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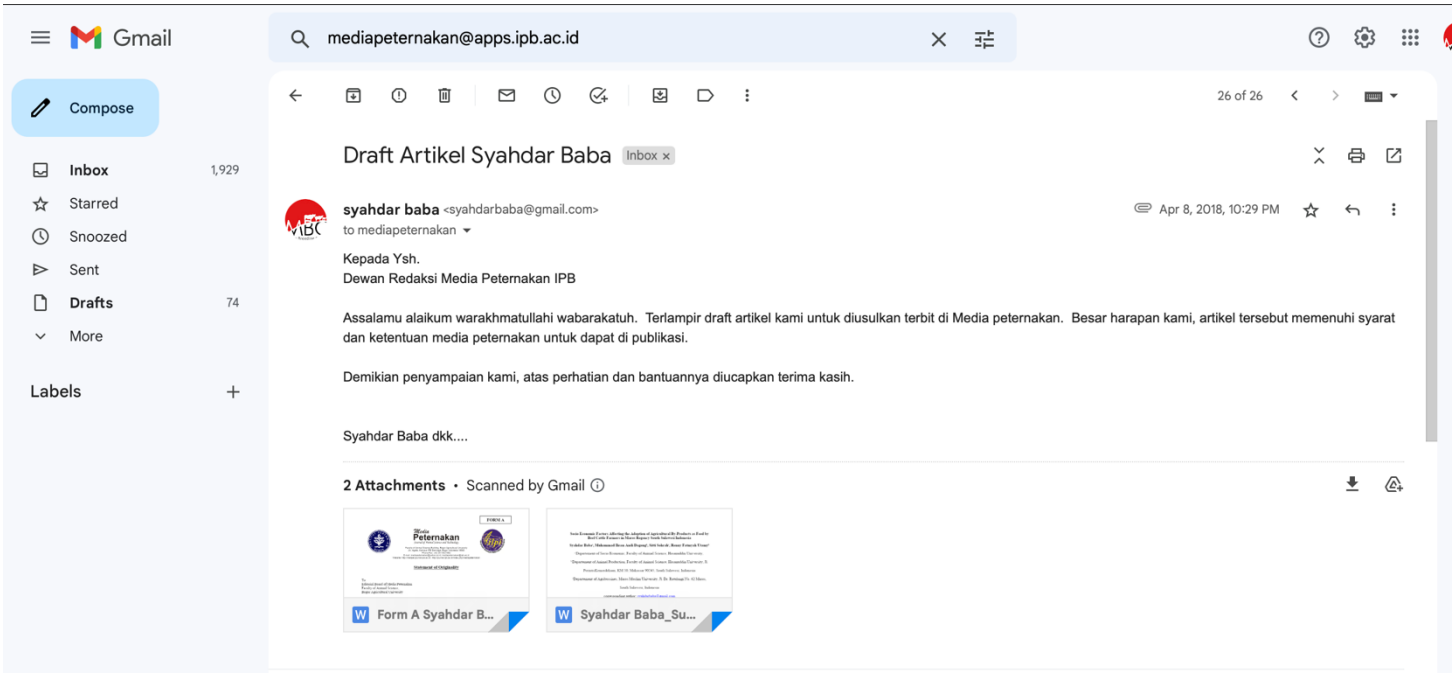
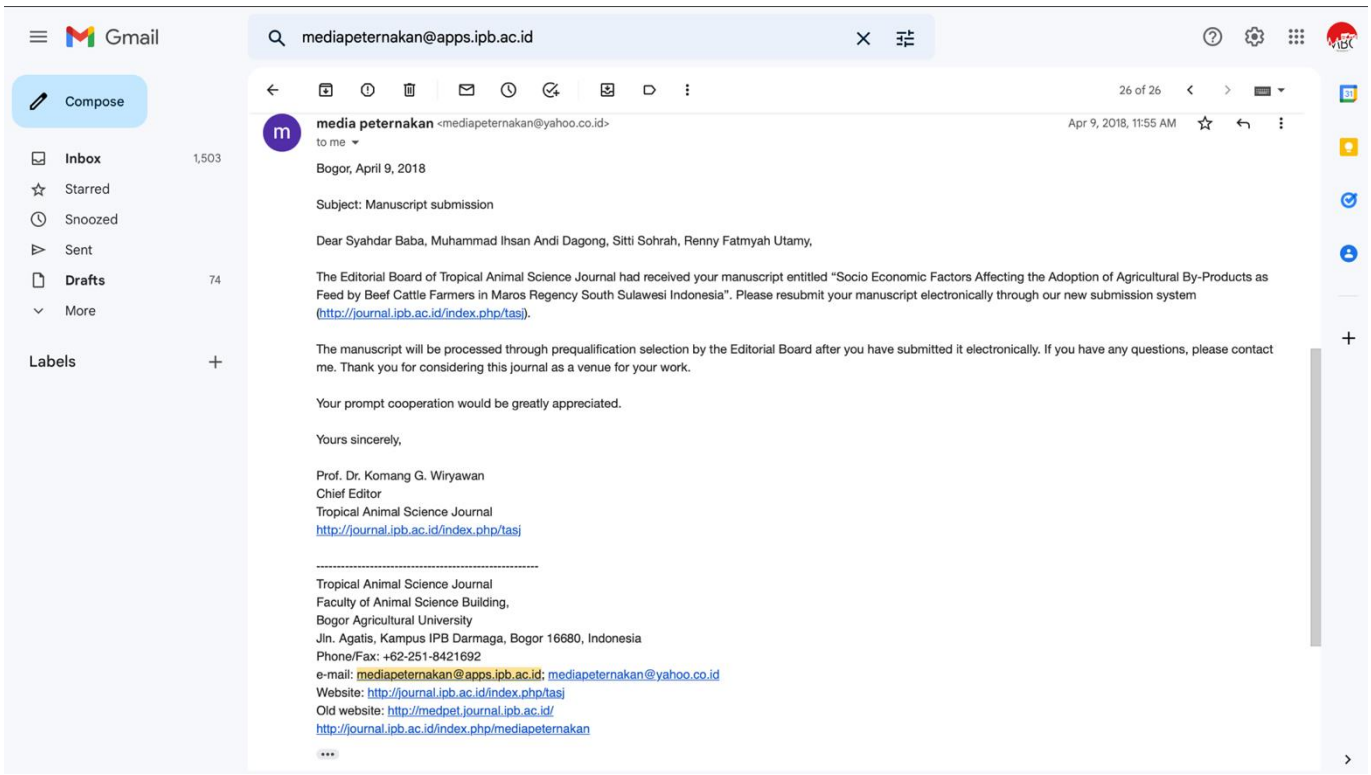
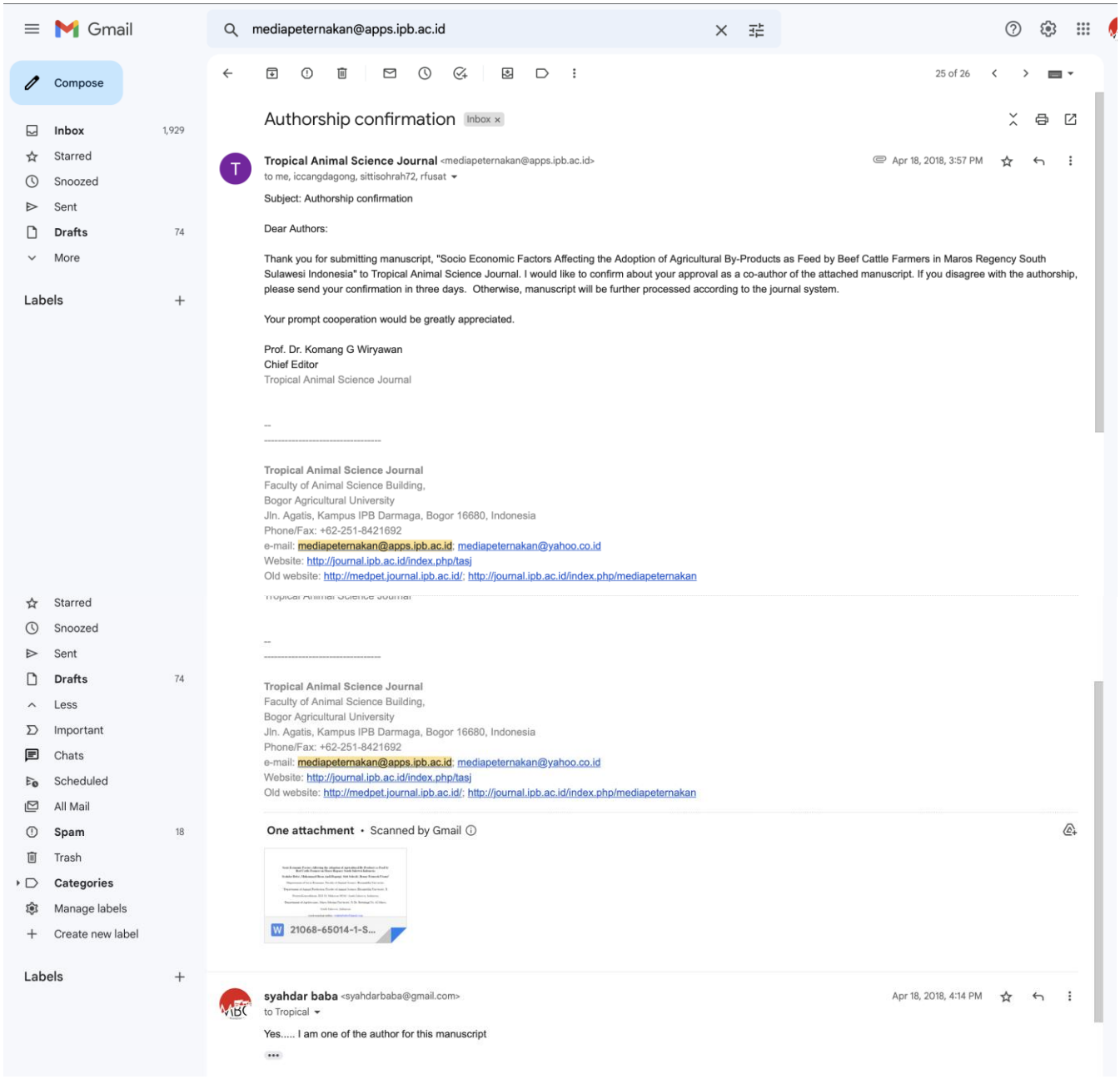


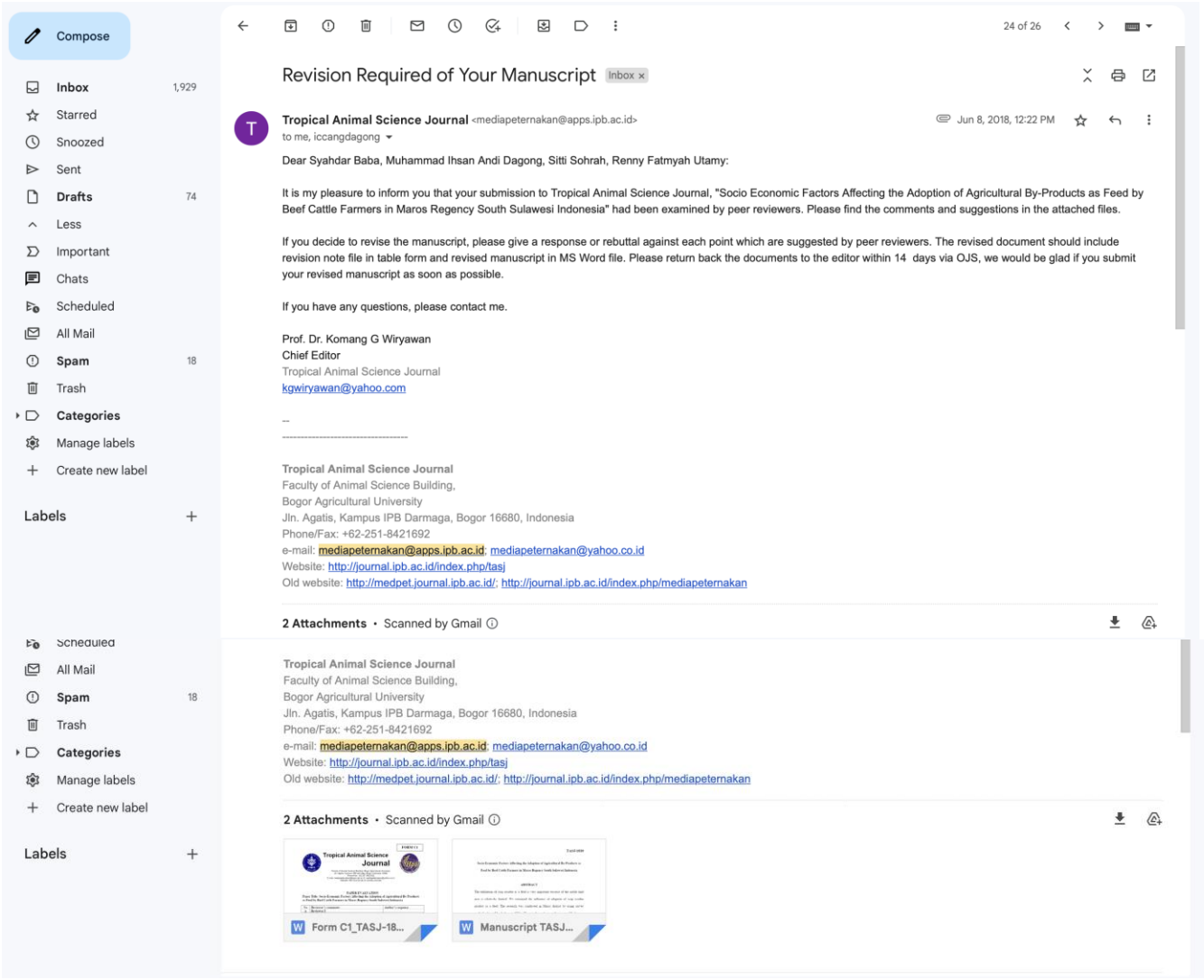
Gambar 1. Bukti Submit Artikel pada tanggal 8 April 2018



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



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

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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"	
3	Baris 40: straw as feed causes shortages	
4	Baris 65-66: grammar ….,….,…..have 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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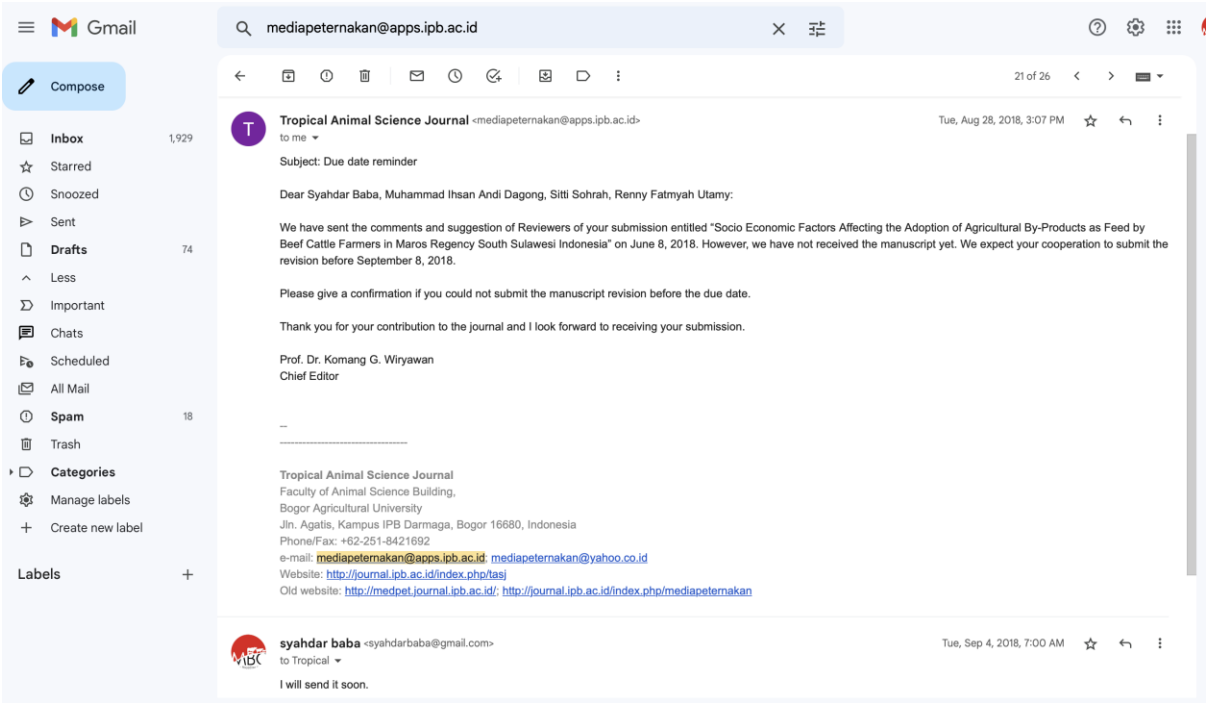
	4. Diusahakan mensitasi terbitan 3 tahun terakhir dari Media Peternakan/TASJ.	
	Referensi kurang: BPS 2014(baris 25) BPS 2015(baris 46; tidak alfabetik (baris 220-223 dst), Haryanto *et al (baris 41)*	
	Daftar pustaka berlebih (tidak bertanda kuning, tidak ada dalam tulisan)	
	Baris 61: penulisan family name	
14	Mohon diperiksa kembali penulisan bahasa Inggris yang digunakan. Akan lebih baik jika naskah dikoreksikan ke English Editor.	
B	**Reviewer II**	
1	There is no hypotheses stated. Please add	
2	There is no objective. Please add	
3	No research question. Please add	
4	There is no regression equation model and no deeply explanation of the equation. Please add	

Gambar 5. Lampiran komentar dari 2 orang blind reviewer



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

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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: grammar ….,…..have 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 didefenisikan sebagai variable dikotomiu 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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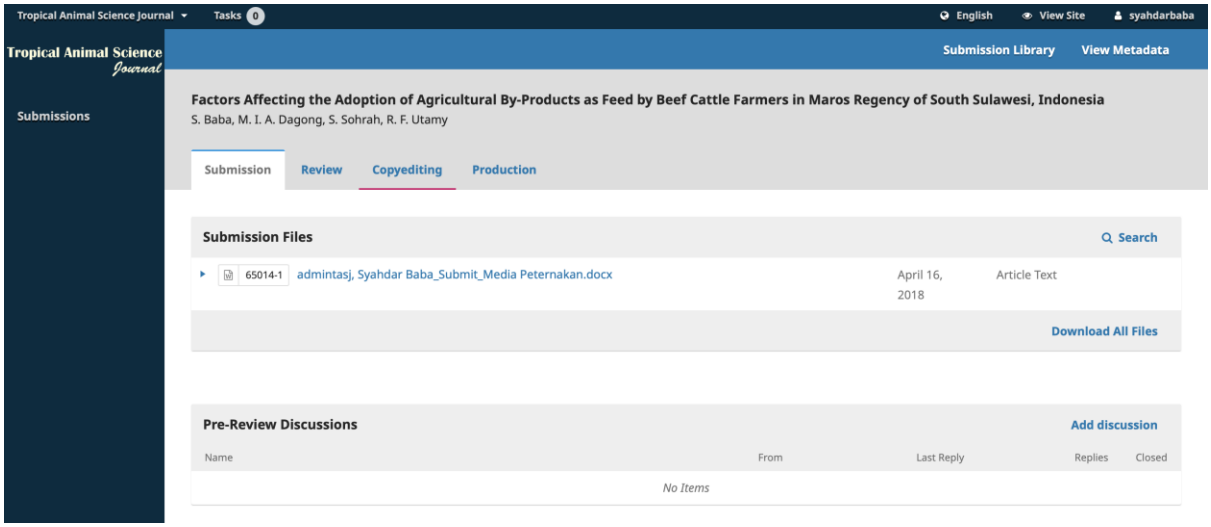
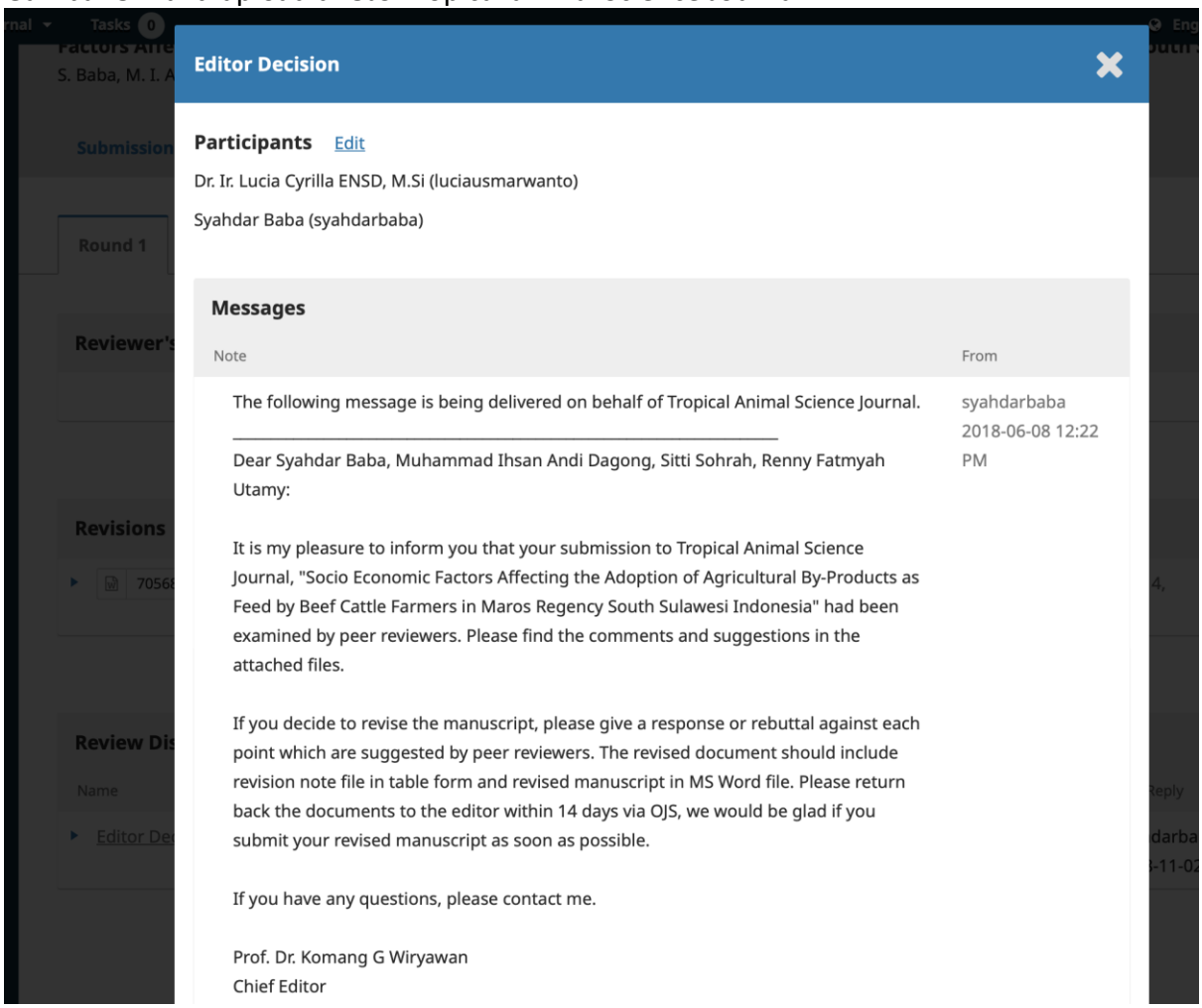
11	Conclusion: disampaikan variable apa yang paling berpengaruh. Bagaimana pengaruhnya (positif atau negatif)	Sudah disampaikan pada kesimpulan
12	Rekomendasi: belum ada. Seharusnya diambil dari variable berpengaruh yang bisa diperbaiki untuk meningkatkan adopsi.	Rekomendasi digabung di kesimpulan
13	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 *et al (baris 41)*	Sudah disesuaikan
	Daftar pustaka berlebih (tidak bertanda kuning, tidak ada dalam tulisan)	Sudah dihapus
	Baris 61: penulisan family name	Sudah disesuaikan
14	Mohon diperiksa kembali penulisan bahasa Inggris yang digunakan. Akan lebih baik jika naskah dikoreksikan ke English Editor.	
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

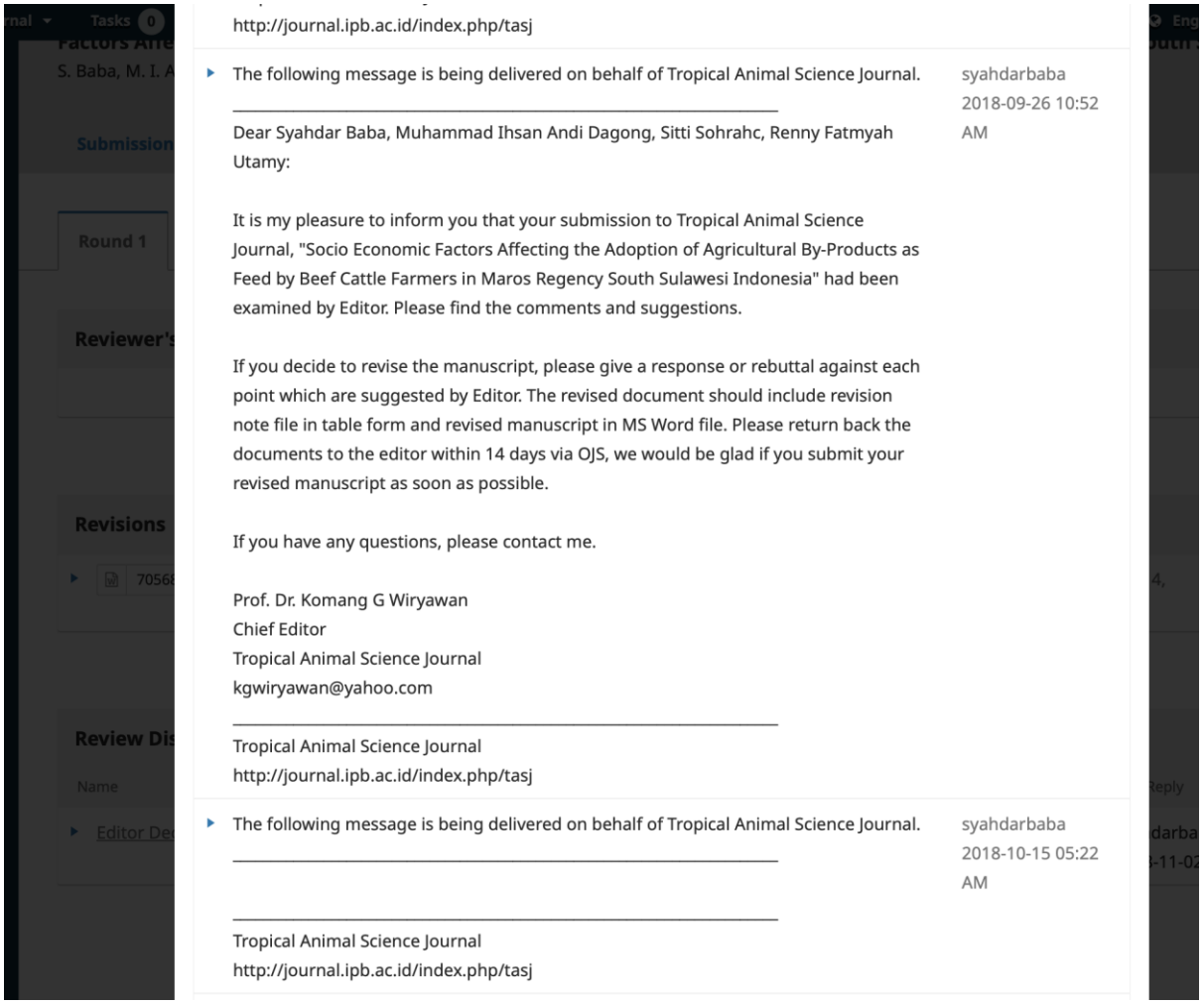
Gambar 7. Bukti perbaikan yang dilakukan oleh Author sesuai dengan saran dari reviewer



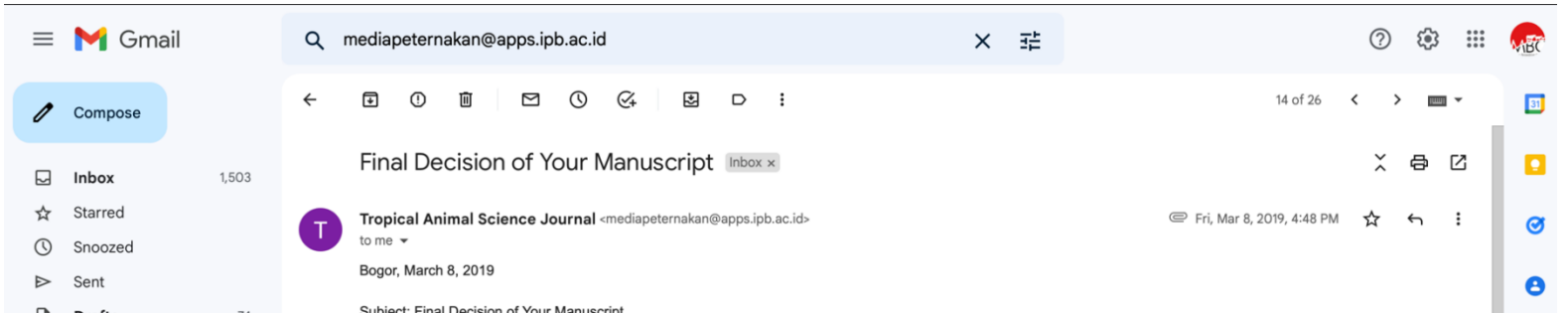
Gambar 8. Bukti upload di OJS Tropical animal Science Journal



Gambar 9. Komentar dari peer review dan editor



Gambar 10. Komentar dari revewer terkait revisi artikel



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

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

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ABSTRACT

The utilization of crop residue as a feed is very important because of the arable land area is relatively limited. We examined the influence of adoption of crop residue product as a feed. The research was conducted in Maros district by using survey methods from March-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. Questionnaire were used to collected data who conducted by trained enumerator. Experiment was arranged using a logistic regression model to identify socioeconomic factors that have influenced the adoption of crop residue as a feed. Work perception (X2), contact with extension workers (X4), rice cultivated areas (X5), number of livestock (X6), subjective norm (X7), and difficulty (X8), as socio-economic variables, influenced by the adoption of crop residue as a feed; however, the variables age (X1), farmer experiences (X3) and the number of family members (X9) have no effect on the adoption of this technology.

Keywords: 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 did not increase and only 3.05 million hectares are available, concentrated in a few provinces (BPS, 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 provides 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). Thus, the utilization of crop residue such as rice-and corn-straw could be an alternative feed supply for smallholder beef farmers, therefore the number of their livestock can be increased.

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

Maros is one of the districts in South Sulawesi that is well known either as a center of 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; Giller*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**

This research was conducted in Maros District, South Sulawesi. The selected site is well-known as a center for rice crop productions, corn, and Bali beef cattle in Eastern Indonesia. Previously, collaboration between University of Hasanuddin, Maros District Government an the Assessment Institute for Agricultural Technology South Sulawesi Province has been disseminating utilization of rice- and corn- straw as a feed. The dissemination includes fermentation and ammoniation of rice- and corn-straw 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 have high palatability.

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

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

$$Y = \ln (pi/1\text{-}pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 +$$

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

Where:

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

$\beta 0$ = Intercept

$\beta 1$- $\beta 7$ = Regression coefficients of the dependent variables

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

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

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

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

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

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

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

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

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

RESULTS

Farmer Characteristics

There were no significant differences between age, business experience, the number of families, and the education level of the farmers whether adopters or non-adopters. However, the number of livestock and extensive landholding of adopter farmers is significantly higher than that for the non-adopter farmers (Table 1). The number of livestock 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.

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

Main reason for smallholder beef farmers not adopted straw as a feed because of the availability of other feed sources such as Napiergrass and Native Grass (Table 3). Smallholder beef farmers plantied Napiergrass close to their cattle pen easier for it harvesting or the livestock grazed in field by twice. Other than that it was not only require labor collected rice- and corn- straw but also the farmers have no free time. Other reason was no available 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 Adopting Crop Residue as Feed

The results of the overall correct prediction (88.7%) and Chi square statistics (93,742) show that the models have ability to predict the chance of adoption of the utilization of rice- and corn- straw were high 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) were variable, having a greater influence on farmers adopting rice- and corn-straw as a feed (Table 4).

Logistic regression analysis showed that six of the nine independent variables had a significant effect on the adoption of straw as a feed. The sixth variables were contact with the extension worker (P<0,01), the number of livestock (P<0,01), paddy cultivated area (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; Wubeneh 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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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 (≤ 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 ($P < 0.01$)

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

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

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

* 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.

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

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Socio Economic 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. We examined 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. Questionnaires were used to collected data conducted by a trained enumerator. Survey was arranged using a logistic regression model to identify socio economic factors which have influenced the adoption of crop residue as a feed. Work perception (X2), contact with extension workers (X4), rice cultivated areas (X5), number of livestock (X6), subjective norm (X7), and difficulty (X8), as socio-economic variables, influenced by the adoption of crop residue as a feed; however, the variables age (X1), farmer experiences (X3), and the number of family members (X9) have no effect on the adoption of this technology.

Keywords: adoption, crop residue, fodder, maros

INTRODUCTION

Generally, in Indonesia, small holder 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 has not been increased and only 3.05 million hectares are 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 provides 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). Thus, the utilization of crop residues such as rice and corn straws could be an alternative feed supply for smallholder beef farmers; therefore, the number of their livestock can be increased.

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

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intensification land which produces high biomass, 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 Bali beef cattle development center. In 2015, the rice harvest area reached 47,648 ha with Bantimurung districts was the highest in harvest with 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 feed. Furthermore, in 2012-2013, a participatory approach is used by University of Hasanuddin to develop the technology. Not only researchers, extension workers, and small beef farmers identify feed potential, but they also conducted 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 and Boath, 1982; He et al., 2009). The participation of extension workers increases not only 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, adoption of crop residue as a feed is still limited. Baba et al. (2014) revealed that utilization of rice and corn straws as a feed 63,5% and 32.5% respectively.

The adoption of crop residues as a feed has been influenced by several social, economic, and technical factors; for example, 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.

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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 conducted 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 University of Hasanuddin, Maros District Government and the Assessment Institute for Agricultural Technology South Sulawesi Province has been disseminating utilization of rice and corn straws as a feed. The dissemination includes fermentation and ammoniation 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* was harvested in young stage (70 days); therefore, it has a high palatability.

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Data collection used questionnaires which are 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 who were selected as respondents from each village using quota sampling. In Samangki and Simbang (Sub District Simbang), there were 25- and 20- respondents, respectively; in Leang-Leang and Minasa Baji (Sub District Bantimurung) there were 23- and 16- respondents, respectively; and in Pattiro Deceng (Sub District 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 was 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 of crop residues technology utilization) measured by using dichotomous model where one means adopted while zero did not. Independent variables were farmers' internal factors, 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 has not been well integrated yet. Therefore, whether adopted or not the technology of crop residue utilization depends on internal factors, socio-economic, and the biophysics of their farming

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

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

Where:

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

$\beta 0$ = Intercept

$\beta 1$- $\beta 7$ = Regression coefficients of the dependent variables

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

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

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

X4 = Contact with extension workers, expressed as the number of contacts with extension workers (frequency in 2015)

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

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

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

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

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

RESULTS

Farmer Characteristics

There were no significant differences between age, business experience, the number of family members, and the education level of the farmers whether adopters or non-adopters. However, the number of livestock and extensive landholding of adopter farmers is significantly higher than that for the non-adopter farmers (Table 1). The number of livestocks 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.

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

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

DISCUSSION

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

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

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

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

The number of livestocks is one of the factors which play an important role in the adoption of the use of crop residue as feed. Variable coefficient of the number of livestock was 2,328. The value means that farmers who have more livestock had opportunity in adopting rice and corn straws as feed doubly compared to farmers who have less livestock. The demand of feed increased through the increase in the number of livestocks. Rice and corn straws are one alternative crop residue to meet the feed demand in Maros district (Table 2). To meet the needs of cattle, rice and corn straws has to be processed before given to cattle because of its poor quality (Haryanto, 2009). Parmawati et al. (2018) revealed that regions where the centre of developing food security such as Pasuruan which 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 utilization of rice straw as feed. The value of variable perception was 1.9, which means

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that most perception of farmers towards their farming and, most adopted the formulated rice and corn straws as feed will increase 1.9 times. Farmers whose livestock business as 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 hour but also in their free time. According to Reimer et al. (2012) a good perception is increased by the increase of farmers' motivation through utilization of free time for their farming.

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

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CONCLUSION

In Maros regency, 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 livestocks, but also the good perception of the farmers increased along with the increase of feed availability, such as utilization of rice and corn straws. However, it decreased with the increase of labor need and the unavailability of straw barns. Therefore, to increase the adoption of technology by using rice and corn straws as a feed, extension workers must support the farmers' skill.

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Education level (person)					
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- senior high school	7		9		
- university	1		0		
Total of farmers	44		52		

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

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ABSTRACT

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Keywords: adoption, crop residue, fodder, maros

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1) Manuscript should be corrected by professional English Edi or the expert
2) References comments has not fully revised
3) Please add Conflict of interest section as written in the journal's guidelines

INTRODUCTION

Generally, in Indonesia, small holder 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 did not increase and only 3.05 million hectares are 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 provides 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). Thus, the utilization of crop residue such as rice-and corn-straw could be an alternative feed supply for smallholder beef farmers, therefore the number of their livestock can be increased.

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

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

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

The adoption of crop residues as a feed has been influenced by several social, economic, and technical factors; for example, discomfort in conducting the processing of crop residue (Trach, 2004); unclear economic benefits (Trach, 2004; Giller et al., 2009); labor shortages for processing of straw as a feed; and a lack of knowledge about the processing of the straw (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 determinant of technology adoption. Adoption of crop residue utilization as a feed has never been done yet in Maros. 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

MATERIALS AND METHODS

Data Collection

This research was conducted in Maros District, South Sulawesi. The selected site is well-known as a center for rice crop productions, corn, and Bali beef cattle in Eastern Indonesia. Previously, collaboration between University of Hasanuddin, Maros District Government and the Assessment Institute for Agricultural Technology South Sulawesi Province has been disseminating utilization of rice- and corn- straw as a feed. The dissemination includes fermentation and ammoniation of rice- and corn-straw 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 was harvested in young stage (70 days), therefore it have high palatability.

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

Statistical Analysis

Adoption of technology is the decision of farmers to accept or reject technology. The decision to adoption of technology was 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 of crop residues technology utilization) measured by used dichotomous model where one means adopted while zero did not. 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 have not been well integrated yet. Therefore, adopted or did not the technology of crop residue utilization depend on internal factors, socio-economic, and the biophysics of their farming

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

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

Where:

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

$\beta 0$ = Intercept

$\beta 1$- $\beta 7$ = Regression coefficients of the dependent variables

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

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

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

X4 = Contact with extension workers, expressed as the number of contacts with extension workers (frequency in 2015)

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

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

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

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

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

RESULTS

Farmer Characteristics

There were no significant differences between age, business experience, the number of families, and the education level of the farmers whether adopters or non-adopters. However, the number of livestock and extensive landholding of adopter farmers is significantly higher than that for the non-adopter farmers (Table 1). The number of livestock 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.

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

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 plantied 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.

151 **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-strawwere 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

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

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

DISCUSSION

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

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

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

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

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

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

Obstacle factor to adopting rice straw as feed was high level of difficulty especially when it collecting and formulating rice-straw. Coefficient level of difficulty was -1.246. The coefficient means it had negative correlation where the adoption decreased by 1.2 times with the increasing of the level of difficulties. Lack of labor and straw barns were the reason for the farmer would not adopt the utilization of rice-straw as feed (Table 3). Need a labor to process corn-straw however it was of 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 by using rice straw as a feed. Likewise, not only number of livestock but also good perception of the farmers increased with the increasing of availability feed such as utilization of rice- and corn- straw. However, it decreased with the increasing of labor need and not available of straw barns. Therefore, to increase the adoption of technology by using rice straw as a feed, extension workers must support the farmers' skill.

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305

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 (≤ 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 ($P > 0.05$), **significantin level 0.01 ($P < 0.01$)

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The adoption of crop residues as a feed has been influenced by several social, economic, and technical factors; for example, 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 conducted 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 University of Hasanuddin, Maros District Government and the Assessment Institute for Agricultural Technology South Sulawesi Province has been disseminating utilization of rice and corn straws as a feed. The dissemination includes fermentation and ammoniation 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* was harvested in young stage (70 days); therefore, it has a high palatability.

Data collection used questionnaires which are 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 who were selected as respondents from each village using quota sampling. In Samangki and Simbang (Sub District Simbang), there were 25- and 20- respondents, respectively; in Leang-Leang and

Minasa Baji (Sub District Bantimurung) there were 23- and 16-respondents, respectively; and in Pattiro Deceng (Sub District 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 was 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 of crop residues technology utilization) measured by using dichotomous model where one means adopted while zero did not. 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 has not been well integrated yet. Therefore, whether adopted or not the technology of crop residue utilization depends on internal factors, socio-economic, and the biophysics of their farming

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

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

Where: *Y* is the opportunity adoption of the utilization of straw as feed (pi= 0 indicates no adoption, pi= 1 indicates adoption); *β0* is intercept; *β1-β7* is regression coefficients

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

RESULTS

Farmer Characteristics

There were no significant differences between age, business experience, the number of family members, and the education level of the farmers whether adopters or non-adopters. However, the number of livestock and extensive landholding of adopter farmers is significantly higher than that for the non-adopter farmers (Table 1). The number of livestocks 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.

Farmer's Reasons to Adopt and Not Adopt

There are many reasons smallholder beef farmers adopting the utilization of crop 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

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

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

DISCUSSION

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

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

CONFLICT OF INTEREST

The authors declare there is no conflict of interest

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305
306
307

308 **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 (≤ junior high school)	36		43		
- senior high school	7		9		
- university	1		0		
Total of farmers	44		52		

309 t-test ns, Non-significant, * significant in level 0.05 (P> 0.05), **significantin level 0.01 (P< 0.01)

310

311 **Table 2.** Farmer'sreasons 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

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

314

315 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

316 * The scale of 5-1 provided from the most important or *vice versa* in any respondents
317 who not adopted (52 respondents)

318

319 Table 4. Logistic regression coefficients of the factors affecting the adoption of
320 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**

321 ** and *, significant at $P<0.01$ and $P<0.05$ respectively. -2likelihood is 77.351; chi
322 square statistic is 93.742**; Nagelkerke R Square 0.709; Overall correct prediction is
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 livestocks, 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.

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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:

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

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 (≤ 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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