used for feed), judul "by product"	
3	Baris 40: straw as feed causes shortages	
4	Baris 65-66: grammarhave been a factor	
5	Baris 99: definisi Y adopsi (bagaimana kriteria penggunaannya: jarang sekali, kadang-kadang, sering, sering sekali, selalu è semua ini masuk dalam kategori adopsi?)	
6	Baris 108: berapa frekwensi kontak selama periode (per bulan atau per tahun?)	
6	Baris 108: berapa frekwensi kontak selama periode (per bulan atau per tahun?)	
7	Baris 295: Tabel 1; tanda bintang (signifikansi) untuk uji apa? Belum ada penjelasannya	
8	Baris 150-151: tanda decimal ada yg koma	
9	Baris 169: twice a day??	
10	Pembahasan baru membahas signifikansi. Belum ada pembahasan tentang arti negatif dan positif, serta besarnya nilai koefisien.	
11	Conclusion: disampaikan variable apa yang paling berpengaruh. Bagaimana pengaruhnya (positif atau negatif)	
12	Rekomendasi: belum ada. Seharusnya diambil dari variable berpengaruh yang bisa diperbaiki untuk meningkatkan adopsi.	
13	References: 1. Agar mengikuti panduan Tropical Animal Science Journal. 2. Jumlah jurnal 10 tahun terakhir seharusnya lebih dari 80% dari total pustaka yang digunakan. 3. Prosiding tidak diperkenankan, mohon diganti dengan jurnal terbaru	



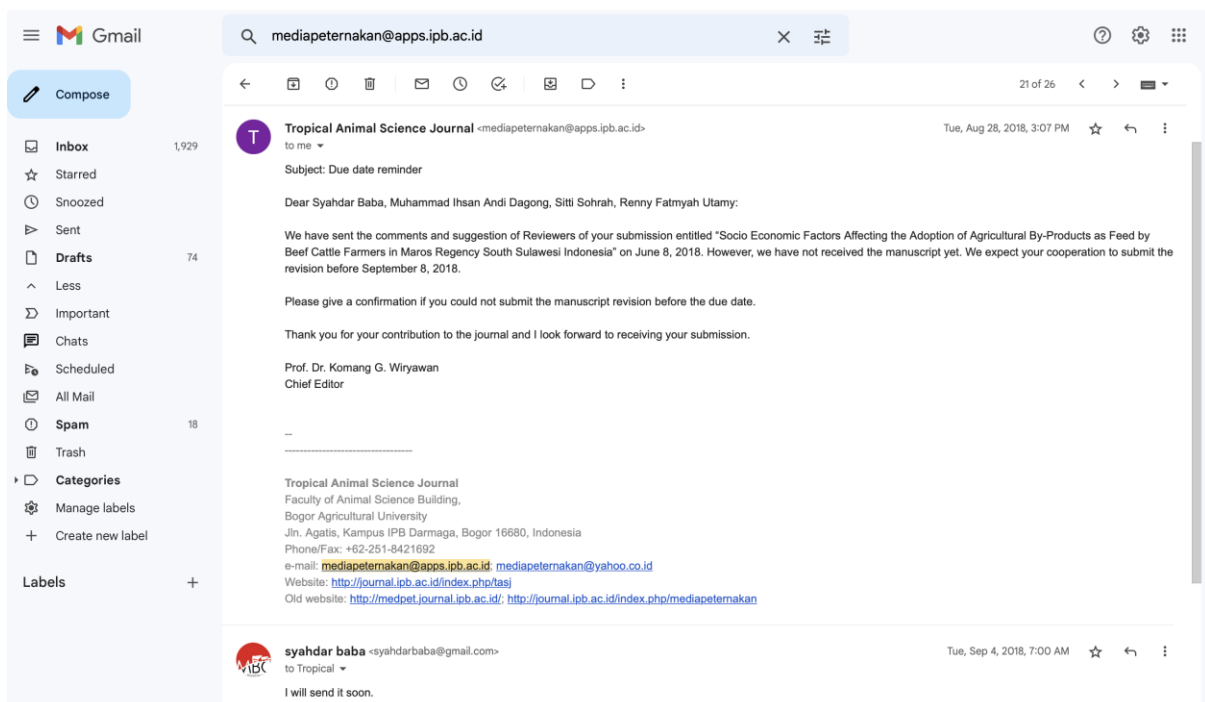
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	4. <u>Diusahakan mensitasi terbitan 3 tahun terakhir dari Media Peternakan/TASJ.</u>	
	<u>Referensi kurang: BPS 2014(baris 25) BPS 2015(baris 46; tidak alfabetik (baris 220-223 dst), Haryanto et al (baris 41)</u>	
	<u>Daftar pustaka berlebih (tidak bertanda kuning, tidak ada dalam tulisan)</u>	
	Baris 61: <u>penulisan family name</u>	
14	<u>Mohon diperiksa kembali penulisan bahasa Inggris yang digunakan. Akan lebih baik jika naskah dikoreksikan ke English Editor.</u>	
B	Reviewer II	
1	<u>There is no hypotheses stated. Please add</u>	
2	<u>There is no objective. Please add</u>	
3	<u>No research question. Please add</u>	
4	<u>There is no regression equation model and no deeply explanation of the equation. Please add</u>	

Gambar 5. Lampiran komentar dari 2 orang blind reviewer



Gambar 6. Peringatan dari penerbit tentang batas akhir pengunggahan hasil perbaikan




PAPER EVALUATION

Paper Title: Socio Economic Factors Affecting the Adoption of Agricultural By-Products as Feed by Beef Cattle Farmers in Maros Regency South Sulawesi Indonesia




No	Reviewer's comments	Author's response
A	Reviewer I	
1	I will use Bahasa in my comments	
2	Baris 34: literature tidak relevan (cereal is used for feed), judul "by product"	Changed to: only Rao and Hall (2003) is used as source
3	Baris 40: straw as feed causes shortages	changed to: "However, the utilization of straw as feed had constraints"
4	Baris 65-66: grammarhave been a factor	have been a factor low adoption of utilization crop residue as feed
5	Baris 99: definisi Y adopsi (bagaimana kriteria penggunaannya: jarang sekali, kadang-kadang, sering, sering sekali, selalu è semua ini masuk dalam kategori adopsi?)	Penjelasan ada di baris 93 dimana Y didefinisikan sebagai variable dikotomi yaitu hanya ada dua pilihan yaitu 1 untuk mengadopsi dan 0 untuk tidak mengadopsi. Mengadopsi artinya, peternak menggunakan limbah pertanian sebagai pakan sepanjang tahun dan tidak mengadopsi adalah peternak tidak menggunakan atau hanya menggunakan pada waktu terbatas.

6	Baris 108: berapa frekwensi kontak selama periode (per bulan atau per tahun?)	Per Tahun khususnya di tahun 2015
7	Baris 295: Tabel 1: tanda bintang (signifikansi) untuk uji apa? Belum ada penjelasannya	Uji yang dimaksud adalah Uji t-test; telah ditambahkan pada Tabel 1 hasil t-test
8	Baris 150-151: tanda decimal ada yg koma	Tanda koma sudah dihilangkan dan diganti dengan titik
9	Baris 169: twice a day??	add "let" the livestock grazed in field by twice.
10	Pembahasan baru membahas signifikansi. Belum ada pembahasan tentang arti negatif dan positif, serta besarnya nilai koefisien.	Pembahasan sudah ditambahkan



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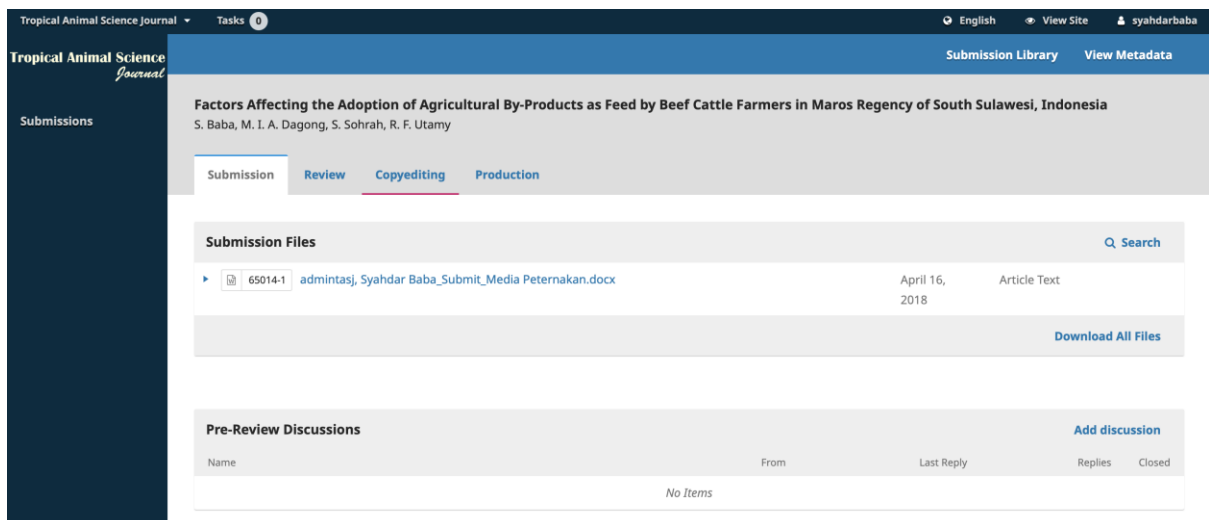


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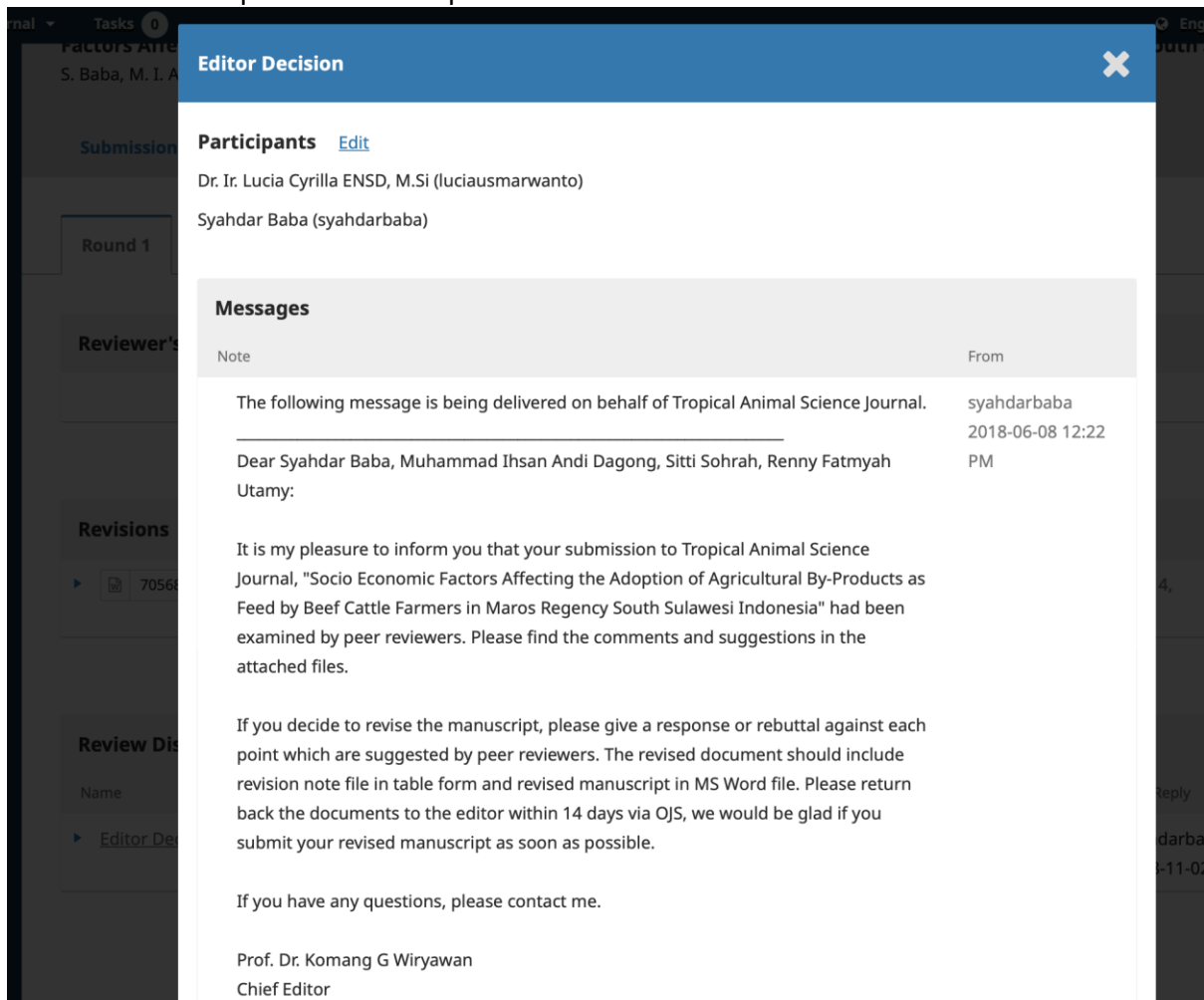
FORM C1

11	Conclusion: disampaikan variable apa yang paling berpengaruh. Bagaimana pengaruhnya (positif atau negatif)	Sudah disampaikan pada kesimpulan
12	Rekomendasi: belum ada. Seharusnya diambil dari variable berpengaruh yang bisa diperbaiki untuk meningkatkan adopsi.	Rekomendasi digabung di kesimpulan
13	References: 1. Agar mengikuti panduan Tropical Animal Science Journal. 2. Jumlah jurnal 10 tahun terakhir seharusnya lebih dari 80% dari total pustaka yang digunakan. 3. Prosiding tidak diperkenankan, mohon diganti dengan jurnal terbaru. 4. Diusahakan mensitasi terbitan 3 tahun terakhir dari Media Peternakan/TASJ.	Sudah disesuaikan
	Referensi kurang: BPS 2014(baris 25) BPS 2015(baris 46; tidak alfabetik (baris 220-223 dst), Haryanto <i>et al</i> (baris 41)	Sudah disesuaikan
	Daftar pustaka berlebih (tidak bertanda kuning, tidak ada dalam tulisan)	Sudah dihapus
	Baris 61: penulisan family name	Sudah disesuaikan
B	Reviewer II	
1	There is no hypotheses stated. Please add	
2	There is no objective. Please add	Therefore, the objective of this study was conducted to determine the socio-economic impact of farmers to adopt the utilization of crop residues as feed
3	No research question. Please add	Has been added
4	There is no regression equation model and no deeply explanation of the equation. Please add	Has been added

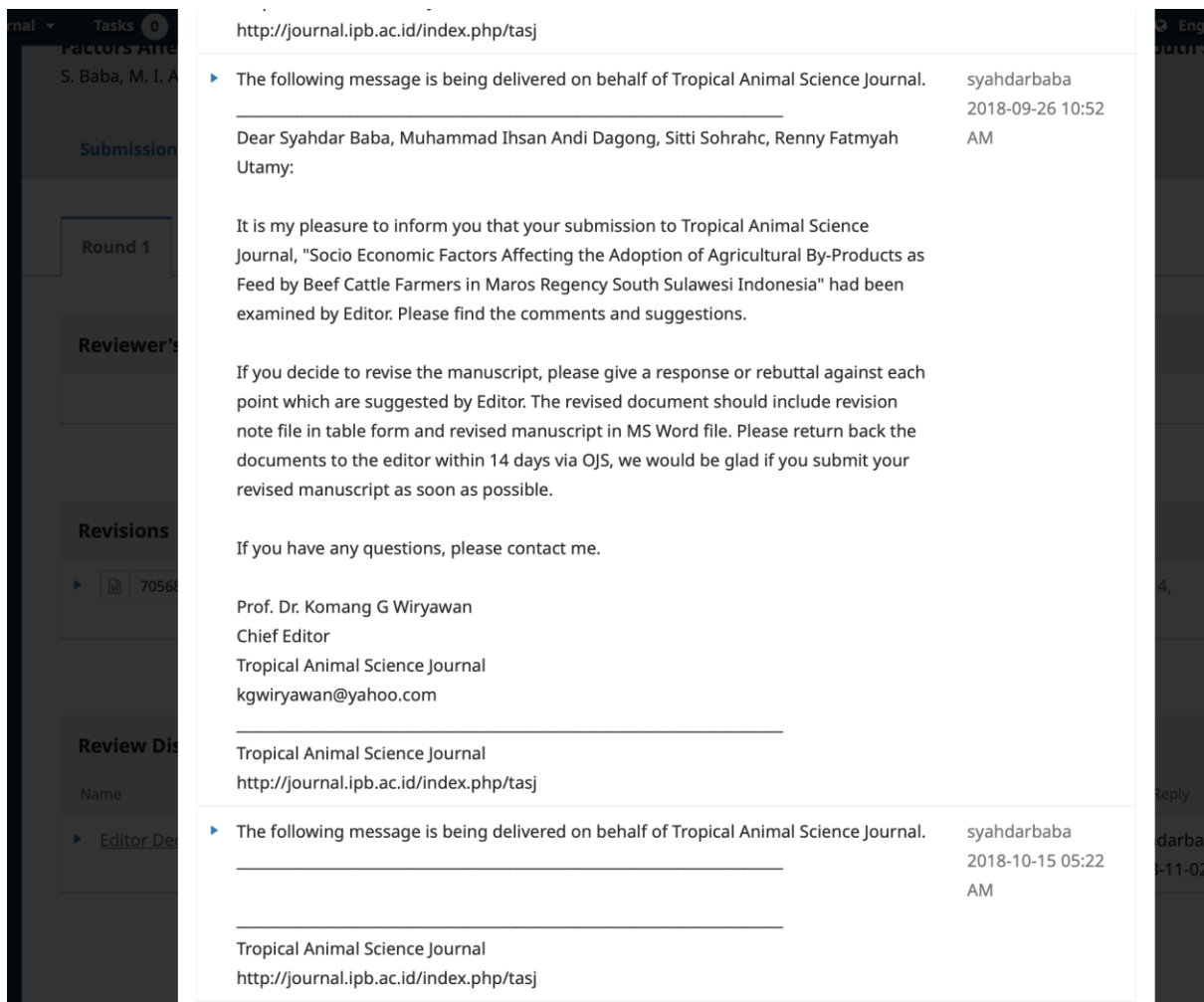
Gambar 7. Bukti perbaikan yang dilakukan oleh Author sesuai dengan saran dari reviewer



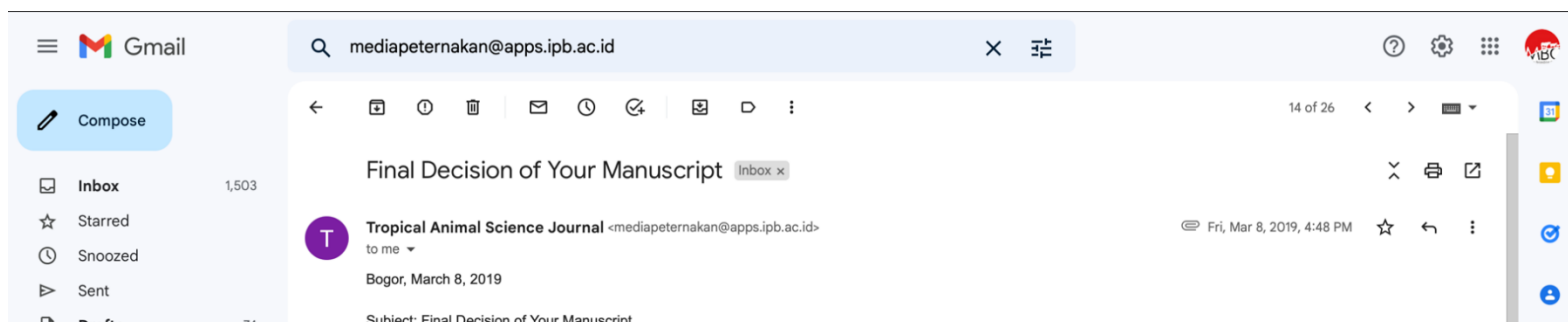
Gambar 8. Bukti upload di OJS Tropical animal Science Journal



Gambar 9. Komentar dari peer review dan editor



Gambar 10. Komentar dari reviewer terkait revisi artikel



Gambar 11. Email terakhir tentang keputusan menerima artikel untuk diterbitkan setelah direvisi

1 **Socio Economic Factors Affecting the Adoption of Agricultural By-Products as Feed by**
2 **Beef Cattle Farmers in Maros Regency South Sulawesi Indonesia**

3 **Syahdar Baba^a, Muhammad Ihsan Andi Dagong^b, Sitti Sohrah^c, Renny Fatmyah**
4 **Utamy^b**

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7 PerintisKemerdekaan, KM 10, Makassar 90245, South Sulawesi, Indonesia

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9 South Sulawesi, Indonesia

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11
12 **ABSTRACT**

13 The utilization of crop residue as a feed is very important because of the arable land area is
14 relatively limited. We examined the influence of adoption of crop residue product as a feed.
15 The research was conducted in Maros district by using survey methods from March-August
16 2015. The number of respondents was 96 farmers scattered throughout the districts of
17 Bantimurung and Camba as centers of rice, corn plant, and cattle. Questionnaire were used to
18 collected data who conducted by trained enumerator. Experiment was arranged using a
19 logistic regression model to identify socioeconomic factors that have influenced the adoption
20 of crop residue as a feed. Work perception (X2), contact with extension workers (X4), rice
21 cultivated areas (X5), number of livestock (X6), subjective norm (X7), and difficulty (X8), as
22 socio-economic variables, influenced by the adoption of crop residue as a feed; however, the
23 variables age (X1), farmer experiences (X3) and the number of family members (X9) have no
24 effect on the adoption of this technology.

25 Keywords: adoption, crop residue, fodder, maros

26 **INTRODUCTION**

27 Generally, in Indonesia, smallholder beef farmers hold a limited number of livestock,
28 approximately 2-3 heads in total (Direktorat Jenderal Peternakan, 2015). The smallholder
29 beef farmers face many obstacles to increase their numbers of livestock. In the past 10 years
30 (2003-2013), extensive pasture did not increase and only 3.05 million hectares are available,
31 concentrated in a few provinces (BPS, 2014). Arable grassland is relatively limited and the
32 nutritive values of forage crops vary between seasons, with significant qualitative and
33 quantitative drops in the dry season. Native pastures provides herbage production for cattle.
34 However, this function has significantly decreased due to the shift of function from native
35 pasture to horticulture and crop fields or settlements, resulting in a shortage of herbage
36 production (Haryanto, 2009). Thus, the utilization of crop residue such as rice-and corn-straw
37 could be an alternative feed supply for smallholder beef farmers, therefore the number of
38 their livestock can be increased.

39 Utilization of crop residue such as rice- and corn-straw as a feed is a well-known
40 methods. In India, cereal is used for a feed reached 45-66% (Kelley and Parthasarathy Rao
41 1996; Ranjhan 1999; Parthasarathy Rao and Hall 2003), while in Indonesia rice-straw is used
42 reaches 31-39%. Since 1990-2000, Indonesian Agency for Agricultural Research and
43 Development, Ministry of Agriculture, has introduced the Crop Livestock System, (CLS
44 program; integrated rice/corn beef) in several provinces, including South Sulawesi (Diwyanto
45 2008; Sariubang and Pasambe, 2005; Baba *et al.*, 2014). However, the utilization of straw as
46 feed causes shortages and smallholder beef farmers do not often store this as a feed reserves
47 for the following season (Rao and Hall, 2003; Haryanto *et al.*, 2009). Even in agricultural
48 intensification land which produces high biomass, feed for beef cattle is relatively limited
49 (Ralevic *et al.*, 2010; Valbuena *et al.*, 2012).

50 Maros is one of the districts in South Sulawesi that is well known either as a center of
51 rice crops or for Bali beef cattle development. In 2015, the rice harvest area reached 47,648

52 ha with Bantimurung districts is the highest harvested 18.31% (BPS, 2015). In 2007-2011,
53 Farmer Empowerment through Agriculture Technology Information (FEATI) encouraged
54 smallholder beef farmers to use rice- and corn-straw as a feed. Further, in 2012-2013, a
55 participatory approach is used by University of Hasanuddin to develop the technology. Not
56 only researchers, extension workers, and small beef farmers identify feed potential, but they
57 also conducted experiments at the farmer level. After the experiments, the smallholder
58 farmers evaluated the technologies that had been developed and decided whether to adopt the
59 technology or not (Rhoades and Boath, 1982; He et al., 2009). The participation of extension
60 workers not only increases access to resources (Ngoc Chi *et al.*, 2007) but also the adoption
61 of the technology (Atmis *et al.*, 2009; Bremer *et al.*, 2014). However, in Maros, adoption of
62 crop residue as a feed is still limited. Baba et al. (2014) revealed that utilization of corn- and
63 rice- straw as a feed 63,5% and 32.5% respectively.

64 The adoption of crop residues as a feed has been influenced by several social,
65 economic, and technical factors; for example, discomfort in conducting the processing of
66 crop residue (Nguyen Xuan Trach 1998); unclear economic benefits (Nguyen Xuan Trach,
67 1998; Gilleret *et al.*, 2009); labor shortages for processing of straw as a feed; and a lack of
68 knowledge about the processing of the straw (Baba *et al.*, 2014; Mudzengi *et al.*, 2014). It
69 also includes the cost of implementation and expected benefits. Interest from smallholder
70 farmers and their perceptions, as well as demographic characteristics, have been a factor
71 (Giller *et al.* 2008). Socioeconomic factors were the main factors that determinant of
72 technology adoption. Adoption of crop residue utilization as a feed has never been done yet
73 in Maros. Therefore, we examined effect of socioeconomic factors on adoption of utilization
74 of crop residue as a feed.

75 MATERIALS AND METHODS

76 Data Collection

77 This research was conducted in Maros District, South Sulawesi. The selected site is
78 well-known as a center for rice crop productions, corn, and Bali beef cattle in Eastern
79 Indonesia. Previously, collaboration between University of Hasanuddin, Maros District
80 Government and the Assessment Institute for Agricultural Technology South Sulawesi
81 Province has been disseminating utilization of rice- and corn- straw as a feed. The
82 dissemination includes fermentation and ammoniation of rice- and corn-straw and silage of
83 corn stalk. In this district, December-March is the first cropping of paddy; April-June is the
84 second cropping of sticky corn, pulut, local name of sticky corn; and July-September is the
85 third cropping of corn, respectively. Pulut is harvested in young stage (70 days), therefore it
86 have high palatability.

87 Data collection used questionnaires who distributed by trained enumerators, ran from
88 March to December 2015. Totally 487 smallholder beef farmers were spread over three sub-
89 districts such as Simbang and Bantimurung (2 villages) and Camba (1 village). Overall, 96
90 farmers who were selected as respondents from each village using quota sampling. In
91 Samangki and Simbang (Sub District Simbang), there were 25- and 20-respondents,
92 respectively; in Leang-Leang and Minasa Baji (Sub District Bantimurung) there were 23- and
93 16-respondents, respectively; and in Pattiro Deceng (Sub District Camba), there were 12-
94 respondents. The collected data were analyzed by logistic regression models with SPSS
95 17.00.

96 Logistic regression model used for determining factors that influenced the adoption of
97 crop residues as a feed. Logistic model used as the dependent variable was measured by
98 dichotomous variables, where 0 means not adopted (unused crop residues as a feed), while 1
99 means adopted. The logistic regression model was as follows:

100
$$Y = \ln(\pi/1-\pi) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 +$$

101
$$\beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \varepsilon$$

102 Where:

103 Y = Opportunity adoption of the utilization of straw as feed (pi = 0 indicates no adoption, pi
104 = 1 indicates adoption)

105 β_0 = Intercept

106 β_1 - β_7 = Regression coefficients of the dependent variables

107 X1 = Age, expressed of the length of reviews their life (year)

108 X2 = Work perception, as a dichotomous variable, where 1 denotes the main work as being a-
109 beef cattle farmer, and 0 otherwise

110 X3 = Farmer expressed experience, reported as the length of their experience as a beef cattle
111 farmer (years)

112 X4 = Contact with extension workers, expressed as the number of contacts with extension
113 workers (frequency)

114 X5 = Rice cultivated area, expressed as the number of hectares (ha)

115 X6 = Number of livestock, expressed as the number of livestock intensively reared (heads)

116 X7 = Subjective norm, expressed as the perception of beef cattle farmers towards what
117 should be done in view of the surrounding community based on their position (score)

118 X8 = Technology difficulty, expressed as difficulty in using crop residues feed by, beef cattle
119 farmers: 1 if the agrees that it is difficult, or 0 if otherwise

120 X9 = Family size, expressed as number of farmers' family (individual)

121

122

RESULTS

123

Farmer Characteristics

124

There were no significant differences between age, business experience, the number
125 of families, and the education level of the farmers whether adopters or non-adopters.

126

However, the number of livestock and extensive landholding of adopter farmers is
127 significantly higher than that for the non-adopter farmers (Table 1). The number of livestock

128

increased as the amount of feed increased such as rice straw. On the contrary, the availability

129

of labor was not a distinguished factor between adopters and non-adopters.

130 **Farmer's Reasons to Adopt and Not Adopt** There are many reasons smallholder
131 beef farmers adopted the utilization of crop residue such as corn-straw as a feed (Table 2).
132 Firstly, there was shortage of land fodder or herbage production. Secondly, corn-straw
133 increased with the increased in harvesting season. Thirdly, the number of livestock
134 increased.

135 Main reason for smallholder beef farmers not adopted straw as a feed because of the
136 availability of other feed sources such as Napiergrass and Native Grass (Table 3).
137 Smallholder beef farmers planted Napiergrass close to their cattle pen easier for it harvesting
138 or the livestock grazed in field by twice. Other than that it was not only require labor
139 collected rice- and corn- straw but also the farmers have no free time. Other reason was no
140 available feed storage. Jabbar *et al.* (2009) stated that labor is one of the factors why farmers
141 did not adopt the utilization of crop residue as a feed.

142 **Factors Affecting Farmers Adopting Crop Residue as Feed**

143 The results of the overall correct prediction (88.7%) and Chi square statistics (93,742)
144 show that the models have ability to predict the chance of adoption of the utilization of rice-
145 and corn- straw were high in Maros district. R square (0.709) showed that 70.9% variation in
146 the dependent variables, was determined by the selected independent variables. Wald
147 indication stated that contact with the extension (12.507) and the number of cattle (11.506)
148 were variable, having a greater influence on farmers adopting rice- and corn-straw as a feed
149 (Table 4).

150 Logistic regression analysis showed that six of the nine independent variables had a
151 significant effect on the adoption of straw as a feed. The sixth variables were contact with the
152 extension worker ($P<0,01$), the number of livestock ($P<0,01$), paddy cultivated area
153 ($P<0,01$), social norms ($P<0.01$), perception on the farm ($P< 0.05$) or the level of difficulty

154 processing straw ($P<0.05$). The variables contact with extension workers, number of
155 livestock, rice cultivated area, social norms and perceptions on the farm had positive
156 regression coefficient values, indicating that they had a positive influence on the adoption of
157 straw as a feed. On the other hand, the level of difficulty processing straw showed a negative
158 coefficient (Table 4). The variables which did not differ significantly regarding the adoption
159 of straw as a feed were age, farmer experience, and the number of families.

160 **Discussion**

161 The adoption of technology by used straws as a feed depends on the adequacy of feed
162 for cattle. If the farmers lack of feed such as grasses, rice- and corn- straw will be used as the
163 main of feed source (44 respondents). The method used by farmers to manage straw as
164 follows: 1) neither planting spot nor harvesting period was same; 2) planted time of corn
165 should be different between farmer for collecting corn-straw; and 3) cultivated and straw
166 storage.

167 Main reason for smallholder beef farmers not adopted straw as a feed because of the
168 availability of other feed sources such as napiergrass and native grass. Smallholder beef
169 farmers planted napiergrass close to their cattle pen easier for it harvesting or the livestock
170 grazed in field by twice. There were 28 farmers (53.85%) who prepare pasture for livestock
171 grazing during the day and therefore do not require any additional feeds. Generally, those
172 farmers who hold a limited number of livestock do not adopt straw as a source of feed (Table
173 1) even though there was shortage in herbage production when compared to the farmer who
174 have large scale farmer.

175 Contact with extension worker is relates to the farmer's intention to meet with
176 counselors. Extension worker is one of the important information source for farmers.
177 Adequate information especially from extension workers is one of a key driver of technology

178 utilization in Maros (Rogers 2003; Wubench and Sanders 2006). They work for the farmers
179 needed, not only demonstrating the utilization of the straw as a feed, as counselors, and as
180 assistants, but also identified and solved problems (Llewellyn, 2007; Bodorkos and Pataki,
181 2009).

182 Social norms was one of factor that encouraged farmers to adopt the utilization of
183 straw as a feed. The smallfarmers who have capability and high commitment will be
184 appointed as a role model and a reference for other farmers (Ajzen 1991; Bergevoet *et al.*,
185 2004).

186 Livestock sector and paddy field were determined regarding the adoption of crop
187 residue as a feed. The number of livestock increased as the amount of feed increased such as
188 rice straw (Table 2). In order to provide nutrition for livestock, rice straw must be processed
189 first (Nguyen Xuan Trach, 2004; Mudzengi, *et al.*, 2014). In Maros district, native grass and
190 napiergrass were combined as a feed and provide supplements, however, they have not
191 provided straw as feed yet.

192 CONCLUSION

193 Factors that influence the adoption of crop residue as a feed are shortages in herbage
194 production, the same perception as the extension worker, paddy field, livestock numbers,
195 subjective norms, and the level of difficulty in using crop residue as feed. Those farmers
196 who have their own paddy field and land fodder prefer not to utilize straw as feed.

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- 286 **Table 1.** Characteristics of farmers and business farming by respondents

Variabel	Adopter		Non Adopter	
	Mean	Std	Mean	Std
Age (Year)	43.45	9.10	43.13	10.65
Business experience(year) ^{ns}	6.36	4.94	5.54	3.31
Family member (person) ^{ns}	4.09	1.21	3.67	1.13
Number of cattle (head)**	3.86	1.17	2.98	0.75
Wide of rice areal (ares)**	49.68	33.37	27.38	18.29
Education level (person)				
- low (\leq junior high school)	36		43	
- senior high school	7		9	

- university	1	0
Total of farmers	44	52

ns : Non significant, * significant in level 0.05 ($P > 0.05$), **significant in level 0.01 ($P < 0.01$)

288 **Table 2.** Farmer's reasons to using crop residueas feed

Reason of adoption	Score*	Rank
Herbage production becomes in shortage	168	1
Holding limited land fodder	160	2
Obtainable of corn-straw	153	3
Straw abundant	110	4
Spend of leisure time	69	5

289 The scale of 5-1 provided from the most important or *vice versa* in any respondents who adopted (44
290 respondents).

291

292 **Table 3.** The reason farmers did not adopt the use of rice-straw/corn- as feed

Reason of non adoption	Score	Rank
The sufficient of other feed source	207	1
Pasture	197	2
Labor to collect straw	149	3
No storage place for feed	140	4
Required surcharge to storage straw	87	5

293 * The scale of 5-1 provided from the most important or *vice versa* in any respondents who
294 adopted (52 respondents).

295 **Table 4.** Logistic regression coefficients of the factors affecting the adoption of utilization of
296 crop residue as feed.

Varaibel	B	SE	Wald	P-Value
Age (X1)	-0.006	0.028	0.048	0.827 ^{ns}
Work perception (X2)	1.918	0.859	4.988	0.026*
Farmer experience (X3)	0.039	0.099	0.154	0.695 ^{ns}
Contact with extension worker (X4)	2.835	0.802	12.507	0.000**
Rice cultivated area (X5)	0.058	0.022	7.179	0.007**
Number of livestock (X6)	1.328	0.392	11.506	0.001**
Social norm (X7)	1.697	0.638	7.075	0.008**
Difficulty (X8)	-1.246	0.601	4.295	0.038*
Number of family (X9)	0.035	0.336	0.011	0.918 ^{ns}
Constant	-13.990	3.498	15.993	0.000**

297 ** and * , significant at $P<0.01$ and $P<0.05$ respectively. -2likelihood is 77.351; chi square
298 statistic is 93.742**; Nagelkerke R Square 0.709; Overall correct prediction is 88.7; Number
299 of Observation : 126

300

1 Socio Economic Factors Affecting the Adoption of Agricultural By-Products as

2 Feed by Beef Cattle Farmers in Maros Regency of South Sulawesi Indonesia

3 **ABSTRACT**

4 The utilization of crop residue as a feed is very important because the arable land area is
5 relatively limited. We examined the influence of adoption of crop residue product as a
6 feed. The research was conducted in Maros district by using survey methods from March
7 to August 2015. The number of respondents was 96 farmers scattered throughout the
8 districts of Bantimurung and Camba as centers of rice, corn plant, and cattle.
9 Questionnaires were used to collect data conducted by a trained enumerator. Survey
10 was arranged using a logistic regression model to identify socio economic factors which
11 have influenced the adoption of crop residue as a feed. Work perception (X2), contact
12 with extension workers (X4), rice cultivated areas (X5), number of livestock (X6),
13 subjective norm (X7), and difficulty (X8), as socio-economic variables, influenced by the
14 adoption of crop residue as a feed; however, the variables age (X1), farmer experiences
15 (X3), and the number of family members (X9) have no effect on the adoption of this
16 technology.

17 Keywords: adoption, crop residue, fodder, maros

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19 **INTRODUCTION**

20 Generally, in Indonesia, small holder beef farmers hold a limited number of
 21 livestock, approximately 2-3 heads in total (Direktorat Jenderal Peternakan, 2015). The
 22 smallholder beef farmers face many obstacles to increase their numbers of livestock. In
 23 the past 10 years (2003-2013), extensive pasture has not been increased and only 3.05
 24 million hectares are available, concentrated in a few provinces (National Statistical
 25 Bureau, 2014). Arable grassland is relatively limited and the nutritive values of forage
 26 crops vary between seasons, with significant qualitative and quantitative drops in the dry
 27 season. Native pastures provides herbage production for cattle. However, this function
 28 has significantly decreased due to the shift of function from native pasture to horticulture
 29 and crop fields or settlements, resulting in a shortage of herbage production (Haryanto,
 30 2009). Thus, the utilization of crop residues such as rice and corn straws could be an
 31 alternative feed supply for smallholder beef farmers; therefore, the number of their
 32 livestock can be increased.

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33 Utilization of crop residues such as rice and corn straws as a feed is a wellknown
 34 methods. In India, crop residue reached 50-60% of total feed so that breeding strategy
 35 towards the development of dual-purposes plant types could increase the adoption of
 36 improved varieties (Rao and Hall 2003), while in Indonesia rice straw is used to reach
 37 31-39%. Since 1990-2000, Indonesian Agency for Agricultural Research and
 38 Development, Ministry of Agriculture, has introduced the Crop Livestock System, (CLS
 39 program; integrated rice/corn beef) in several provinces, including South Sulawesi
 40 (Haryanto, 2009; Winarso and Basuno, 2013; Baba et al., 2014). However, the utilization
 41 of straw as feed causes shortages and smallholder beef farmers do not often store this as
 42 a feed reserves for the following season (Haryanto, 2009). Even in agricultural

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46 intensification land which produces high biomass, feed for beef cattle is relatively limited
47 (Ralevic et al., 2010; Valbuena et al., 2012).

48 Maros is one of the well known districts in South Sulawesi which is either as a
49 center of rice crops or as Bali beef cattle development center. In 2015, the rice harvest
50 area reached 47,648 ha with Bantimurung districts was the highest in harvest with 18.31%
51 (BPS, 2015). In 2007-2011, Farmer Empowerment through Agriculture Technology
52 Information (FEATI) encouraged smallholder beef farmers to use rice and corn straws as
53 feed. Furthermore, in 2012-2013, a participatory approach is used by University of
54 Hasanuddin to develop the technology. Not only researchers, extension workers, and
55 small beef farmers identify feed potential, but they also conducted experiments at the
56 farmer level. After the experiments, the smallholder farmers evaluated the technologies
57 which had been developed and decided whether to adopt the technology or not (Rhoades
58 and Boath, 1982; He et al., 2009). The participation of extension workers increases not
59 only access to resources (Hauser, et al., 2016) but also the adoption of the technology
60 (Atmis et al., 2009; Bremer et al., 2014). However, in Maros, adoption of crop residue as
61 a feed is still limited. Baba et al. (2014) revealed that utilization of rice and corn straws
62 as a feed 63,5% and 32.5% respectively.

63 The adoption of crop residues as a feed has been influenced by several social,
64 economic, and technical factors; for example, difficulty in making rice straw compost
65 (Suparn, et al., 2013), unclear economic benefits (Giller et al., 2009), labor shortages
66 for processing of straw as a feed, and a lack of knowledge about the processing of the
67 straw (Suparn, et al., 2013; Baba et al., 2014; Mudzengi et al., 2014). It also includes
68 the cost of implementation and expected benefits. Interest from smallholder farmers and
69 their perceptions, as well as demographic characteristics, have been a factor (Giller et al.

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71 2009). Socio economic factors were the main factors that are the determinant of
72 technology adoption. The adoption of crop residue utilization as a feed has never been
73 done yet in Maros. Therefore, the objective of this study was conducted to determine the
74 socio-economic impact of farmers to adopt the utilization of crop residues as feed.

75 MATERIALS AND METHODS

76 Data Collection

77 This research was conducted in Maros District, South Sulawesi. The selected site
78 is a well-known center for rice crop productions, corn, and Bali beef cattle in Eastern
79 Indonesia. Previously, collaboration between University of Hasanuddin, Maros District
80 Government and the Assessment Institute for Agricultural Technology South Sulawesi
81 Province has been disseminating utilization of rice and corn straws as a feed. The
82 dissemination includes fermentation and ammoniation of rice and corn straws and silage
83 of corn stalk. In this district, December-March is the first cropping of paddy; April-June
84 is the second cropping of sticky corn, *pulut*, local name of sticky corn; and July-
85 September is the third cropping of corn, respectively. *Pulut* was harvested in young stage
86 (70 days); therefore, it has a high palatability.

87 Data collection used questionnaires which are distributed by trained enumerators,
88 running from March to December 2015. In total, 487 smallholder beef farmers were
89 spread over three sub-districts such as Simbang and Bantimurung (2 villages) and Camba
90 (1 village). Overall, 96 farmers who were selected as respondents from each village using
91 quota sampling. In Samangki and Simbang (Sub District Simbang), there were 25- and
92 20- respondents, respectively; in Leang-Leang and Minasa Baji (Sub District
93 Bantimurung) there were 23- and 16- respondents, respectively; and in Pattiro Deceng
94 (Sub District Camba), there were 12-respondents.

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95 **Statistical Analysis**

96 Adoption of technology is the decision of farmers to accept or reject technology.

97 The decision to the adoption of technology was influenced by many factors such as
 98 environmental factors, smallholder farmers characteristics, socio-economics, farming
 99 purposes, biophysics and technology delivery method to the farmers. Dependent
 100 variables (i.e. adoption of crop residues technology utilization) measured by using
 101 dichotomous model where one means adopted while zero did not. Independent variables
 102 were farmers' internal factors, socio economy of the farmers, and biophysical farming.

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103 These factors were determined because of the cattle business and paddy field had long
 104 been carried out by them even though it has not been well integrated yet. Therefore,
 105 whether adopted or not the technology of crop residue utilization depends on internal
 106 factors, socio-economic, and the biophysics of their farming

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107 Logistic regression model was used for determining factors that influenced the
 108 adoption of crop residues as a feed. Logistic model was used as the dependent variable
 109 measured by dichotomous variables, where 0 means not adopted (unused crop residues
 110 as a feed), while 1 means adopted (used crop residues as a feed the whole time). The
 111 logistic regression model was as follows:

$$112 \quad Y = \ln (p_i/1-p_i) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 +$$

$$113 \quad \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon$$

114 Where:

115 Y = Opportunity adoption of the utilization of straw as feed (pi = 0 indicates no adoption,
 116 pi = 1 indicates adoption)

117 β_0 = Intercept

118 β_1 - β_7 = Regression coefficients of the dependent variables

- 121 X1 = Age, expressed of the length of reviews their life (year)
- 122 X2 = Work perception, as a dichotomous variable, where 1 denotes the main work as
123 being a-beef cattle farmer, and 0 otherwise
- 124 X3 = Farmer expressed experience, reported as the length of their experience as a beef
125 cattle farmer (years)
- 126 X4 = Contact with extension workers, expressed as the number of contacts with extension
127 workers (frequency in 2015)
- 128 X5 = Rice cultivated area, expressed as the number of hectares (ha)
- 129 X6 = Number of livestock, expressed as the number of livestock intensively reared
130 (heads)
- 131 X7 = Subjective norm, expressed as the perception of beef cattle farmers towards what
132 should be done in view of the their community based on their position (score)
- 133 X8 = Technology difficulty, expressed as difficulty in using crop residues feed by, beef
134 cattle farmers: 1 if the agrees that it is difficult, or 0 if otherwise
- 135 X9 = Family size, expressed as number of farmers' family (individual)

136 RESULTS

137 Farmer Characteristics

138 There were no significant differences between age, business experience, the
139 number of family members, and the education level of the farmers whether adopters or
140 non-adopters. However, the number of livestock and extensive landholding of adopter
141 farmers is significantly higher than that for the non-adopter farmers (Table 1). The
142 number of livestock₂ increased as the amount of feed increased such as rice straw. On the
143 contrary, the availability of labor was not a distinguished factor between adopters and
144 non-adopters.

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146 **Farmer's Reasons to Adopt and Not Adopt**

147 There are many reasons smallholder beef farmers adopting the utilization of crop
 148 residue such as corn-straw as a feed (Table 2). First, there was shortage of land fodder or
 149 herbage production. Second, corn-straw increased with the increased in harvesting
 150 season. Third, the number of livestock increased.

151 Main reason for smallholder beef farmers not adopting straw as feed because of
 152 the availability of other feed sources such as Napiergrass and Native Grass (Table 3).

153 Small holder beef farmers planted Napier grass close to their cattle pen so it was easy to
 154 be harvested or the livestock could graze on field twice a day. Another reason that it was
 155 not only require labor collected rice and corn straws, but also the farmers have no free
 156 time. Other reason was no available feed storage. Jabbar *et al.* (2009) stated that labor
 157 is one of the factors why farmers did not adopt the utilization of crop residue as a feed.

158 **Factors Affecting Farmers Adopting Crop Residue as Feed**

159 The results of the overall correct prediction (88.7%) and Chi square statistics
 160 (93,742) show that the models have ability to predict the chance of adoption of the
 161 utilization of rice and corn straws were high in Maros district. R square (0.709) showed
 162 that 70.9% variation in the dependent variables, was determined by the selected
 163 independent variables. Wald indication stated that contact with the extension (12.507)
 164 and the number of cattle (11.506) were variable, having a greater influence on farmers
 165 adopting rice and corn straws as a feed (Table 4).

166 Logistic regression analysis showed that six of nine independent variables had
 167 significant effect on the adoption of straw as a feed. These variables were contact with
 168 the extension worker ($P < 0.01$), the number of livestock ($P < 0.01$), paddy cultivated area
 169 ($P < 0.01$), social norms ($P < 0.01$), perception on the farm ($P < 0.05$) and the level of

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181 difficulty processing straw ($P<0.05$). Contact with extension workers, number of
 182 livestock, rice cultivated area, social norms and perceptions on the farm had positive
 183 regression coefficient values, indicating that they had a positive influence on the adoption
 184 of straw as a feed. It means that increased contact with extension agents, the number of
 185 cattle, the increase of paddy fields extension, social norm, the higher perception of
 186 farming, and the adoption of the use of straw as feed also increased.

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187 On the other hand, the level of difficulty processing straw showed a negative
 188 coefficient (Table 4). The more difficult in handling rice and corn straws, the lower the
 189 level in adopting straw as the feed. The variables which did not differ significantly
 190 regarding the adoption of straw as a feed were age, farmer_ experience, and the number
 191 of family member,

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192 DISCUSSION

193 The adoption of technology by using straws as feed depends on the adequacy of
 194 feed for cattle. If the farmers lacks feeds such as grasses, rice and corn straws, these will
 195 be used as the main of feed source (44 respondents). The method used by farmers to
 196 manage straw was as follows: 1) neither planting spot nor harvesting period was same; 2)
 197 planted time of corn should be different between farmers for collecting corn straw; and
 198 3) cultivated and straw storage.

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199 Main reason for smallholder beef farmers not adopting straw as a feed because of
 200 the availability of other feed sources such as napier grass and native grass. Smallholder
 201 beef farmers planted napier grass close to their cattle pen so that it is easier to be harvested
 202 or the livestock grazed in field twice a day. There were 28 farmers (53.85%) who prepare
 203 pasture for livestock grazing during the day, and therefore this do not require any
 204 additional feeds. Generally, those farmers who hold a limited number of livestock do not

208 adopt straw as a source of feed (Table 1); eventhough, there ~~were~~ shortage in herbage
 209 production when compared to the farmers who have large scale farm.

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210 Coefficient value of the intensity contact with extension worker was 2,835. The
 211 value means, farmer who has a contact with extension higher than other, had opportunity
 212 adopted 2.835 times compared to other farmers who did not have any contacts with
 213 extension worker. Extension worker is one of the important information sources for
 214 farmers. Adequate information especially from extension workers is one of the key
 215 drivers of technology utilization in Maros (Rogers 2003; Feola and Binder, 2010). They
 216 work for the farmers needs, not only demonstrating the utilization of the straw as a feed,
 217 as counselors, and as assistants, but also identified and solved problems (Bodorkos and
 218 Pataki, 2009; Hauser ~~et al.~~, 2016).

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219 The number of livestock~~s~~ is one of the factors which play an important role in the
 220 adoption of the use of crop residue as feed. Variable coefficient of the number of livestock
 221 was 2,328. The value means that farmers who have more livestock had opportunity in
 222 adopting rice and corn straws as feed doubly compared to farmers who have less
 223 livestock. The demand of feed increased through the increase in the number of livestock~~s~~.
 224 Rice and corn straws are one alternative crop residue to meet the feed demand in Maros
 225 district (Table 2). To meet the needs of cattle, rice and corn straws has to be processed
 226 before given to cattle because of its poor quality (Haryanto, 2009). Parmawati et al.
 227 (2018) revealed that regions where the centre of developing food security such as
 228 Pasuruan which is able to support the availability of feed for livestock and the integration
 229 programs between livestock and crop.

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230 The perception of livestock business is one of the drivers of farmer to adopt
 231 utilization of rice straw as feed. The value of variable perception was 1.9, which means

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236 that most perception of farmers towards their farming and, most adopted the formulated
 237 rice and corn straws as feed will increase 1.9 times. Farmers whose livestock business as
 238 the primary source of their income will maintain their livestock properly through the
 239 provision of sustainable feed. For instance rice and corn straws will be collected by the
 240 farmers not only in their rush hour but also in their free time. According to Reimer et al.
 241 (2012) a good perception is increased by the increase of farmers' motivation through
 242 utilization of free time for their farming.

243 Obstacle factor in adopting rice and corn straws as feed was a high level of
 244 difficulty especially when collecting and formulating rice and corn straws. Coefficient
 245 level of difficulty was -1.246. The coefficient had negative correlation means that the
 246 adoption decreased by 1.2 times with the increase of the level of difficulties. The lack of
 247 labor and straw barns was the reason for the farmer not adopting the utilization of rice
 248 and corn straws as feed (Table 3). Needing a labor to process corn straw however, was
 249 of the main factor inhibiting the utilization of corn straw as feed (Mudzengi, 2014).

250 CONCLUSION

251 In Maros regency, extension workers play an important role in increasing the
 252 adoption of technology by using rice and corn straws as a feed. Likewise, not only the
 253 number of livestock~~s~~, but also the good perception of the farmers increased along with
 254 the increase of feed availability, such as utilization of rice and corn straws. However, it
 255 decreased with the increase of labor need and the unavailability of straw barns. Therefore,
 256 to increase the adoption of technology by using rice and corn straws as a feed, extension
 257 workers must support the farmers' skill.

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326

327 **Table 1.** Characteristics of farmers and business farming

Variabel	Adopter		Non Adopter		T-Test
	Mean	Std	Mean	Std	
Age (Year)	43.45	9.10	43.13	10.65	0.386 ^{ns}
Business experience(year)	6.36	4.94	5.54	3.31	0.270 ^{ns}
Family member (person)	4.09	1.21	3.67	1.13	0.914 ^{ns}
Number of cattle (head)	3.86	1.17	2.98	0.75	0.000**
Wide of rice areal (ares)	49.68	33.37	27.38	18.29	0.003**
Education level (person)					
- low (\leq junior high school)	36		43		
- senior high school	7		9		
- university	1		0		
Total of farmers	44		52		

328 t-test ns; Non-significant, * significant in level 0.05 ($P > 0.05$), **significant in level 0.01 ($P < 0.01$)329 **Table 2.** Farmer's reasons to using crop residueas feed

Reason of adoption	Score*	Rank
Herbage production becomes in shortage	168	1
Holding limited land fodder	160	2
Obtainable of corn-straw	153	3
Straw abundant	110	4
Spend_of leisure time	69	5

330 The scale of 5-1 provided from the most important or vice versa in any respondents who adopted (44
331 respondents).

332 Table 3. The reason farmers did not adopt the use of rice and corn straws as feed

Reason of non-adoption	Score	Rank
The sufficient of other feed source	207	1
Pasture	197	2
Labor to collect straw	149	3
No storage place for feed	140	4
Required surcharge to storage straw	87	5

Deleted:

337 * The scale of 5-1 provided from the most important or *vice versa* in any respondents who
338 adopted (52 respondents).

339 Table 4. Logistic regression coefficients of the factors affecting the adoption of
340 utilization of crop residue as feed.

Varaibel	B	SE	Wald	P-Value
Age (X1)	-0.006	0.028	0.048	0.827 ^{ns}
Work perception (X2)	1.918	0.859	4.988	0.026 [*]
Farmer experience (X3)	0.039	0.099	0.154	0.695 ^{ns}
Contact with extension worker (X4)	2.835	0.802	12.507	0.000 ^{**}
Rice cultivated area (X5)	0.058	0.022	7.179	0.007 ^{**}
Number of livestock (X6)	2.328	0.392	11.506	0.001 ^{**}
Social norm (X7)	1.697	0.638	7.075	0.008 ^{**}
Difficulty (X8)	-1.246	0.601	4.295	0.038 [*]
Number of family (X9)	0.035	0.336	0.011	0.918 ^{ns}
Constant	-13.990	3.498	15.993	0.000 ^{**}

341 ^{**} and ^{*}, significant at $P < 0.01$ and $P < 0.05$ respectively. -2likelihood is 77.351; chi
342 square statistic is 93.742^{**}; Nagelkerke R Square 0.709; Overall correct prediction is
343 88.7; Number of Observation : 126

1 **Socio Economic Factors Affecting the Adoption of Agricultural By-Products as**
2 **Feed by Beef Cattle Farmers in Maros Regency South Sulawesi Indonesia**

3 **ABSTRACT**

4 The utilization of crop residue as a feed is very important because of the arable land
5 area is relatively limited. We examined the influence of adoption of crop residue
6 product as a feed. The research was conducted in Maros district by using survey
7 methods from March-August 2015. The number of respondents was 96 farmers
8 scattered throughout the districts of Bantimurung and Camba as centers of rice, corn
9 plant, and cattle. Questionnaire were used to collected data who conducted by trained
10 enumerator. Survey was arranged using a logistic regression model to identify socio
11 economic factors that have influenced the adoption of crop residue as a feed. Work
12 perception (X2), contact with extension workers (X4), rice cultivated areas (X5),
13 number of livestock (X6), subjective norm (X7), and difficulty (X8), as socio-economic
14 variables, influenced by the adoption of crop residue as a feed; however, the variables
15 age (X1), farmer experiences (X3) and the number of family members (X9) have no
16 effect on the adoption of this technology.

17 **Keywords:** adoption, crop residue, fodder, maros

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Commented [MP1]: Generally, Authors have accommodated several reviewer's suggestions. However, there are still some recommendations that need to be addressed:
1) Manuscript should be corrected by professional English Editor or the expert
2) References comments has not fully revised
3) Please add Conflict of interest section as written in the journal's guidelines

19

INTRODUCTION

20 Generally, in Indonesia, small holder beef farmers hold a limited number of
21 livestock, approximately 2-3 heads in total (Direktorat Jenderal Peternakan, 2015). The
22 smallholder beef farmers face many obstacles to increase their numbers of livestock. In
23 the past 10 years (2003-2013), extensive pasture did not increase and only 3.05 million
24 hectares are available, concentrated in a few provinces (National Statistical Bureau,
25 2014). Arable grassland is relatively limited and the nutritive values of forage crops
26 vary between seasons, with significant qualitative and quantitative drops in the dry
27 season. Native pastures provides herbage production for cattle. However, this function
28 has significantly decreased due to the shift of function from native pasture to
29 horticulture and crop fields or settlements, resulting in a shortage of herbage production
30 (Haryanto, 2009). Thus, the utilization of crop residue such as rice-and corn-straw could
31 be an alternative feed supply for smallholder beef farmers, therefore the number of their
32 livestock can be increased.

33 Utilization of crop residue such as rice- and corn-straw as a feed is a well-known
34 methods. In India, crop residue obtained 50-60% of total feed so that breeding strategy
35 towards the development of dual-purposes plant types could increase the adoption of
36 improved varieties (Rao and Hall 2003), while in Indonesia rice-straw is used reaches
37 31-39%. Since 1990-2000, Indonesian Agency for Agricultural Research and
38 Development, Ministry of Agriculture, has introduced the Crop Livestock System, (CLS
39 program; integrated rice/corn beef) in several provinces, including South Sulawesi
40 (Diwyanto 2008; Sariubang and Pasambe, 2005; Baba et al, 2014). However, the
41 utilization of straw as feed has shortages and smallholder beef farmers do not often store
42 this as a feed reserves for the following season (Rao and Hall, 2003; Haryanto et al.,

43 2009). Even in agricultural intensification land which produces high biomass, feed for
44 beef cattle is relatively limited (Ralevic et al., 2010; Valbuena et al., 2012).

45 Maros is one of the districts in South Sulawesi that is well known either as a
46 center of rice crops or for Bali beef cattle development. In 2015, the rice harvest area
47 reached 47,648 ha with Bantimurung districts is the highest harvested 18.31% (BPS,
48 2015). In 2007-2011, Farmer Empowerment through Agriculture Technology
49 Information (FEATI) encouraged smallholder beef farmers to use rice- and corn-straw
50 as a feed. Further, in 2012-2013, a participatory approach is used by University of
51 Hasanuddin to develop the technology. Not only researchers, extension workers, and
52 small beef farmers identify feed potential, but they also conducted experiments at the
53 farmer level. After the experiments, the smallholder farmers evaluated the technologies
54 that had been developed and decided whether to adopt the technology or not (Rhoades
55 and Boath, 1982; He et al., 2009). The participation of extension workers not only
56 increases access to resources (Ngoc Chi et al., 2007) but also the adoption of the
57 technology (Atmis et al., 2009; Bremer et al., 2014). However, in Maros, adoption of
58 crop residue as a feed is still limited. Baba et al. (2014) revealed that utilization of corn-
59 and rice- straw as a feed 63,5% and 32.5% respectively.

60 The adoption of crop residues as a feed has been influenced by several social,
61 economic, and technical factors; for example, discomfort in conducting the processing
62 of crop residue (Trach, 2004); unclear economic benefits (Trach, 2004; Giller et al.,
63 2009); labor shortages for processing of straw as a feed; and a lack of knowledge about
64 the processing of the straw (Baba et al., 2014; Mudzengi et al., 2014). It also includes
65 the cost of implementation and expected benefits. Interest from smallholder farmers and
66 their perceptions, as well as demographic characteristics, have been a factor (Giller et al.

67 2009). Socio economic factors were the main factors that determinant of technology
68 adoption. Adoption of crop residue utilization as a feed has never been done yet in
69 Maros. Therefore, the objective of this study was conducted to determine the socio-
70 economic impact of farmers to adopt the utilization of crop residues as feed

71 MATERIALS AND METHODS

72 Data Collection

73 This research was conducted in Maros District, South Sulawesi. The selected
74 site is well-known as a center for rice crop productions, corn, and Bali beef cattle in
75 Eastern Indonesia. Previously, collaboration between University of Hasanuddin, Maros
76 District Government and the Assessment Institute for Agricultural Technology South
77 Sulawesi Province has been disseminating utilization of rice- and corn- straw as a feed.
78 The dissemination includes fermentation and ammoniation of rice- and corn-straw and
79 silage of corn stalk. In this district, December-March is the first cropping of paddy;
80 April-June is the second cropping of sticky corn, pulut, local name of sticky corn; and
81 July-September is the third cropping of corn, respectively. Pulut was harvested in
82 young stage (70 days), therefore it have high palatability.

83 Data collection used questionnaires who distributed by trained enumerators, ran
84 from March to December 2015. Totally 487 smallholder beef farmers were spread over
85 three sub-districts such as Simbang and Bantimurung (2 villages) and Camba (1
86 village). Overall, 96 farmers who were selected as respondents from each village using
87 quota sampling. In Samangki and Simbang (Sub District Simbang), there were 25- and
88 20-respondents, respectively; in Leang-Leang and Minasa Baji (Sub District
89 Bantimurung) there were 23- and 16-respondents, respectively; and in Pattiro Deceng
90 (Sub District Camba), there were 12-respondents.

91 **Statistical Analysis**

92 Adoption of technology is the decision of farmers to accept or reject technology.
 93 The decision to adoption of technology was influenced by many factors such as
 94 environmental factors, smallholder farmers characteristics, socio-economics, farming
 95 purposes, biophysics and technology delivery method to the farmers. Dependent
 96 variables (i.e. adoption of crop residues technology utilization) measured by used
 97 dichotomous model where one means adopted while zero did not. Independent
 98 variables were internal factors of farmers, socio economy of the farmers, and
 99 biophysical farming. These factors were determined because of the cattle-business and
 100 paddy field- had long been carried out by them even though it have not been well
 101 integrated yet. Therefore, adopted or did not the technology of crop residue utilization
 102 depend on internal factors, socio-economic, and the biophysics of their farming

103 Logistic regression model used for determining factors that influenced the
 104 adoption of crop residues as a feed. Logistic model used as the dependent variable was
 105 measured by dichotomous variables, where 0 means not adopted (unused crop residues
 106 as a feed), while 1 means adopted (used crop residues as a feed whole time). The
 107 logistic regression model was as follows:

$$108 \quad Y = \ln \left(\frac{p_i}{1-p_i} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 +$$

$$109 \quad \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \epsilon$$

110 Where:

111 Y = Opportunity adoption of the utilization of straw as feed (pi = 0 indicates no
 112 adoption, pi = 1 indicates adoption)

113 β_0 = Intercept

114 β_1 - β_7 = Regression coefficients of the dependent variables

- 115 X1 = Age, expressed of the length of reviews their life (year)
116 X2 = Work perception,as a dichotomous variable, where 1 denotes the main work as
117 being a-beef cattle farmer, and 0 otherwise
118 X3 = Farmer expressed experience, reported as the length of their experience as a beef
119 cattle farmer (years)
120 X4 = Contact with extension workers, expressed as the number of contacts with
121 extension workers (frequency in 2015)
122 X5 = Rice cultivated area, expressed as the number of hectares (ha)
123 X6 = Number of livestock, expressed as the number of livestock intensively reared
124 (heads)
125 X7 = Subjective norm, expressed as the perception of beef cattle farmers towards what
126 should be done in view of the their community based on their position (score)
127 X8 = Technology difficulty, expressed as difficulty in using crop residues feed by, beef
128 cattle farmers: 1 if the agrees that it is difficult, or 0 if otherwise
129 X9 = Family size, expressed as number of farmers' family (individual)

130 RESULTS

131 Farmer Characteristics

132 There were no significant differences between age, business experience, the
133 number of families, and the education level of the farmers whether adopters or non-
134 adopters. However, the number of livestock and extensive landholding of adopter
135 farmers is significantly higher than that for the non-adopter farmers (Table 1). The
136 number of livestock increased as the amount of feed increased such as rice straw. On the
137 contrary, the availability of labor was not a distinguished factor between adopters and
138 non-adopters.

Farmer's Reasons to Adopt and Not Adopt

139
140 There are many reasons smallholder beef farmers adopted the utilization of crop
141 residue such as corn-straw as a feed (Table 2). Firstly, there was shortage of land
142 fodder or herbage production. Secondly, corn-straw increased with the increased in
143 harvesting season. Thirdly, the number of livestock increased.

144 Main reason for smallholder beef farmers not adopted straw as a feed because of
145 the availability of other feed sources such as Napiergrass and Native Grass (Table 3).
146 Small holder beef farmers planted Napier grass close to their cattle pen easier for it
147 harvesting or the livestock grazed in field by twice. Other than that it was not only
148 require labor collected rice- and corn- straw but also the farmers have no free time.
149 Other reason was no available feed storage. Jabbar *et al.* (2009) stated that labor is one
150 of the factors why farmers did not adopt the utilization of crop residue as a feed.

Factors Affecting Farmers Adopting Crop Residue as Feed

152 The results of the overall correct prediction (88.7%) and Chi square statistics
153 (93,742) show that the models have ability to predict the chance of adoption of the
154 utilization of rice- and corn-straw were high in Maros district. R square (0.709) showed
155 that 70.9% variation in the dependent variables, was determined by the selected
156 independent variables. Wald indication stated that contact with the extension (12.507)
157 and the number of cattle (11.506) were variable, having a greater influence on farmers
158 adopting rice- and corn- straw as a feed (Table 4).

159 Logistic regression analysis showed that six of the nine independent variables
160 had a significant effect on the adoption of straw as a feed. The sixth variables were
161 contact with the extension worker ($P<0.01$), the number of livestock ($P<0.01$), paddy
162 cultivated area ($P<0.01$), social norms ($P<0.01$), perception on the farm ($P< 0.05$) or

163 the level of difficulty processing straw ($P<0.05$). Contact with extension workers,
164 number of livestock, rice cultivated area, social norms and perceptions on the farm had
165 positive regression coefficient values, indicating that they had a positive influence on
166 the adoption of straw as a feed. It means, Increased contact with extension agents, the
167 number of cattle, the increasing extent of paddy fields, social norm and the higher
168 perception of farming, the adoption of the use of straw as feed also increased.

169 On the other hand, the level of difficulty processing straw showed a negative
170 coefficient (Table 4). The more difficult in handling Corn- and rice- straw, the lower
171 level adopted straw as feed. The variables which did not differ significantly regarding
172 the adoption of straw as a feed were age, farmer experience, and the number of families.

173 DISCUSSION

174 The adoption of technology by used straws as a feed depends on the adequacy of
175 feed for cattle. If the farmers lack of feed such as grasses, rice- and corn- straw will be
176 used as the main of feed source (44 respondents). The method used by farmers to
177 manage straw as follows: 1) neither planting spot nor harvesting period was same; 2)
178 planted time of corn should be different between farmer for collecting corn-straw; and
179 3) cultivated and straw storage.

180 Main reason for smallholder beef farmers not adopted straw as a feed because of
181 the availability of other feed sources such as napier grass and native grass. Smallholder
182 beef farmers planted napier grass close to their cattle pen easier for it harvesting or the
183 livestock grazed in field by twice. There were 28 farmers (53.85%) who prepare
184 pasture for livestock grazing during the day and therefore do not require any additional
185 feeds. Generally, those farmers who hold a limited number of livestock do not adopt

186 straw as a source of feed (Table 1) eventhough there was shortage in herbage production
187 when compared to the farmer who have large scale farmer.

188 Coefficient value of the intensity contact with extension worker was 2,835. The
189 value means, farmer who has contact with extension higher than other, had opportunity
190 adopted 2.835 times compared to other farmer who did not have any contacts with
191 extension worker. Extension worker is one of the important information source for
192 farmers. Adequate information especially from extension workers is one of a key driver
193 of technology utilization in Maros (Rogers 2003; Wubenehand Sanders 2006). They
194 work for the farmers needed, not only demonstrating the utilization of the straw as a
195 feed, as counselors, and as assistants, but also identified and solved problems
196 (Llewellyn, 2007; Bodorkos and Pataki, 2009).

197 Number of livestock is one of the factors which play an important role in the
198 adoption of the using of crop residue as feed. Variable coefficient of the number of
199 livestock was 2,328. The value means that farmers who belong more livestock had
200 opportunity adopted rice straw as feed doubly compared to farmers who have less
201 livestock. Demand feed increased by increased the number of livestock. Rice-straw
202 and corn- are one alternative crop residue to meet feed demand in Maros district (Table
203 2). According to Trach (2004) utilization of rice-straw as feed could be formulated in
204 several methods not only by chemical, physical, biological but also other
205 supplementation to meet livestock need. Parmawati et al. (2018) revealed that regions
206 where the centre of developing food security such as Pasuruan are able to support the
207 availability of feed for livestock and support integration programs between livestock
208 and crop.

209 Perception of livestock business is one of the drivers of farmer to adopt
210 utilization of rice-straw as feed. The value of Variable perception was 1.9, which
211 means that the most perception of farmers towards their farming, the most adopted the
212 formulated rice-straw as feed will be increased 1.9 times. Farmers who livestock
213 business as the primarily source of their income will be maintained their livestock
214 properly through the provision of sustainable feed. For instance rice-straw will be
215 collected by the farmers not only in their rush hour but also in free time. According to
216 Reimer et al. (2012) a good perception increased by the increasing of farmers'
217 motivation through utilization of free time for their farming.

218 Obstacle factor to adopting rice straw as feed was high level of difficulty
219 especially when it collecting and formulating rice-straw. Coefficient level of difficulty
220 was -1.246. The coefficient means it had negative correlation where the adoption
221 decreased by 1.2 times with the increasing of the level of difficulties. Lack of labor and
222 straw barns were the reason for the farmer would not adopt the utilization of rice-straw
223 as feed (Table 3). Need a labor to process corn-straw however it was of the main factor
224 inhibiting the utilization of corn-straw as feed (Mudzengi, 2014).

225 CONCLUSION

226 In Maros regency, extension workers play an important role in increasing the
227 adoption of technology by using rice straw as a feed. Likewise, not only number of
228 livestock but also good perception of the farmers increased with the increasing of
229 availability feed such as utilization of rice- and corn- straw. However, it decreased with
230 the increasing of labor need and not available of straw barns. Therefore, to increase the
231 adoption of technology by using rice straw as a feed, extension workers must support
232 the farmers' skill.

233

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306 **Table 1.** Characteristics of farmers and business farming by respondents

Variabel	Adopter		Non Adopter		T-Test
	Mean	Std	Mean	Std	
Age (Year)	43.45	9.10	43.13	10.65	0.386 ^{ns}
Business experience(year)	6.36	4.94	5.54	3.31	0.270 ^{ns}
Family member (person)	4.09	1.21	3.67	1.13	0.914 ^{ns}
Number of cattle (head)	3.86	1.17	2.98	0.75	0.000 ^{**}
Wide of rice areal (ares)	49.68	33.37	27.38	18.29	0.003 ^{**}
Education level (person)					
- low (\leq junior high school)	36		43		
- senior high school	7		9		
- university	1		0		
Total of farmers	44		52		

307 t-test ns : Non significant, * significant in level 0.05 ($P > 0.05$), **significant in level 0.01 ($P < 0.01$)

308

309 **Table 2.** Farmer's reasons to using crop residue as feed

Reason of adoption	Score*	Rank
Herbage production becomes in shortage	168	1
Holding limited land fodder	160	2
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Straw abundant	110	4
Spend of leisure time	69	5

310 The scale of 5-1 provided from the most important or *vice versa* in any respondents who adopted (44
311 respondents).

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313 Table 3. The reason farmers did not adopt the use of rice-straw/corn- as feed

Reason of non adoption	Score	Rank
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317 Table 4. Logistic regression coefficients of the factors affecting the adoption of
 318 utilization of crop residue as feed.

Varaiabel	B	SE	Wald	P-Value
Age (X1)	-0.006	0.028	0.048	0.827 ^{ns}
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Number of livestock (X6)	2.328	0.392	11.506	0.001**
Social norm (X7)	1.697	0.638	7.075	0.008**
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Number of family (X9)	0.035	0.336	0.011	0.918 ^{ns}
Constant	-13.990	3.498	15.993	0.000**

319 ** and *, significant at $P < 0.01$ and $P < 0.05$ respectively. -2likelihood is 77.351; chi
 320 square statistic is 93.742**; Nagelkerke R Square 0.709; Overall correct prediction is
 321 88.7; Number of Observation : 126

1 **Socio Economic Factors Affecting the Adoption of Agricultural By-Products as**
2 **Feed by Beef Cattle Farmers in Maros Regency of South Sulawesi Indonesia**

3

4

ABSTRACT

5 The utilization of crop residue as a feed is very important because the arable land area is
6 relatively limited. We examined the influence of adoption of crop residue product as a
7 feed. The research was conducted in Maros district by using survey methods from
8 March to August 2015. The number of respondents was 96 farmers scattered throughout
9 the districts of Bantimurung and Camba as centers of rice, corn plant, and
10 cattle. Questionnaires were used to collect data conducted by a trained enumerator.
11 Survey was arranged using a logistic regression model to identify socioeconomic factors
12 which have influenced the adoption of crop residue as a feed. Work perception (X2),
13 contact with extension workers (X4), rice cultivated areas (X5), number of livestock
14 (X6), subjective norm (X7), and difficulty (X8), as socio-economic variables,
15 influenced by the adoption of crop residue as a feed; however, the variables age (X1),
16 farmer experiences (X3), and the number of family members (X9) have no effect on the
17 adoption of this technology. Extension workers play an important role in increasing the
18 adoption of technology by using rice and corn straws as a feed. Likewise, not only the
19 number of livestock, but also the good perception of the farmers increased along with
20 the increase of feed availability, such as utilization of rice and corn straws.

21 Keywords: adoption, crop residue, fodder, maros

22

23

INTRODUCTION

24 Generally, in Indonesia, smallholder beef farmers hold a limited number of
25 livestock, approximately 2-3 heads in total (Direktorat Jenderal Peternakan, 2015). The
26 smallholder beef farmers face many obstacles to increase their numbers of livestock. In
27 the past 10 years (2003-2013), extensive pasture has not been increasing and only 3.05
28 million hectares are available, concentrated in a few provinces (National Statistical
29 Bureau, 2014). Arable grassland is relatively limited and the nutritive values of forage
30 crops vary between seasons, with significant qualitative and quantitative drops in the
31 dry season. Native pastures provides herbage production for cattle. However, this
32 function has significantly decreased due to the shift of function from native pasture to
33 horticulture and crop fields or settlements, resulting in a shortage of herbage production
34 (Haryanto,2009). Thus, the utilization of crop residues such as riceand cornstraws could
35 be an alternative feed supply for smallholder beef farmers; therefore, the number of
36 their livestock can be increased.

37 Utilization of crop residues such as rice and corn straws as a feed is a wellknown
38 methods. In India, crop residue reached 50%-60% of total feed so that breeding strategy
39 towards the development of dual-purposes plant types could increase the adoption of
40 improved varieties (Rao & Hall, 2003), while in Indonesia rice straw is used to reaching
41 31%-39%. Since 1990-2000, Indonesian Agency for Agricultural Research and
42 Development, Ministry of Agriculture, has introduced the Crop Livestock System, (CLS
43 program; integrated rice/corn beef) in several provinces, including South Sulawesi
44 (Haryanto, 2009; Winarso & Basuno, 2013; Baba *et al.*, 2014). However, the utilization
45 of straw as feed causes shortages and smallholder beef farmers do not often store this as
46 a feed reserves for the following season (Haryanto, 2009). Even in agricultural

47 intensification land which produces high biomass, feed for beef cattle is relatively
48 limited (Ralevic *et al.*, 2010; Valbuena *et al.*, 2012).

49 Maros is one of the well known districts in South Sulawesi which is either as a
50 center of rice crops or as Bali beef cattle development center. In 2015, the rice harvest
51 area reached 47,648 ha with Bantimurung districts was the highest in harvest
52 with 18.31% (BPS, 2015). In 2007-2011, Farmer Empowerment through Agriculture
53 Technology Information (FEATI) encouraged smallholder beef farmers to use rice and
54 cornstraws as a feed. Furthermore, in 2012-2013, a participatory approach is used by
55 University of Hasanuddin to develop the technology. Not only researchers, extension
56 workers, and small beef farmers identify feed potential, but they also conducted
57 experiments at the farmer level. After the experiments, the smallholder farmers
58 evaluated the technologies which had been developed and decided whether to adopt the
59 technology or not (Rhoades & Boath, 1982; He *et al.*, 2009). The participation of
60 extension workers increases not only access to resources (Hauser *et al.*, 2016) but also
61 the adoption of the technology (Atmis *et al.*, 2009; Bremer *et al.*, 2014). However, in
62 Maros, adoption of crop residue as a feed is still limited. Baba *et al.* (2014) revealed that
63 utilization of rice and corn straws as a feed 63.5% and 32.5% respectively.

64 The adoption of crop residues as a feed has been influenced by several social,
65 economic, and technical factors; for example, difficulty in making rice straw compost
66 (Supaporn *et al.*, 2013), unclear economic benefits (Giller *et al.*, 2009), labor shortages
67 for processing of straw as a feed, and a lack of knowledge about the processing of the
68 straw (Supaporn *et al.*, 2013; Baba *et al.*, 2014; Mudzengi *et al.*, 2014). It also includes
69 the cost of implementation and expected benefits. Interest from smallholder farmers and
70 their perceptions, as well as demographic characteristics, have been a factor (Giller *et*

71 *al.*, 2009). Socio economic factors were the main factors that are the determinant of
72 technology adoption. The adoption of crop residue utilization as a feed has never been
73 done yet in Maros. Therefore, the objective of this study was conducted to determine
74 the socio-economic impact of farmers to adopt the utilization of crop residues as feed.

75

76 MATERIALS AND METHODS

77

Data Collection

78 This research was conducted in Maros District, South Sulawesi. The selected
79 site is a well-known center for rice crop productions, corn, and Bali beef cattle in
80 Eastern Indonesia. Previously, collaboration between University of Hasanuddin, Maros
81 District Government and the Assessment Institute for Agricultural Technology South
82 Sulawesi Province has been disseminating utilization of rice and corn straws as a feed.
83 The dissemination includes fermentation and ammoniation of rice and corn straws and
84 silage of corn stalk. In this district, December-March is the first cropping of paddy;
85 April-June is the second cropping of sticky corn, *pulut*, local name of sticky corn; and
86 July-September is the third cropping of corn, respectively. *Pulut* was harvested in young
87 stage (70 days); therefore, it has a high palatability.

88 Data collection used questionnaires which are distributed by trained
89 enumerators, running from March to December 2015. In total, 487 smallholder beef
90 farmers were spread over three sub-districts such as Simbang and Bantimurung (2
91 villages) and Camba (1 village). Overall, 96 farmers who were selected as respondents
92 from each village using quota sampling. In Samangki and Simbang (Sub District
93 Simbang), there were 25- and 20- respondents, respectively; in Leang-Leang and

94 Minasa Baji (Sub District Bantimurung) there were 23- and 16-respondents,
 95 respectively; and in Pattiro Deceng (Sub District Camba), there were 12-respondents.

96 **Statistical Analysis**

97 Adoption of technology is the decision of farmers to accept or reject technology.
 98 The decision to the adoption of technology was influenced by many factors such as
 99 environmental factors, smallholder farmers characteristics, socio-economics, farming
 100 purposes, biophysics and technology delivery method to the farmers. Dependent
 101 variables (i.e. adoption of crop residues technology utilization) measured by using
 102 dichotomous model where one means adopted while zero did not. Independent
 103 variables were internal factors of farmers, socio economy of the farmers, and
 104 biophysical farming. These factors were determined because of the cattle business and
 105 paddy field had long been carried out by them even though it has not been well
 106 integrated yet. Therefore, whether adopted or not the technology of crop residue
 107 utilization depends on internal factors, socio-economic, and the biophysics of their
 108 farming

109 Logistic regression model was used for determining factors that influenced the
 110 adoption of crop residues as a feed. Logistic model was used as the dependent variable
 111 measured by dichotomous variables, where 0 means not adopted (unused crop residues
 112 as a feed), while 1 means adopted (used crop residues as a feed the whole time). The
 113 logistic regression model was as follows:

$$114 \quad Y = \ln (pi/1-pi) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 +$$

$$115 \quad \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \varepsilon$$

116 Where: Y is the opportunity adoption of the utilization of straw as feed ($pi= 0$ indicates
 117 no adoption, $pi= 1$ indicates adoption); β_0 is intercept; $\beta_1-\beta_7$ is regression coefficients

118 of the dependent variables; $X1$ is age, expressed of the length of reviews their life
119 (year); $X2$ is work perception, as a dichotomous variable, where 1 denotes the main
120 work as being a-beef cattle farmer, and 0 otherwise; $X3$ is farmer expressed experience,
121 reported as the length of their experience as a beef cattle farmer (years); $X4$ is contact
122 with extension workers, expressed as the number of contacts with extension workers
123 (frequency in 2015); $X5$ is rice cultivated area, expressed as the number of hectares (ha);
124 $X6$ is number of livestock, expressed as the number of livestock intensively reared
125 (heads); $X7$ is subjective norm, expressed as the perception of beef cattle farmers
126 towards what should be done in view of the their community based on their position
127 (score); $X8$ is technology difficulty, expressed as difficulty in using crop residues feed
128 by, beef cattle farmers: 1 if the agrees that it is difficult, or 0 if otherwise; and $X9$ is
129 family size, expressed as number of farmers' family (individual).

130 RESULTS

131 Farmer Characteristics

132 There were no significant differences between age, business experience, the
133 number of family members, and the education level of the farmers whether adopters or
134 non-adopters. However, the number of livestock and extensive landholding of adopter
135 farmers is significantly higher than that for the non-adopter farmers (Table 1). The
136 number of livestock increased as the amount of feed increased such as rice straw. On
137 the contrary, the availability of labor was not a distinguished factor between adopters
138 and non-adopters.

139 Farmer's Reasons to Adopt and Not Adopt

140 There are many reasons smallholder beef farmers adopting the utilization of crop
141 residue such as corn-straw as a feed (Table 2). First, there was shortage of land fodder

142 or herbage production. Second, corn-straw increased with the increased in harvesting
143 season. Third, the number of livestocks increased.

144 Main reason for smallholder beef farmers not adopting straw as a feed because
145 of the availability of other feed sources such as Napiergrass and Native Grass (Table 3).
146 Small holder beef farmers planted Napier grass close to their cattle pen so it was easier
147 for it to beharvested or the livestock could graze on field twice a day. Other than that it
148 was not only require labor collected rice and corn straws, but also the farmers have no
149 free time. Other reason was no available feed storage. Jabbar *et al.* (2009) stated that
150 labor is one of the factors why farmers did not adopt the utilization of crop residue as a
151 feed.

152 **Factors Affecting Farmers Adopting Crop Residue as Feed**

153 The results of the overall correct prediction (88.7%) and Chi square statistics
154 (93,742) show that the models have ability to predict the chance of adoption of the
155 utilization of rice and corn straws were high in Maros district. R square (0.709) showed
156 that 70.9% variation in the dependent variables, was determined by the selected
157 independent variables. Wald indication stated that contact with the extension (12.507)
158 and the number of cattle (11.506) variables were having a greater influence on farmers
159 adopting rice and corn straws as a feed (Table 4).

160 Logistic regression analysis showed that six out of the nine independent
161 variables had a significant effect on the adoption of straw as a feed. The sixth variables
162 were contact with the extension worker ($P<0.01$), the number of livestock ($P<0.01$),
163 paddy cultivated area ($P<0.01$), social norms ($P<0.01$), perception on the farm ($P<$
164 0.05) and the level of difficulty processing straw ($P<0.05$). Contact with extention
165 workers, number of livestocks, rice cultivated area, social norms and perceptions on the

166 farm had positive regression coefficient values, indicating that they had a positive
167 influence on the adoption of straw as a feed. It means that increased contact with
168 extension agents, the number of cattle, the increase of paddy fields extension, social
169 norm, the higher perception of farming, and the adoption of the use of straw as feed also
170 increased.

171 On the other hand, the level of difficulty processing straw showed a negative
172 coefficient (Table 4). The more difficult in handling rice and corn straws, the lower the
173 level in adopting straw as the feed. The variables which did not differ significantly
174 regarding the adoption of straw as a feed were age, farmer experience, and the number
175 of family member.

176 DISCUSSION

177 The adoption of technology by using straws as a feed depends on the adequacy
178 of feed for cattle. If the farmers lacks feeds such as grasses, rice and corn straws, these
179 will be used as the main of feed source (44 respondents). The method used by farmers
180 to manage straw was follows: 1) neither planting spot nor harvesting period was same;
181 2) planted time of corn should be different between farmers for collecting corn straw;
182 and 3) cultivated and straw storage.

183 Main reason for smallholder beef farmers not adopting straw as a feed because
184 of the availability of other feed sources such as napier grass and native grass.
185 Smallholder beef farmers planted napier grass close to their cattle pen so that it is easier
186 to be harvested or the livestock grazed in field twice a day. There were 28 farmers
187 (53.85%) who prepare pasture for livestock grazing during the day, and therefore this do
188 not require any additional feeds. Generally, those farmers who hold a limited number of
189 livestock do not adopt straw as a source of feed (Table 1); eventhough, there was

190 shortage in herbage production when compared to the farmers who have large scale
191 farm.

192 Coefficient value of the intensity contact with extension worker was 2.835. The
193 value means, farmer who has a contact with extension higher than other, had
194 opportunity adopted 2.835 times compared to other farmers who did not have any
195 contacts with extension worker. Extension worker is one of the important information
196 sources for farmers. Adequate information especially from extension workers is one of
197 the key drivers of technology utilization in Maros (Rogers 2003; Feola & Binder, 2010).
198 They work for the farmers needs, not only demonstrating the utilization of the straw as a
199 feed, as counselors, and as assistants, but also identified and solved problems (Bodorkos
200 & Pataki, 2009; Hauser *et al.*, 2016).

201 The number of livestock is one of the factors which play an important role in
202 the adoption of the use of crop residue as feed. Variable coefficient of the number of
203 livestock was 2.328. The value means that farmers who have more livestock had
204 opportunity in adopting rice and corn straws as feed doubly compared to farmers who
205 have less livestock. The demand of feed increased through the increase in the number of
206 livestock. Rice and corn straws are one alternative crop residue to meet the feed
207 demand in Maros district (Table 2). To meet the needs of cattle, rice and corn straws
208 has to be processed before given to cattle because of its poor quality (Haryanto, 2009).
209 Parmawati *et al.* (2018) revealed that regions as the centre of developing food security,
210 such as Pasuruan, is able to support the availability of feed for livestock and the
211 integration programs between livestock and crop.

212 The perception of livestock business is one of the drivers of farmer to adopt
213 utilization of rice straw as feed. The value of variable perception was 1.9, which means

214 that most perception of farmers towards their farming and, most adopted the formulated
215 rice and corn straws as feed will increase 1.9 times. Farmers whose livestock business
216 as the primary source of their income will maintain their livestock properly through the
217 provision of sustainable feed. For instance rice and corn straws will be collected by the
218 farmers not only in their rush hour but also in their free time. According to Reimer et
219 al. (2012) a good perception is increased by the increase of farmers' motivation through
220 utilization of free time for their farming.

221 Obstacle factor in adopting rice and corn straws as feed was a high level of
222 difficulty especially when collecting and formulating rice and corn straws. Coefficient
223 level of difficulty was -1.246. The coefficient means it had negative correlation where
224 that the adoption decreased by 1.2 times with the increase of the level of difficulties.
225 The lack of labor and straw barns were the reason for the farmer not adopting the
226 utilization of rice and corn straws as feed (Table 3). Needing a labor to process corn
227 straw however, was of the main factor inhibiting the utilization of corn straw as feed
228 (Mudzengi, 2014).

229

CONCLUSION

230 In Maros regency, extension workers play an important role in increasing the
231 adoption of technology by using rice and corn straws as a feed. Likewise, not only the
232 number of livestock, but also the good perception of the farmers increased along with
233 the increase of feed availability, such as utilization of rice and corn straws. However, it
234 decreased with the increase of labor need and the unavailability of straw barns.
235 Therefore, to increase the adoption of technology by using rice and corn straws as a
236 feed, extension workers must support the farmers' skill.

237

238

CONFLICT OF INTEREST

239 The authors declare there is no conflict of interest

240

241

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- senior high school	7		9		
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 323 88.7; Number of observation : 96

Factors Affecting the Adoption of Agricultural By-Products as Feed by Beef Cattle Farmers in Maros Regency of South Sulawesi, Indonesia

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ABSTRACT

The utilization of crop residue as a feed is very important because the arable land area is relatively limited. The study was aimed to examine the influence of adoption of crop-residue product as a feed. The research was conducted in Maros District by using survey methods from March to August 2015. The number of respondents was 96 farmers scattered throughout the Districts of Bantimurung and Camba as centers of rice, corn plant, and cattle productions. Questionnaires were used to collect data conducted by a trained enumerator. Survey was arranged using a logistic regression model to identify socio economic factors influencing the adoption of crop residue as a feed. Work perception (X2), contact with extension workers (X4), rice cultivated areas (X5), the number of livestock (X6), subjective norm (X7), and difficulty (X8) were socio-economic variables influencing the adoption of crop residue as a feed. However, the variables age (X1), farmer experiences (X3), and the number of family members (X9) had no effect on the adoption of this technology. In conclusion, extension workers play an important role in increasing the adoption of technology by using rice and corn straws as a feed. Likewise, not only the number of livestock, but also the good perception of the farmers increased along with the increase of feed availability, such as utilization of rice and corn straws.

Keywords: technology adoption; crop residue; fodder; Maros

INTRODUCTION

Generally, in Indonesia, smallholder beef farmers hold a limited number of livestock, approximately 2-3 heads in total (Direktorat Jenderal Peternakan, 2015). The smallholder beef farmers face many obstacles to increase their numbers of livestock. In the past 10 years (2003-2013), extensive pasture had not been increasing and only 3.05 million hectares were available, concentrated in a few provinces (National Statistical Bureau, 2014). Arable grassland is relatively limited and the nutritive values of forage crops vary between seasons, with significant qualitative and quantitative drops in the dry season. Native pastures provide herbage production for cattle. However, this function has significantly decreased due to the shift of function from native pasture to horticulture and crop fields or settlements, resulting in a shortage of herbage production (Haryanto, 2009). Therefore, the utilization of crop residues such as rice and corn straws could be an alternative feed supply for smallholder beef farmers that can support the increase in the number of their livestock.

The utilization of crop residues such as rice and corn straws as a feed is a well-known method. In

India, crop residue reached 50%-60% of total feed used so that breeding strategy towards the development of dual-purposes plant types could increase the adoption of improved varieties (Rao & Hall, 2003), while in Indonesia the use of rice straw for animal feed just reached 31%-39%. Since 1990-2000, Indonesian Agency for Agricultural Research and Development, Ministry of Agriculture, introduced the Crop Livestock System, (CLS program; integrated rice/corn beef) in several provinces, including South Sulawesi (Haryanto, 2009; Winarso & Basuno, 2013; Baba *et al.*, 2014). However, the utilization of straw as feed causes shortages of the straw and smallholder beef farmers usually do not store the straw as a feed reserve for the following season (Haryanto, 2009). Even in the agricultural intensification land which produces high biomasses, the availability of feed for beef cattle is relatively limited (Ralevic *et al.*, 2010; Valbuena *et al.*, 2012).

Maros is one of the well-known districts in South Sulawesi which is either as a center of rice crops or as a Bali beef cattle development center. In 2015, the rice harvest area reached 47,648 ha with Bantimurung District had the highest harvest area i.e., 18.31% (BPS, 2015). In 2007-2011, Farmer Empowerment through

Agriculture Technology Information (FEATI) encouraged smallholder beef farmers to use rice and corn straws as feeds. Furthermore, in 2012-2013, a participatory approach was used by the University of Hasanuddin to develop the technology. The researchers, extension workers, and smallholder beef farmers not only identified the feed potential, but they also conducted some experiments at the farmer level. After the experiments, the smallholder farmers evaluated the technologies which had been developed and decided whether to adopt the technology or not (Rhoades & Boath, 1982; He *et al.*, 2009). The participation of extension workers not only increases the access to resources (Hauser *et al.*, 2016) but also the adoption of the technology (Atmis *et al.*, 2009; Bremer *et al.*, 2014). However, in Maros, the adoption of crop residue to be used as a feed is still limited. Baba *et al.* (2014) revealed that utilizations of rice and corn straws as feeds were only 63.5% and 32.5%, respectively.

The success of crop residues utilization as a feed is influenced by several social, economic, and technical factors; for example, the difficulty in making rice straw compost (Supaporn *et al.*, 2013), unclear economic benefits (Giller *et al.*, 2009), labor shortages for processing of straw as a feed, and a lack of knowledge about the processing of the straw (Supaporn *et al.*, 2013; Baba *et al.*, 2014; Mudzengi *et al.*, 2014). It also includes the cost of implementation and expected benefits. Interest from smallholder farmers and their perceptions, as well as demographic characteristics, have been a factor (Giller *et al.*, 2009). Socio economic factors were the main factors that are the determinant of technology adoption. The adoption of crop residue utilization as a feed has never been done yet in Maros. Therefore, the objective of this study was to determine the socio-economic impact of farmers to adopt the utilization of crop residues as feed.

MATERIALS AND METHODS

Data Collection

This research was conducted in Maros District, South Sulawesi. The selected site is a well-known center for rice crop productions, corn, and Bali beef cattle in Eastern Indonesia. Previously, collaboration between the University of Hasanuddin, Maros District Government, and the Assessment Institute for Agricultural Technology, South Sulawesi Province disseminated utilization of rice and corn straws as a feed. The dissemination included fermentation and ammonization of rice and corn straws and silage of corn stalk. In this district, December-March is the first cropping of paddy; April-June is the second cropping of sticky corn, *pulut*, local name of sticky corn; and July-September is the third cropping of corn, respectively. *Pulut* is harvested in young stage (70 days); therefore, it has a high palatability.

Data collection used questionnaires which were distributed by trained enumerators, running from March to December 2015. In total, 487 smallholder beef farmers were spread over three sub-districts such as Simbang and Bantimurung (2 villages) and Camba

(1 village). Overall, 96 farmers were selected as respondents from each village using quota sampling. In Samangki and Simbang (Subdistrict Simbang), there were 25 and 20 respondents, respectively; in Leang-Leang and Minasa Baji (Subdistrict Bantimurung) there were 23 and 16 respondents, respectively; and in Pattiro Deceng (Subdistrict Camba), there were 12 respondents.

Statistical Analysis

Adoption of technology is the decision of farmers to accept or reject technology. The decision to the adoption of technology is influenced by many factors such as environmental factors, smallholder-farmers characteristics, socio-economics, farming purposes, biophysics, and technology delivery method to the farmers. Dependent variables (i.e. adoption and utilization of crop-residues technology) were measured by using dichotomous model where 1 meant was adopted while 0 meant was not adopted. Independent variables were internal factors of farmers, socio economy of the farmers, and biophysical farming. These factors were determined because of the cattle business and paddy field had long been carried out by them even though it had not been well integrated yet. Therefore, whether adopted or not adopted the technology of crop residue utilization depends on internal factors, socio-economic, and the biophysics of their farming.

Logistic regression model was used for determination of factors influencing the adoption of crop residues as a feed. Logistic model was used as the dependent variable measured by dichotomous variables, where 0 meant was not adopted (unused crop residues as a feed), while 1 meant was adopted (used crop residues as a feed the whole time). The logistic regression model was as follows:

$$Y = \ln(\pi/1-\pi) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \epsilon$$

Where: Y was the opportunity for adoption or the utilization of straw as feed ($\pi=0$ indicated no adoption, $\pi=1$ indicated adoption); β_0 was intercept; β_1 - β_7 was regression coefficient of the dependent variable; X_1 was age, expressed of the length of their life (year); X_2 was work perception, as a dichotomous variable, where 1 denoted the main work as being a beef cattle farmer, and 0 otherwise; X_3 was farmer experience, reported as the length of their experience as a beef cattle farmer (years); X_4 was contact with extension workers, expressed as the number of contacts with extension workers (frequency in 2015); X_5 was rice cultivated area, expressed as the number of hectares (ha); X_6 was the number of cattle, expressed as the number of cattle intensively reared (heads); X_7 was subjective norm, expressed as the perception of beef cattle farmers towards what should be done in view of their community based on their position (score); X_8 was technology difficulties, expressed as a difficulty in using crop residues feed by beef cattle farmers: 1 if they agree that it is difficult, or 0 if otherwise; and X_9 was family size, expressed as the number of farmers' family (individual).

RESULTS

Farmer Characteristics

There were no significant differences between age, farmer experience, family size, and the education level of the farmers whether adopters or non-adopters. However, the number of cattle and rice cultivated area of adopter farmers was significantly higher than that of the non-adopter farmers (Table 1). The number of cattle increased as the amount of feed increased such as rice straw. On the contrary, the availability of labor was not a distinguished factor between adopters and non-adopters.

The Farmer's Reasons to Adopt and Not Adopt

There were many reasons for smallholder beef farmers to adopt the utilization of crop residue such as corn-straw as a feed (Table 2). The first reason was the shortage of land fodder or herbage production. The second reason was the limited of land fodder holding and the third was the increase in corn straw with the increase in harvesting season.

The main reason for smallholder beef farmers not adopting straw as a feed was the availability of the other feed sources such as Napier grass and Native grass (Table 3). In addition, the farmers did not only require labor to collect rice and corn straws, but they also had no free time. Another reason was the non-available facility for feed storage. Jabbar *et al.* (2009) stated that

labor is one of the factors why farmers did not adopt the utilization of crop residue as a feed.

Factors Affecting Farmers to Adopt Crop Residue as Feed

The results of the overall correct prediction (88.7%) and Chi square statistics (93.742) showed that the models had the high ability to predict the chance to adopt the utilization of rice and corn straws as feed in Maros District. R square (0.709) showed that 70.9% variation in the dependent variables was determined by the selected independent variables. Wald indication stated that contact with the extension (12.507) and the number of cattle (11.506) variables had a greater influence on the farmer's adoption of rice and corn straws as a feed (Table 4).

Logistic regression analysis showed that 6 out of 9 independent variables had significant effects on the adoption of straw as a feed. The 6 variables were contact with the extension worker ($P<0.01$), the number of cattle ($P<0.01$), rice cultivated area ($P<0.01$), subjective norms ($P<0.01$), work perception ($P<0.05$), and the level of technology difficulty in processing straw ($P<0.05$). Contact with extension workers, the number of cattle, rice cultivated area, social norms, and work perceptions had positive regression coefficient values indicating that they had positive influences on the adoption of straw as a feed. These results indicated that the increased contact with the extension agents, the number of cattle, the increase of rice cultivated area, social norm, and the higher perception of farming would increase the adoption of straw as feed.

Table 1. Characteristics of farmers and business farming by respondents

Variable	Adopter		Non Adopter		T-Test
	Mean	Std	Mean	Std	
Age (Year)	43.45	9.10	43.13	10.65	0.386 ^{ns}
Business experience (year)	6.36	4.94	5.54	3.31	0.270 ^{ns}
Family member (person)	4.09	1.21	3.67	1.13	0.914 ^{ns}
Number of cattle (head)	3.86	1.17	2.98	0.75	0.000 ^{**}
Wide of rice areal (are)	49.68	33.37	27.38	18.29	0.003 ^{**}
Education level (person)					
Low (\leq junior high school)		36		43	
Senior high school		7		9	
University		1		0	
Total of farmers		44		52	

Note: t-test ns= Non-significant; * significant in level 0.05 ($P<0.05$), **significant in level 0.01 ($P<0.01$).

Table 2. Farmer's reasons for using crop residue as feed

Reason of adoption	Score*	Rank
Herbage production becomes in shortage	168	1
Holding limited land fodder	160	2
Obtainable of corn-straw	153	3
Straw abundant	110	4
Spend of leisure time	69	5

Note: The scale of 5-1 provided from the most important or vice versa in any respondents who adopted (44 respondents).

Table 3. The farmer's reason for not adopting the use of rice and corn straws as feed

Reason of non-adoption	Score	Rank
The sufficient of the other feed sources	207	1
Pasture	197	2
Labor to collect straw	149	3
No storage place for feed	140	4
Required surcharge for storage of straw	87	5

Note: The scale of 5-1 provided from the most important or vice versa in any respondents who adopted (52 respondents).

Table 4. Logistic regression coefficients of the factors affecting the adoption of utilization of crop residue as feed

Variable	B	SE	Wald indication	P-Value
Age (X1)	-0.006	0.028	0.048	0.827 ^{ns}
Work perception (X2)	1.918	0.859	4.988	0.026*
Farmer experience (X3)	0.039	0.099	0.154	0.695 ^{ns}
Contact with extension worker (X4)	2.835	0.802	12.507	0.000**
Rice cultivated area (X5)	0.058	0.022	7.179	0.007**
Number of cattle (X6)	2.328	0.392	11.506	0.001**
Subjective norm (X7)	1.697	0.638	7.075	0.008**
Technology difficulties (X8)	-1.246	0.601	4.295	0.038*
Family size (X9)	0.035	0.336	0.011	0.918 ^{ns}
Constant	-13.99	3.498	15.993	0.000**

Note: ** and * = significant at P<0.01 and P<0.05, respectively; -2 likelihood is 77.351; chi square statistic is 93.742**; Nagelkerke R Square 0.709; Overall correct prediction is 88.7; the number of observation= 96; B= coefficient value; SE= standard error.

On the other hand, the level of difficulty in processing straw showed a negative coefficient (Table 4). The higher the difficulty in handling rice and corn straws, the lower the success in adopting rice and corn straws as feed. The variables which did not significantly affect the adoption of straw as a feed were age, farmer experience, and the family size.

DISCUSSION

The success of the beef cattle farmers in adopting technology to use straws as a feed depends on the adequacy of feed for cattle. If the farmers lack feeds such as grasses, they will use rice straw and corn straw as the main feed source (44 respondents). The method used by the farmers to manage straw was as follow: 1) neither planting spot nor harvesting period was the same; 2) planting time of corn should be different among farmers for collecting corn straw; and 3) cultivation and storage of straw.

The main reason for smallholder beef farmers not adopting straw as a feed is the availabilities of the other feed sources such as Napier grass and native grass. Smallholder beef farmers plant Napier grass close to their cattle pens so that it is easier to be harvested or the livestock can graze in field twice a day. There were 28 farmers (53.85%) who prepared pasture for livestock grazing during the day, and therefore this condition did not require any additional feeds. Generally, farmers who hold a limited number of livestock do not adopt straw as a source of feed (Table 1); however, there was a shortage in herbage production when compared to the farmers who had large farm scales.

Coefficient value of the intensity of contact with the extension worker was 2.835. The value means that farmer who has a contact with the extension worker had 2.835 times opportunity to adopt compared to the other farmers who did not have any contacts with the extension worker. Extension worker is one of the important sources of information for farmers. Adequate information especially from extension workers is one of the key drivers of technology utilization in Maros (Rogers 2003; Feola & Binder, 2010). They work for the farmer's needs, not only demonstrating the utilization of the straw as a

feed, as counselors, and as assistants, but also they help the farmers to identify and solve the problems they have in the field (Bodorkos & Pataki, 2009; Hauser *et al.*, 2016).

The number of livestock is one of the factors which play an important role in the adoption and use of crop residue as feed. The variable coefficient of the number of livestock was 2.328. The value means that the farmers who have more livestock have 2.328 times opportunity in adopting rice and corn straws as feed compared to farmers who have less livestock. The demand of feed increased with the increase in the number of livestock. Rice and corn straws are two alternative crop residues to meet the feed demand in Maros District (Table 2). To meet the needs of cattle, rice and corn straws have to be processed before being given to cattle because of their poor qualities (Haryanto, 2009). Parmawati *et al.* (2018) reveal that region as the center of developing food security, such as Pasuruan, is able to support the availability of feed for livestock and the integration programs between livestock and crop.

The perception of livestock business is one of the drivers of farmer to adopt the utilization of rice straw as feed. The value of variable perception is 1.918, which means that the higher the value of farmer's perception towards their farming the higher the probability they will adopt the formulated rice and corn straws as feed i.e., it will increase 1.918 times. The farmers whose livestock business is the primary source of their income will maintain their livestock properly through the provision of sustainable feed. For instance, rice and corn straws will be collected by the farmers not only in their rush hours but also in their free times. According to Reimer *et al.* (2012), a good perception is increased by the increase of farmers' motivation through the utilization of free time for their farming.

The obstacle factor in adopting rice and corn straws as feed is a high level of difficulty especially when collecting and formulating rice and corn straws. Coefficient level of difficulty was -1.246. The coefficient means it have a negative correlation with the adoption of rice and corns straws: the success in adoption of rice and corn straws as feed will decrease by 1.2 times with the increased level of difficulties. The lack of labor and straw barns were the reason for the farmer not adopting

the utilization of rice and corn straws as feed (Table 3). However, the need for a labor to process corn straw was the main factor inhibiting the utilization of corn straw as feed (Mudzengi, 2014).

CONCLUSION

In Maros Regency, extension workers play an important role in increasing the adoption of technology in using rice and corn straws as a feed. Likewise, not only the number of livestock, but also the good perception of the farmers increased along with the increased feed availability, such as utilization of rice and corn straws. However, it decreased with the increased labor need and the unavailability of straw barns. Therefore, to increase the adoption of technology in using rice and corn straws as a feed, extension workers must support the farmers' skill.

CONFLICT OF INTEREST

The authors declare there is no conflict of interest.

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