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### SOCIO-ECONOMIC FACTORS AFFECTING THE ADOPTION OF AGRICULTURAL BY-PRODUCTS AS FEED OF BY BEEF CATTLE FARMERS IN MAROS

#### ABSTRACT

The Utilization of crop residue as feed is very important because the arable land area is relatively limited. The objective of this study was to examine the influence of adoption of crop residue product as 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. Data were collected using questionnaires conducted by a trained enumerator. The experiment was arranged using a logistic regression model to identify socioeconomic factors that have influenced the adoption of crop residue as 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 the adoption of crop residue as feed; however, the variables age (X1), farmer experience (X3) and the number of family members (X9) have no effect on the adoption of this technology.

Keywords: Adoption, crop residue, fodder, Maros

#### 1. INTRODUCTION

Generally, in Indonesia, smallholder beef farmers holding a limited number of livestock, approximately 2-3 heads in total (Directorate General of Livestock, 2014). 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 (CBS, 2014). Arable grassland is relatively limited and the nutritive values of forage crops vary among 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). Thus, the utilization of crop residue such as rice and corn straw could be an alternative feed supply for the smallholder beef farmers, meaning that the numbers of livestock can be increased.

The Utilization of crop residue as feed such as rice and corn straw as feed is a well-known method. In India, the use of cereals for dairy cattle feed reached 45-66% (Kelley and Parthasarathy Rao 1996; Ranjhan 1999; Parthasarathy Rao and Hall 2003), while in Indonesia, rice straw for beef cattle reached 31-39% in Indonesia. Since 2000, Agricultural Research Organizations have introduced some of the Crop Livestock System (CLS program; integrated rice/corn beef?) in several provinces, including in South Sulawesi (Diwyanto 2008; Sariubang and Pasambe, 2005; Baba *et al.*, 2013). However, the utilization of straw as feed causes shortages and the smallholder beef farmer did not often store this as feed reserves for the next following season (Devendra, 1997; Haryanto *et al.*, 2003). Even in agricultural intensification land which produces high biomass, feed for beef cattle is relatively limited (Ralevic *et al.*, 2010; Valbuena *et al.*, 2012).

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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 accounting for the most: 18.31% (CBS, 2015). In 2007-2011, Farmer Empowerment through Agriculture Technology Information (FEATI) encouraged smallholder beef farmers to use rice- and corn-straw as feed. Further, in 2012-2013, Hasanuddin University, Unhas used a participatory approach to develop the technology. Not only did researchers, extension workers, and small beef farmers identify feed potential, but they also conducted experiments at the farmer level. After the experiments, the smallholder beef 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; Sewell *et al.*, 2014). 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 the use of crop residue as feed is still limited. Only 62.5% of the farmers have reported adopting the use of corn-straw, while 32.5% are adopting the use of rice-straw as feed (Baba *et al.*, 2013).

The adoption of crop residues as feed has been influenced by several social, economic, and technical factors; for example, discomfort in conducting the processing of crop residue (Nguyen Xuan Trach 2004); unclear economic benefits (Nguyen Xuan Trach, 2004; Gillers *et al.*, 2009); labor shortages for the processing of straw as feed; and a lack of knowledge about the processing of straw (Baba *et al.*, 2013; Mudzengi *et al.*, 2014). It also includes the cost of implementation and expected benefits. Interest from smallholder beef farmers and their perceptions, as well as demographic characteristics, have been a factor (Giller *et al.* 2011; Oladele 2005). Socioeconomic factors were the main determinants of the adoption of the technology. Experimentation regarding the factors that influence the adoption of crop residue as feed has not been undertaken in Maros. This study was therefore conducted to determine the effect of socioeconomic factors on the adoption of crop residue as feed.

## 2. METHODS

### 2.1 Data Collection

This research was conducted in Maros District, South Sulawesi. The selected site is a well-known center for the production of rice crops, corn, and Bali beef cattle in eastern Indonesia. Also, the technological utilization of rice-straw and corn- as feed has been disseminated in some farmer groups by Hasanuddin University, Maros District Government and the Assessment Institute for Agricultural Technology South Sulawesi Province. The technology disseminated includes fermentation and ammoniation of rice-straw and corn-straw and silage of corn stalk. The first-cropping season was rice (December-March), the second was Sticky Corn-1, Pulut, local name (April-June); and the third was Pulut Corn-2 (July-September). Sticky corn is corn that is harvested at a young stage (75 days) for food, meaning that the stalk is still fresh and has high palatability.

Data collection used questionnaires distributed by trained enumerators, and ran from March to December 2015. In total, the 487 smallholder beef farmers were spread over three sub-districts: 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 (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 using the logit regression model with SPSS 17.00.

The logit regression model was used to determine the factors that influenced the adoption of crop residues as feed. The logit model was used as the dependent variable was measured by using a dichotomous variable, where 0 means not adopted (unused crop residues feed), and 1 means adopted. The logit 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 indicating 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 farmer agrees that it is difficult, or 0 if otherwise

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

## RESULTS

### 1. 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 for the non-adopter farmers (Table 1). The number of livestock held increased as the amount of feed given by the farmer increased; therefore, the utilization of rice straw also increased. In contrast, labor availability was not a factor that distinguished between adopters and non-adopters.

### 2. Farmers' reasons to adopt and not adopt

There were many reasons why smallholder beef farmers adopted the utilization of crop residue such as corn-straw as feed (Table 2). Firstly, there was no shortage of land fodder or herbage production; secondly, corn-straw increases with the increase in harvesting season and availability; and thirdly, the number of livestock was increasing.

The main reason for smallholder beef farmers not adopting straw as feed was the availability of other feed sources such as Napiergrass and native grass (Table 3). Those smallholder beef farmers planting Napiergrass close to their cattle pen found it easy to harvest. In addition, the livestock were grazing in the pasture with native grass twice, one in the morning and once in the afternoon. Also, it requires labor to collect corn- and rice-straw and there is often no feed storage available. Rice- and corn-harvesting requires time that the farmers do not have, and the same is true for rice- or corn-straw

. Jabbar *et al.* (2009) stated that labor is one of the factors why farmers did not adopt the utilization of crop residue as 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 the ability to predict the chance of adoption of the utilization of rice-straw and corn; the results were high in Maros district. R square (0.709) showed 70.9% variation in the dependent variables, as 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 feed.

Logit regression analysis shows that six of the nine independent variables had a significant effect on the adoption of straw as feed. The six variables that had a significant effect were: contact with the extension worker ( $P < 0.01$ ), the number of livestock ( $P < 0.01$ ), rice cultivated area ( $P < 0.01$ ), social norms ( $P < 0.01$ ), perception on the farm ( $P > 0.05$ ) or the level of difficulty processing straw ( $P < 0.05$ ). The variables 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 feed. On the other hand, the level of difficulty processing straw showed a negative coefficient. 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 for the utilization of straws as feed depends upon the adequacy of feed for cattle. If the farmers have no alternative sto feed such as grass and pasture, they will use straws the main feed source (44 respondents). The method used by farmers to manage straw was: 1) no difference in planting spot or harvesting period; 2) cooperating with other farmers to plant corn at different times so that they could take advantage of the corn straw together; and 3) cultivating and storing straw.

The main reason for smallholder beef farmers not adopting straw as feed was the availability of other feed sources such as Napier grass (rumput gajah) and native grass. Napier grass was planted close to their cattle pens for easy harvesting or in the pasture as a storage herbage production. There were 28 farmers (53.85%) who prepare pasture for livestock grazing during the day and therefore do not require any additional feed. Generally, those farmers who hold a limited number of livestock do not adopt straw as a source of feed (Table 1) even though there is a shortage in herbage production when compared with large-scale farmers.

Contact with extension workers relates to the farmer's intention to meet with counselors. Extension workers are an important information source for farmers. The availability of information, especially from extension workers, is a key driver of technology utilization in Maros. Extension workers are not only some of the most important people to provide information to farmers, but also have the adoption keys of the technology (Rogers 2003; Wubeneh and Sanders 2006). They work for the farmers, not only demonstrating the utilization of the straw as feed, as counselors, and as assistants, but they also recognize and solve problems (Llewellyn, 2007; Bodorkos and Pataki, 2009). Extension workers s demonstrate the utilization of straw as feed through to the plot demonstration and then the farmers continue to practice and evaluate the implementation of this plot demonstration.

Commented [LB2]: What unit of measurement is this? need to explain

Commented [LB3]: What unit of measurement is this?

Commented [LB4]: What unit of measurement?

Commented [LB5]: Is this correct?

Commented [LB6]: This doesn't make sense

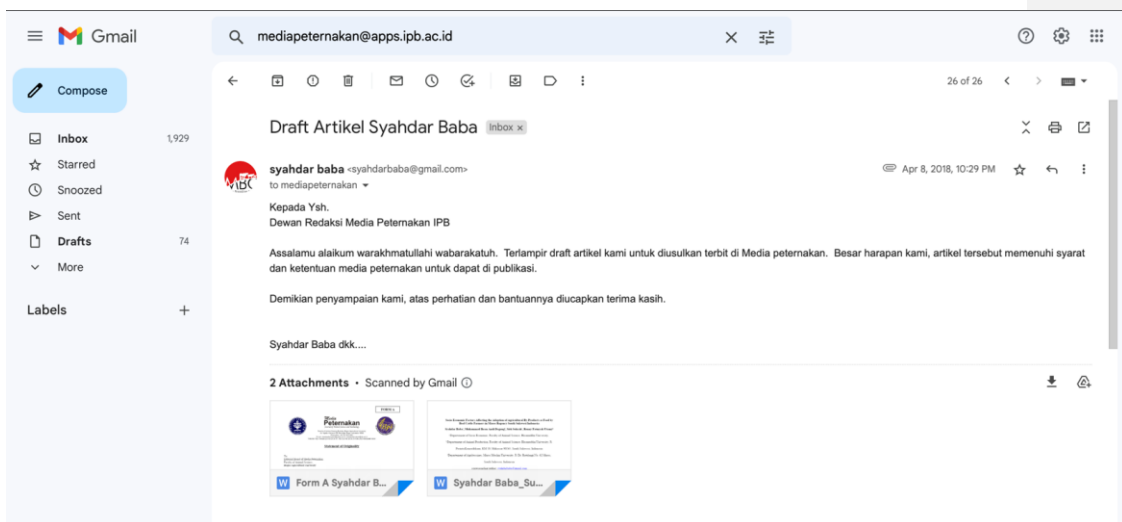
Social norms are one factor that is encouraging farmers to adopt the utilization of straw as feed. Farmers who have the capability and high commitment are normally seen as role models and a reference for other farmers (Ajzen 1991; Bergevoet *et al.*, 2004).

The livestock sector and rice cultivated areas were determined regarding the adoption of crop residue as feed. The number of livestock held increased as the amount of feed increased; therefore, the utilization of straw also increased (Table 2). In order to provide nutrition for livestock, rice straw must first be processed (Trach, 2004; Mudzengi, *et al.*, 2014). In Maros district, the farmers combine native grass and Napiergrass as feed and give supplements; however, they have not provided straw as feed yet.

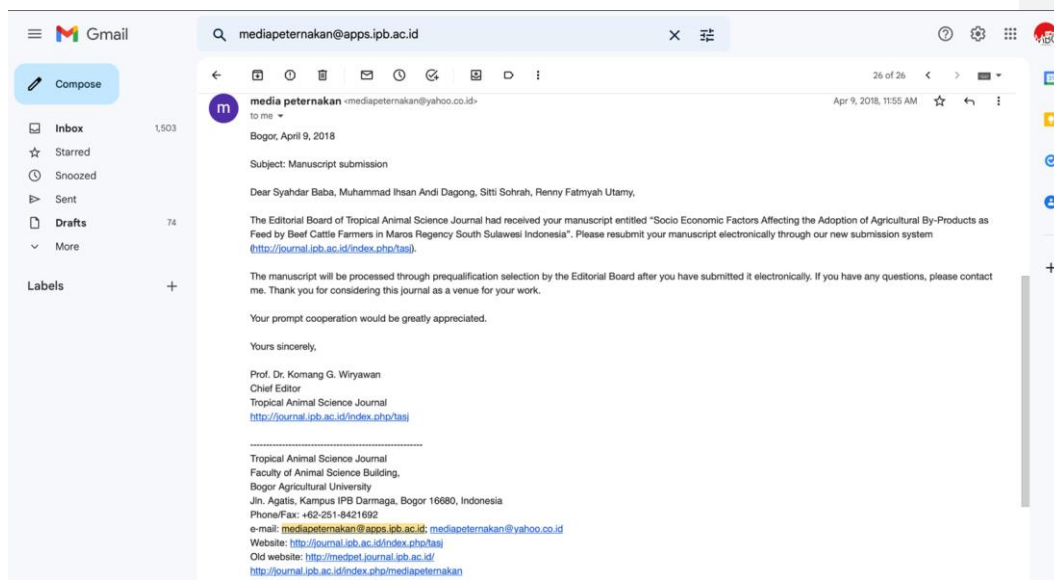
## CONCLUSION

Factors that influence the adoption of crop residue as feed are shortages in herbage production, the same perception as the extension worker, rice cultivated areas, livestock numbers, norms, and the level of difficulty in using crop residue as feed. Those farmers who have their own rice cultivated and land fodder prefer not to utilize straw as feed.

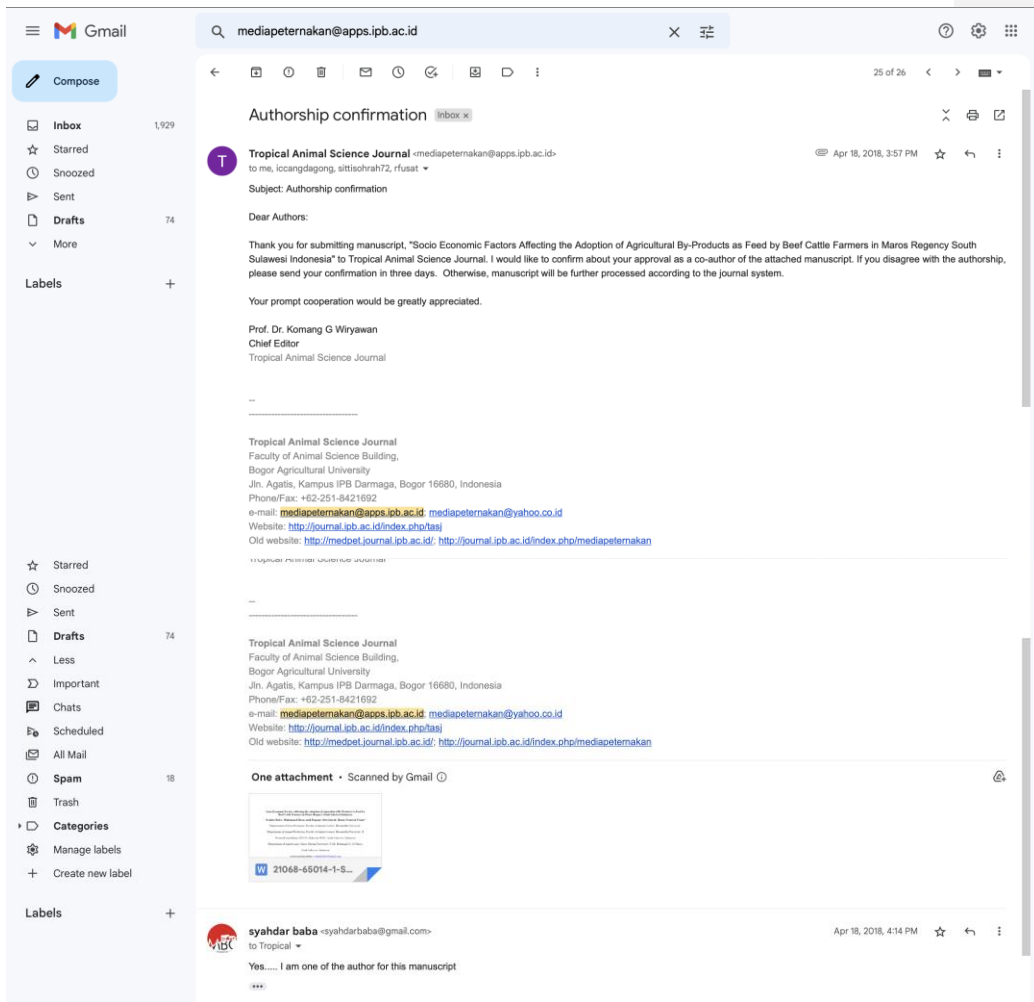
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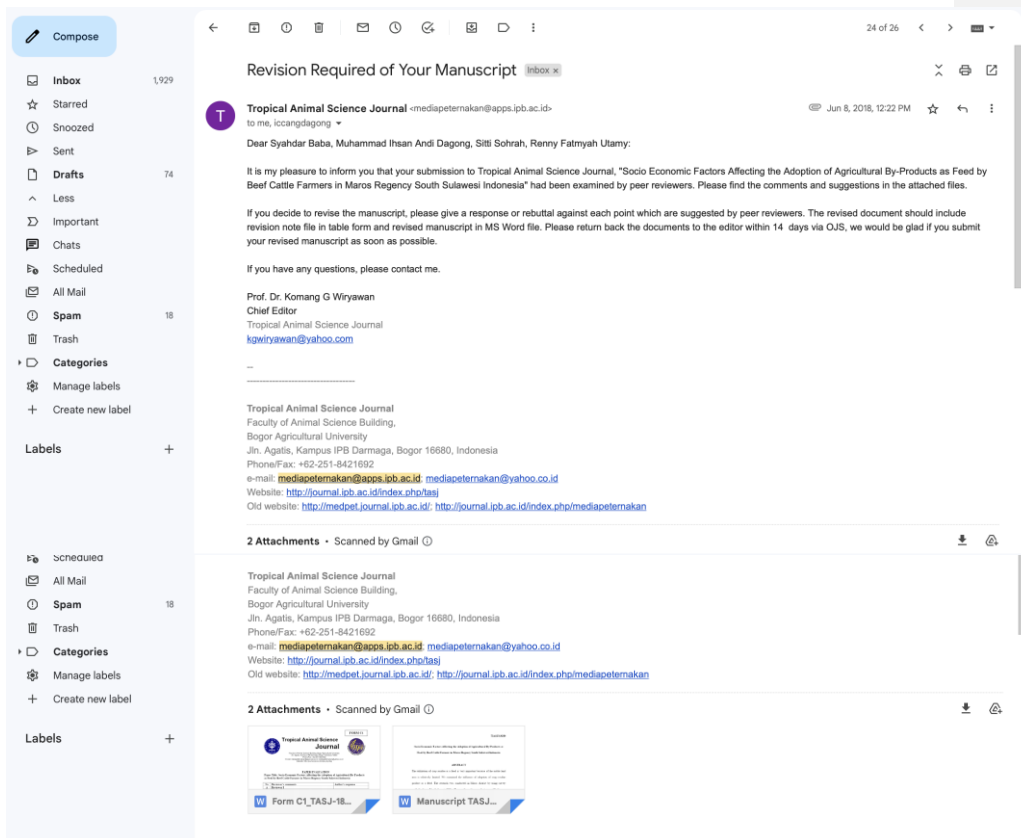
Gambar 1. Bukti Submit Artikel pada tanggal 8 April 2018



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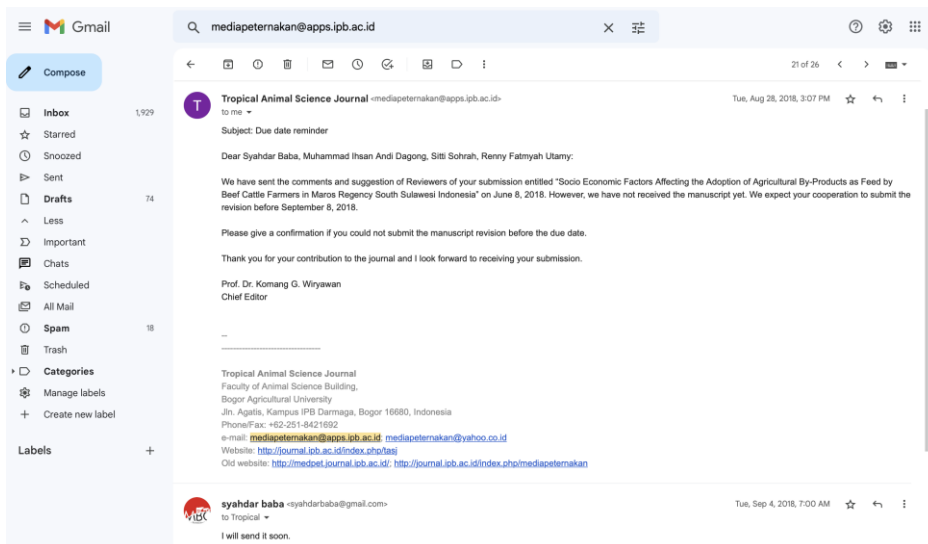
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	4. <u>Diusahakan mensitasi terbitan 3 tahun terakhir dari Media Peternakan/TASJ.</u>	
	<u>Referensi kurang: BPS 2014(baris 25) BPS 2015(baris 46; tidak alfabetik (baris 220-223 dst), Haryanto et al (baris 41)</u>	
	<u>Daftar pustaka berlebih (tidak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

Gambar 5. Lampiran komentar dari 2 orang blind reviewer



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



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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	<b>Reviewer 1</b>	
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 didefinisikan sebagai variable dikotomi yaitu hanya ada dua pilihan yaitu 1 untuk mengadopsi dan 0 untuk tidak mengadopsi. Mengadopsi artinya, peternak menggunakan limbah pertanian sebagai pakan sepanjang tahun dan tidak mengadopsi adalah peternak tidak menggunakan atau hanya menggunakan pada waktu terbatas.

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

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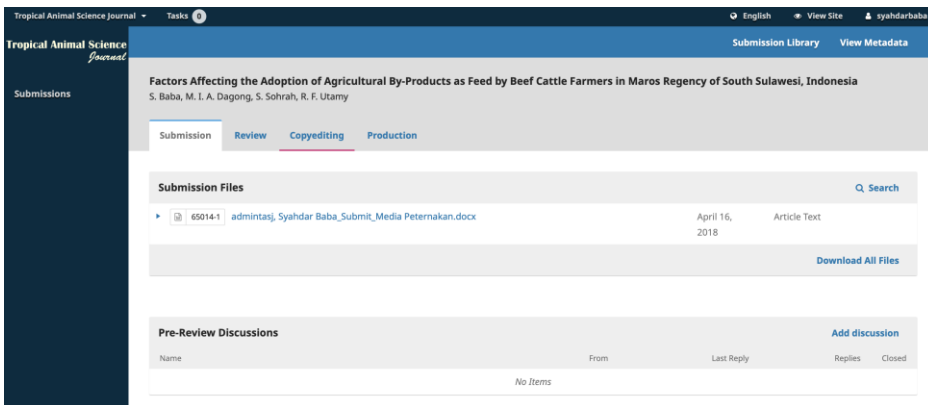
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*Journal*



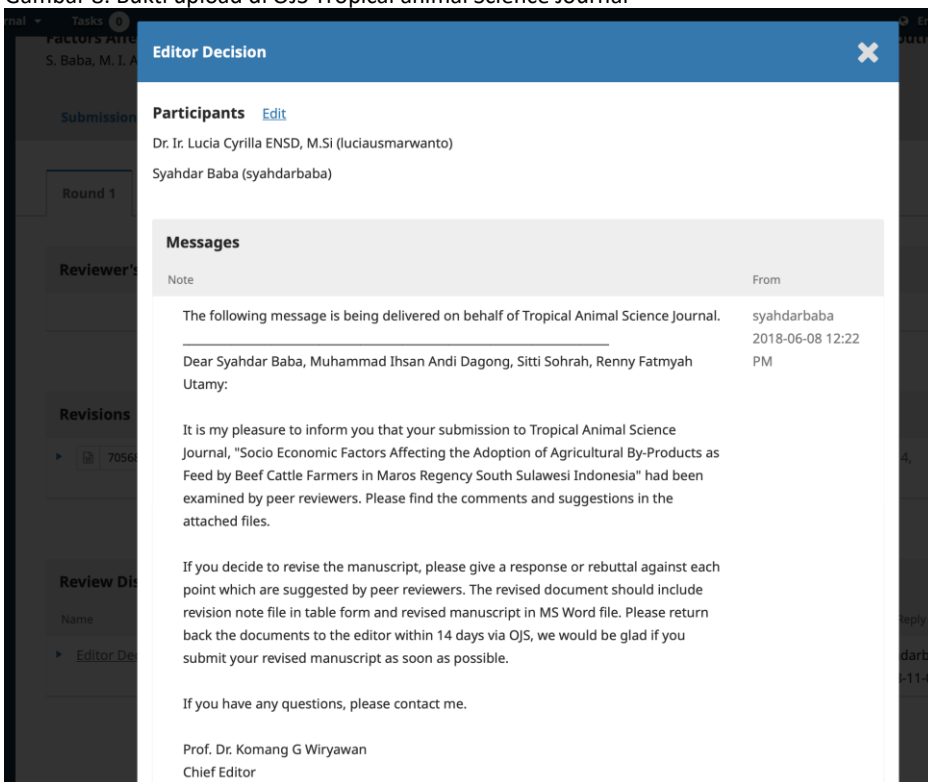
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11	Conclusion: disampaikan variable apa yang paling berpengaruh. Bagaimana pengaruhnya (positif atau negatif)	Sudah disampaikan pada kesimpulan
12	Rekomendasi: belum ada. Seharusnya diambil dari variable berpengaruh yang bisa diperbaiki untuk meningkatkan 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 <i>et al</i> (baris 41)	Sudah disesuaikan
	Daftar pustaka berlebih (tidak bertanda kuning, tidak ada dalam tulisan)	Sudah dihapus
	Baris 61: penulisan family name	Sudah disesuaikan
14	Mohon diperiksa kembali penulisan bahasa Inggris yang digunakan. Akan lebih baik jika naskah dikoreksikan ke English Editor.	
<b>B Reviewer II</b>		
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

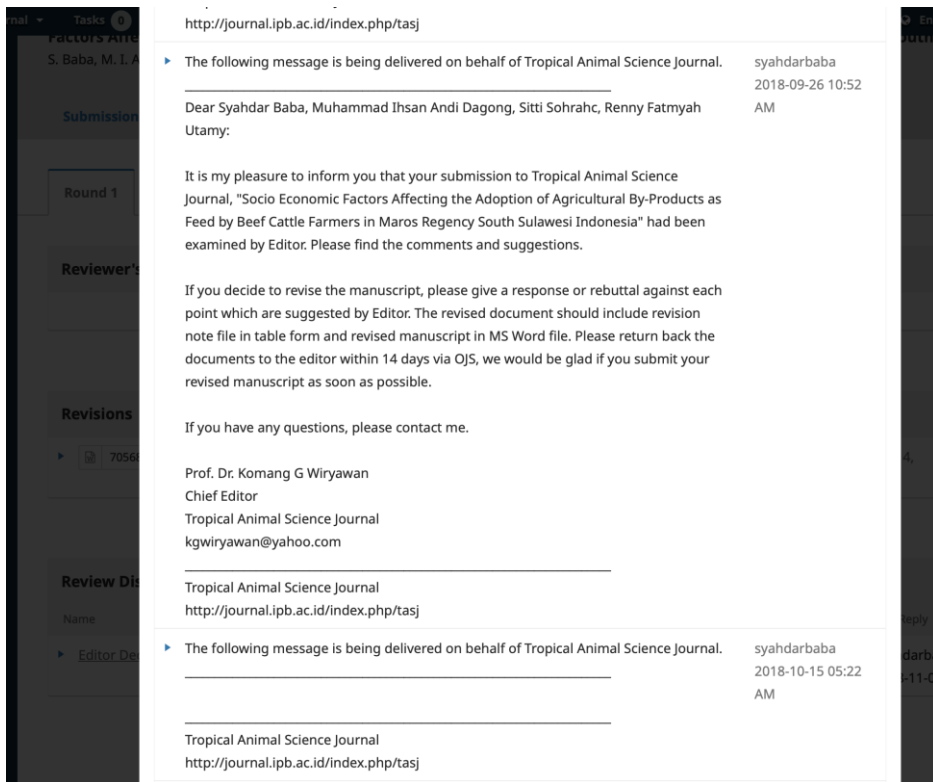
Gambar 7. Bukti perbaikan yang dilakukan oleh Author sesuai dengan saran dari reviewer



Gambar 8. Bukti upload di OJS Tropical animal Science Journal



Gambar 9. Komentar dari peer review dan editor di OJS TASJ



Gambar 10. Komentar dari reviewer terkait revisi artikel di OJS TASJ

## ARTIKEL AWAL YANG DI SUBMIT DI OJS TASJ

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

3 **Syahdar Baba<sup>a</sup>, Muhammad Ihsan Andi Dagong<sup>b</sup>, Sitti Sohrah<sup>c</sup>, Renny Fatmyah**  
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11

12

### ABSTRACT

13 The utilization of crop residue as a feed is very important because of the arable land area is  
14 relatively limited. We examined the influence of adoption of crop residue product as a feed.  
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25 Keywords: adoption, crop residue, fodder, maros

26

### INTRODUCTION

27 Generally, in Indonesia, smallholder beef farmers hold a limited number of livestock,  
28 approximately 2-3 heads in total (Direktorat Jenderal Peternakan, 2015). The smallholder  
29 beef farmers face many obstacles to increase their numbers of livestock. In the past 10 years  
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34 However, this function has significantly decreased due to the shift of function from native  
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39 Utilization of crop residue such as rice- and corn-straw as a feed is a well-known  
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44 program; integrated rice/corn beef) in several provinces, including South Sulawesi (Diwyanto  
45 2008; Sariubang and Pasambe, 2005; Baba *et al.*, 2014). However, the utilization of straw as  
46 feed causes shortages and smallholder beef farmers do not often store this as a feed reserves  
47 for the following season (Rao and Hall, 2003; Haryanto *et al.*, 2009). Even in agricultural  
48 intensification land which produces high biomass, feed for beef cattle is relatively limited  
49 (Ralevic *et al.*, 2010; Valbuena *et al.*, 2012).

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

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

64 The adoption of crop residues as a feed has been influenced by several social,  
65 economic, and technical factors; for example, discomfort in conducting the processing of  
66 crop residue (Nguyen Xuan Trach 1998); unclear economic benefits (Nguyen Xuan Trach,  
67 1998; 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

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

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

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

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

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

102 Where:

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

105  $\beta_0$  = Intercept

106  $\beta_1$ -  $\beta_7$  = Regression coefficients of the dependent variables

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

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

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

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

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

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

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

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

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

121

122

## RESULTS

123

### Farmer Characteristics

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

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

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

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

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

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

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

## 160 **Discussion**

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

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

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

178 utilization in Maros (Rogers 2003; 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.

## 197 REFERENCE

198 Atmiş, E., H. B. Günşen, B. B. Lise, W. Lise. 2009. Factors affecting forest cooperative's  
199 participation in forestry in Turkey. Forest policy and economics 11:102-108.

- 200 **Ajzen, I. 1991.** The theory of planned behaviour. *Organisational Behaviour and Human*  
201 *Decision Processes* 20:179–211
- 202 **Baba, S., S.N. Sirajuddin, A. Abdullah dan M. Aminawar. 2014.** Barrier to adoption of  
203 integration of maize-livestock in Maros, Gowa and Takalar Regency. *JITP Vol. 3 No.*  
204 *2: 114 – 120.*
- 205 **Bergevoet, R. H. M., C. J. M. Ondersteijn, H. W. Saatkamp, C. M. J. van Woerkum**  
206 **and R. B. M. Huirne. 2004.** Entrepreneurial behaviour of dutch dairy farmers  
207 under a milk quota system: goals, objectives and attitudes. *Agricultural Systems*, 80:1  
208 – 21.
- 209 **Bodorkos, B. and G. Pataki. 2009.** Linking Academic and Local Knowledge:  
210 Community-Based Research and Service Learning for Sustainable Rural  
211 Development in Hungaria. *J. of Clean. Product.* 17:1123-1131.
- 212 **Bremer L. L., K. A. Farley and Lopez-Carr David. 2014.** What factors influence  
213 participation in payment for ecosystem services programs? An evaluation of  
214 Ecuador's Socio Paramo program. *Land Use Policy*, 36:122-133.
- 215 **Direktorat Jenderal Peternakan. 2014.** Data populasi ternak di Indonesia. Dirjen  
216 Peternakan, Kementerian Pertanian Republik Indonesia, Jakarta.
- 217 **Diwyanto, K. 2008.** Pemanfaatan sumber daya lokal dan inovasi teknologi dalam  
218 mendukung pengembangan usaha sapi potong di Indonesia. *Pengemb. Inov. Pert.*  
219 *I(3):173-188.*
- 220 **Devendra, C. 1991.** Crop Residues for Feeding Animals in Asia: Technology Development  
221 and Adoption in Crop-Livestock Systems. In: *Crop Residues in Sustainable Mixed*  
222 *Crop/Livestock Farming Systems.* Editor: C. Renard. CAB International,  
223 Wallingford Oxon.

- 224 **Devendra, C. 2007.** Constraint analysis to improve integrated dairy production system in  
225 developing countries: Importance of participatory rural appraisal. *Trop. Anim. Health*  
226 *Prod.* 39:549-556.
- 227 **FAO 2001** Mixed Crop-Livestock Farming. FAO, Rome.
- 228 **Giller K E, E. Witter, M. Corbeels and P. Tittonell. 2008.** Conservation agriculture and  
229 smallholder farming in Africa:the heretics'view. *Field Crops Res.* 114:23-34.
- 230 **Haryanto, B. 2009.** Inovasi teknologi pakan ternak dalam sistem integrasi Tanaman-Ternak  
231 bebas limbah mendukung upaya peningkatan produksi daging. *Pengembangan*  
232 *Inovasi Pertanian* 2(3):163-176.
- 233 **He, J., Z. Zhou, H. Weyerhaeuser, J. Xu. 2009.** Participatory technology development for  
234 incorporating non-timber forest products into forest restoration in Yunnan, Southwest  
235 China. *Forest Ecology and Management* 257:2010-2016.
- 236 **Jabbar M. A., H. Muzafar, F.M. Khatta, T. N. Pasha and A. Khaliq. 2009.**  
237 Simplification of urea treatment method of wheat straw for its better adoption by the  
238 farmers. *South African Journal of Animal Science* 39 (supl. 1):58 - 61
- 239 **Kelley, T. G. and R. P. Parthasarathy. 1996.** Availability and requirement of different  
240 sources of livestock feed in India with special reference to sorghum and millet straw.  
241 In Devendra C and Gardiner P (Editors) *Global agenda for livestock research:*  
242 *Proceedings for the South Asia Region, 6 - 8 June 1995.* International Livestock  
243 Research Institute (ILRI), Nairobi, Kenya and International Crops Research Institute  
244 for Semi-Arid Tropics (ICRISAT), Hyderabad, India. Pp. 53-65.
- 245 **Llewellyn, R. S. 2007.** Information quality and effectiveness for more rapid adoption  
246 decisions by farmers. *Field Crops Res.* 104:148 – 156,

- 247 **Mudzengi C. P., Taderera L. M., Tigere A., Kapembeza C. S., Moyana S., Zimondi M.,**  
248 **Derembwe E. T. and Dahwa E. 2014.** Adoption of urea treatment of maize stover  
249 technology for dry season supplementation of cattle in Wedza, Zimbabwe. *Livestock*  
250 *Research for Rural Development. Volume 26, Article #160.* Retrieved March 14,  
251 2018, from <http://www.lrrd.org/lrrd26/9/mudz26160.htm>
- 252 **Nguyen Xuan Trach. 1998.** The need for improved utilisation of rice straw as feed for  
253 ruminants in Vietnam: An overview. *Livestock Research for Rural Development. Vol.*  
254 *10, Art. #20.* Retrieved March 27, 2017, from  
255 <http://www.lrrd.org/lrrd10/2/trach102.htm>
- 256 **Nguyen Xuan Trach. 2004.** An evaluation of adoptability of alkali treatment of rice straw  
257 as feed for growing beef cattle under smallholders' circumstances. *Livestock Research*  
258 *for Rural Development. Vol. 16, Art. #52.* Retrieved March 27, 2017, from  
259 <http://www.lrrd.org/lrrd16/7/trac16052.htm>
- 260 **Ngoc Chi, T.T., P.V. Liem, T. Pharis. 2007.** Farmers Participation in Rice Variety  
261 Selection. *Journal of Omonrice* 15: 159-163.
- 262 **Parthasarathy, R. P. and A. Hall. 2003.** Importance of crop residues in crop-livestock  
263 systems in India and farmers' perceptions of fodder quality in coarse cereals. *Field*  
264 *Crops Research* 84: 189-198.
- 265 **Ralevic P., S.G. Patil and G. van Loon. 2010.** Integrated agriculture production systems  
266 for meeting household food, fodder and fuel security. *J. Sust, Agric.* 34, 878-906.
- 267 **Rajhan, S. K. 1999.** Dairy feeding systems. In Falvey L and Chantalakhana C (Editors) .  
268 ILRI (International Livestock Research Institute), Nairobi, Kenya. 462pp.

- 269 **Rao, P. P. and A. J. Hall. 2003.** Importance of Crop Residues in crop-livestock systems in  
 270 India and farmers' perceptions of fodder quality in coarsecereals. *Field Crops*  
 271 *Research* 84:189-198.
- 272 **Rhoades, R. E. and R. H. Boath. 1982.** Farmer-back-to-farmer: a Model for Generating  
 273 Acceptable Agriculture Technology. *Agr. Admin.* 11;127-137.
- 274 **Rogers, E. M. 2003.** *Diffusion of Innovations.* Fifth Ed., New York Press, New York.
- 275 **Sariubang, M. dan D. Pasambe. 2005.** Sistem Integrasi Jagung-Sapi Potong di Kabupaten  
 276 Takalar Sulawesi Selatan. Proseeding Seminar Nasional Teknologi Peternakan dan  
 277 Veteriner. Bogor, 10-11 November 2005. Puslitbang Peternakan. Departemen  
 278 Pertanian. 198-208.
- 279 **Valbuena D, O. Erensteinb, S. Homann-Kee Tuic, T. Abdoulayed, L. Claessense, A.J.**  
 280 **Duncang, B. Gérarda, M. C. Rufinoh, N. Teufeli, A. van Rooyenc and M.T.**  
 281 **van Wijkh. 2012.** Conservation agriculture in Mixed crop-livestock systems:  
 282 Scoping crop residue trade-offs in sub-saharan Africa and South Asia. *Field Crops*  
 283 *Res.* 132:175-184.
- 284 **Wubeneh, N. G. and J. H. Sanders. 2006.** Farm-level adoption of sorghum technologies in  
 285 Tigray Ethiopia. *Agricultural systems* 91:122-134.
- 286 **Table 1.** Characteristics of farmers and business farming by respondents

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

- university	1	0
Total of farmers	44	52

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

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

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

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

291

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

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

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

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

Variabel	B	SE	Wald	P-Value
Age (X1)	-0.006	0.028	0.048	0.827 <sup>ns</sup>
Work perception (X2)	1.918	0.859	4.988	0.026*
Farmer experience (X3)	0.039	0.099	0.154	0.695 <sup>ns</sup>
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 <sup>ns</sup>
Constant	-13.990	3.498	15.993	0.000**

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

300

## KOREKSIAN DARI AUDITOR TASJ

TASJ-1820

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

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

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3 ABSTRACT

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

17 Keywords: adoption, crop residue, fodder, maros

18

19 **INTRODUCTION**

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

33 Utilization of crop residues such as rice and corn straws as a feed is a wellknown  
 34 methods. In India, crop residue reached 50-60% of total feed so that breeding strategy  
 35 towards the development of dual-purposes plant types could increase the adoption of  
 36 improved varieties (Rao and Hall 2003), while in Indonesia rice straw is used to reach  
 37 31-39%. Since 1990-2000, Indonesian Agency for Agricultural Research and  
 38 Development, Ministry of Agriculture, has introduced the Crop Livestock System, (CLS  
 39 program; integrated rice/corn beef) in several provinces, including South Sulawesi  
 40 (Haryanto, 2009; Winarso and Basuno, 2013; Baba et al., 2014). However, the utilization  
 41 of straw as feed causes shortages and smallholder beef farmers do not often store this as  
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46 intensification land which produces high biomass, feed for beef cattle is relatively limited  
47 (Ralevic et al., 2010; Valbuena et al., 2012).

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

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

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

## 75 MATERIALS AND METHODS

### 76 Data Collection

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

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

95 **Statistical Analysis**

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

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

$$112 \quad Y = \ln \left( \frac{pi}{1-pi} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 +$$

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

114 Where:

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

116 pi = 1 indicates adoption)

117  $\beta_0$  = Intercept

118  $\beta_1 - \beta_7$  = Regression coefficients of the dependent variables

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

## 136 RESULTS

### 137 Farmer Characteristics

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

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#### Farmer's Reasons to Adopt and Not Adopt

146  
147 There are many reasons smallholder beef farmers adopting the utilization of crop  
148 residue such as corn-straw as a feed (Table 2). First, there was shortage of land fodder or  
149 herbage production. Second, corn-straw increased with the increased in harvesting  
150 season. Third, the number of livestock<sub>s</sub> 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.

#### Factors Affecting Farmers Adopting Crop Residue as Feed

158  
159 The results of the overall correct prediction (88.7%) and Chi square statistics  
160 (93,742) show that the models have ability to predict the chance of adoption of the  
161 utilization of rice and corn straws were high in Maros district. R square (0.709) showed  
162 that 70.9% variation in the dependent variables, was determined by the selected  
163 independent variables. Wald indication stated that contact with the extension (12.507)  
164 and the number of cattle (11.506) were variable, having a greater influence on farmers  
165 adopting rice and corn straws as a feed (Table 4).

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

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

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

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#### 192 DISCUSSION

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

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

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

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

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

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

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

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

#### 250 CONCLUSION

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

#### 258 REFERENCES

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- 262 Atmiş, E., H. B. Günşen, B. B. Lise, W. Lise. 2009. Factors affecting forest cooperative's  
263 participation in forestry in Turkey. *Forest policy and economics* 11:102-108.
- 264 Baba, S., S.N. Sirajuddin, A. Abdullah dan M. Aminawar. 2014. Barrier to adoption  
265 of integration of maize-livestock in Maros, Gowa and Takalar Regency. *JITP*  
266 Vol. 3 No. 2: 114 – 120.
- 267 Bodorkos, B. and G. Pataki. 2009. Linking Academic and Local Knowledge:  
268 Community-Based Research and Service Learning for Sustainable Rural  
269 Development in Hungaria. *J. of Clean. Product.* 17:1123-1131.
- 270 Bremer L. L., K. A. Farley and Lopez-Carr David. 2014. What factors influence  
271 participation in payment for ecosystem services programs? An evaluation of  
272 Ecuador's Socio Paramo program. *Land Use Pol.*, 36:122-133.
- 273 Direktorat Jenderal Peternakan. 2015. Data populasi ternak di Indonesia. Dirjen  
274 Peternakan, Kementerian Pertanian Republik Indonesia, Jakarta.
- 275 Feola G. and C.R. Binder. 2010. Towards and improved understanding of farmer's  
276 behavior: The integrative agent-centered (IAC) framework. *Ecological*  
277 *Economics* 69:2323-2333.
- 278 Giller K E, E. Witter, M. Corbeelsand, P. Tittonell. 2009. Conservation agriculture  
279 and smallholder farming in Africa: the heretics' view. *Field Crops Res.* 114:23-  
280 34.
- 281 Hauser, M., M. Lintdner, S. Prehsler, L. Probst. 2016. Farmer participatory  
282 research: why extension workers should understand and facilitate farmer's role  
283 transitions. *Journal of Rural Studies* 47:52-61.

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- 284 **Haryanto, B.** 2009. Inovasi teknologi pakan ternak dalam sistem integrasi Tanaman-  
285 Ternak bebas limbah mendukung upaya peningkatan produksi daging.  
286 Pengembangan Inovasi Pertanian 2(3):163-176.
- 287 **He, J., Z. Zhou, H. Weyerhaeuser, J. Xu.** 2009. Participatory technology  
288 development for incorporating non-timber forest products into forest restoration  
289 in Yunnan, Southwest China. *Forest Ecology and Management* 257:2010-2016.
- 290 **Mudzengi C. P., Taderera L. M., Tigere A., Kapembeza C. S., Moyana S., Zimondi**  
291 **M., Derebwe E. T. and Dahwa E.** 2014. Adoption of urea treatment of  
292 maize stover technology for dry season supplementation of cattle in Wedza,  
293 Zimbabwe. *Livestock Research for Rural Development. Volume 26, Article*  
294 *#160*. Retrieved March 14, 2018, from  
295 <http://www.lrrd.org/lrrd26/9/mudz26160.htm>
- 296 **National Statistical Bureau – BPS.** 2014. Statistik Indonesia.  
297 <https://www.bps.go.id/publication/2014/05/05/8d2c08d9d41aa8c02fad22e7/statistik-indonesia-2014.html>  
298 [stik-indonesia-2014.html](https://www.bps.go.id/publication/2014/05/05/8d2c08d9d41aa8c02fad22e7/statistik-indonesia-2014.html)
- 299 **National Statistical Bureau – BPS.** 2015. Statistik Padi Kabupaten Maros Tahun  
300 2014. Badan Pusat Statistik Kabupaten Maros, Maros.
- 301 **Supaporn, P., T. Kobayashi, C. Supawadee.** 2013. Factors affecting farmer's  
302 decisions on utilization of rice straw compost in Northeastern Thailand. *J. of*  
303 *Agr. Rural Develop. Trop. Subtrop.* 114-1:21-27.
- 304 **Parmawati, R., Mashudi, A. Budiarto, Suyadi and A.S. Kurnianto.** 2018.  
305 Developing sustainable livestock production by feed adequacy map: A case  
306 study in Pasuruan Indonesia. *Tropical Animal Sci. Journal.* 41(1):67-76.

- 307 **Ralevic P., S. G. Patiland, G. van Loon. 2010.** Integrated agriculture production  
308 systems for meeting household food, fodder and fuel security. *J. Sust, Agric.*  
309 34, 878-906.
- 310 **Reimer, A.P., D.K. Weinkauff and L.S. Prokopy. 2012.** The Influence of perceptions  
311 of practice characteristics: An examination of agriculture best management  
312 practice adoption in two Indiana watersheds. *J. of Rural Studies* 28:118-128.
- 313 **Rhoades, R. E. and R. H. Boath. 1982.** Farmer-back-to-farmer: a Model for  
314 Generating Acceptable Agriculture Technology. *Agr. Admin.* 11;127-137.
- 315 **Rogers, E. M. 2003.** Diffusion of Innovations. Fifth Ed., New York Press, New York.
- 316 **Valbuena D, O. Erensteinh, S. Homann-Kee Tuic, T. Abdoulayed, L. Claessense,**  
317 **A.J. Duncang, B. Gérarda, M. C. Rufinoh, N. Teufeli, A. van Rooyencand,**  
318 **M.T. van Wijkh. 2012.** Conservation agriculture in Mixed crop-livestock  
319 systems: Scoping crop residue trade-offs in sub-saharan Africa and South Asia.  
320 *Field Crops Res.* 132:175-184.
- 321 **Winarsoh, B. dan E. Basuno. 2013.** Pengembangan pola integrasi Tanaman-Ternak  
322 merupakan bagian upaya mendukung usaha pembibitan sapi potong dalam  
323 negeri. *For. Penelitian Agroekonomi*, Vol. 31 No. 2:151-169.
- 324
- 325

326

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

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

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

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

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

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

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337 \* The scale of 5-1 provided from the most important or *vice versa* in any respondents who  
 338 adopted (52 respondents).  
 339 Table 4. Logistic regression coefficients of the factors affecting the adoption of  
 340 utilization of crop residue as feed.

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

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

# ARTIKEL SETELAH DIPERBAIKI BERDASARKAN KOREKSIAN DARI REVIEWER 1 DAN 2

TASJ-1820\_Revised by Author

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

## 3 ABSTRACT

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

17 Keywords: adoption, crop residue, fodder, maros

18

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

19 **INTRODUCTION**

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

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

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

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

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

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

## 71 MATERIALS AND METHODS

### 72 Data Collection

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

83 Data collection used questionnaires who distributed by trained enumerators, ran  
84 from March to December 2015. Totally 487 smallholder beef farmers were spread over  
85 three sub-districts such as Simbang and Bantimurung (2 villages) and Camba (1  
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91 **Statistical Analysis**

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 93 The decision to adoption of technology was influenced by many factors such as  
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 99 biophysical farming. These factors were determined because of the cattle-business and  
 100 paddy field- had long been carried out by them even though it have not been well  
 101 integrated yet. Therefore, adopted or did not the technology of crop residue utilization  
 102 depend on internal factors, socio-economic, and the biophysics of their farming

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

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

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

110 Where:

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

113  $\beta_0$  = Intercept

114  $\beta_1 - \beta_7$  = Regression coefficients of the dependent variables

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

## 130 RESULTS

### 131 Farmer Characteristics

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

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 planted Napier grass close to their cattle pen easier for it  
147 harvesting or the livestock grazed in field by twice. Other than that it was not only  
148 require labor collected rice- and corn- straw but also the farmers have no free time.  
149 Other reason was no available feed storage. Jabbar *et al.* (2009) stated that labor is one  
150 of the factors why farmers did not adopt the utilization of crop residue as a feed.

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-straw were high in Maros district. R square (0.709) showed  
155 that 70.9% variation in the dependent variables, was determined by the selected  
156 independent variables. Wald indication stated that contact with the extension (12.507)  
157 and the number of cattle (11.506) were variable, having a greater influence on farmers  
158 adopting rice- and corn- straw as a feed (Table 4).

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

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

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

### 173 DISCUSSION

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

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

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

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

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

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

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

#### 225 CONCLUSION

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

## REFERENCES

- 233
- 234 **Atmiş, E., H. B.Günşen, B. B.Lise, W.Lise. 2009.** Factors affecting forest  
235 cooperative's participation in forestry in Turkey. Forest policy and economics  
236 11:102-108.
- 237 **Baba, S., S.N. Sirajuddin, A.Abdullah dan M. Aminawar. 2014.** Barrier to adoption  
238 of integration of maize-livestock in Maros, Gowa and Takalar Regency. JITP  
239 Vol. 3 No. 2: 114 – 120.
- 240 **Bodorkos, B.and G. Pataki. 2009.** Linking Academic and Local Knowledge:  
241 Community-Based Research and Service Learning for Sustainable Rural  
242 Development in Hungaria. J. of Clean. Product. 17:1123-1131.
- 243 **Bremer L. L., K. A. Farley and Lopez-Carr David.2014.** What factors influence  
244 participation in payment for ecosystem services programs? An evaluation of  
245 Ecuador's Socio Paramo program. Land Use Pol., 36:122-133.
- 246 **Direktorat Jenderal Peternakan. 2015.** Data populasi ternak di Indonesia. Dirjen  
247 Peternakan, Kementerian Pertanian Republik Indonesia, Jakarta.
- 248 **Diwyanto, K. 2008.** Pemanfaatan sumber daya lokal dan inovasi teknologi dalam  
249 mendukung pengembangan usaha sapi potong di Indonesia. Pengemb. Inov.  
250 Pert. I (3):173-188.
- 251 **Giller KE, E. Witter, M. Corbeelsand, P. Tittonell. 2008.** Conservation agriculture  
252 and smallholder farming in Africa:the heretics'view. Field Crops Res. 114:23-  
253 34.
- 254 **Haryanto, B. 2009.** Inovasi teknologi pakan ternak dalam sistem integrasi Tanaman-  
255 Ternak bebas limbah mendukung upaya peningkatan produksi daging.  
256 Pengembangan Inovasi Pertanian 2(3):163-176.

**Commented [MP2]:** The number of 10 year journal publications (<2008) is still below 80%. Yours are 54% (13/24). Please add. Proceeding (Sarubang & Pasambe) is not allowed, please replace with recent journal.

- 257 **He, J., Z. Zhou, H. Weyerhaeuser, J. Xu. 2009.** Participatory technology  
258 development for incorporating non-timber forest products into forest restoration  
259 in Yunnan, Southwest China. *Forest Ecology and Management* 257:2010-2016.
- 260 **Llewellyn, R. S. 2007.** Information quality and effectiveness for more rapid adoption  
261 decisions by farmers. *Field Crops Res.* 104:148 – 156,
- 262 **Mudzengi C. P., Taderera L. M., Tigere A., Kapembeza C. S., Moyana S., Zimondi**  
263 **M., Derembwe E. T. and Dahwa E. 2014.** Adoption of urea treatment of  
264 maize stover technology for dry season supplementation of cattle in Wedza,  
265 Zimbabwe. *Livestock Research for Rural Development. Volume 26, Article*  
266 *#160.* Retrieved March 14, 2018, from  
267 <http://www.lrrd.org/lrrd26/9/mudz26160.htm>
- 268 **National Statistical Bureau – BPS 2014.** Statistik Indonesia.  
269 <https://www.bps.go.id/publication/2014/05/05/8d2c08d9d41aa8c02fad22e7/statistik-indonesia-2014.html>  
270
- 271 **National Statistical Bureau – BPS 2015.** Statistik Padi Kabupaten Maros Tahun 2014.  
272 Badan Pusat Statistik Kabupaten Maros, Maros.
- 273 **Trach, N. X. 2004.** An evaluation of adoptability of alkali treatment of rice straw as  
274 feed for growing beef cattle under smallholders' circumstances. *Livestock*  
275 *Research for Rural Development. Vol. 16, Art. #52.* Retrieved March 27, 2017,  
276 from <http://www.lrrd.org/lrrd16/7/trac16052.htm>
- 277 **Ngoc Chi, T.T., P.V. Liem, T. Pharis. 2007.** Farmers Participation in Rice Variety  
278 Selection. *Journal of Omonrice* 15: 159-163.

- 279 **Parmawati, R., Mashudi, A. Budiarto, Suyadi and A.S. Kurnianto.** 2018.  
280 Developing sustainable livestock production by feed adequacy map: A case  
281 study in Pasuruan Indonesia. *Tropical Animal Sci. Journal.* 41(1):67-76.
- 282 **Ralevic P., S. G. Patiland, G. van Loon.** 2010. Integrated agriculture production  
283 systems for meeting household food, fodder and fuel security. *J. Sust. Agric.*  
284 34, 878-906.
- 285 **Rao, P. P. and A. J. Hall.** 2003. Importance of Crop Residues in crop-livestock  
286 systems in India and farmers' perceptions of fodder quality in coarse cereals.  
287 *Field Crops Res.* 84:189-198.
- 288 **Reimer, A.P., D.K. Weinkauff and L.S. Prokopy.** 2012. The Influence of perceptions  
289 of practice characteristics: An examination of agriculture best management  
290 practice adoption in two Indiana watersheds. *J. of Rural Studies* 28:118-128.
- 291 **Rhoades, R. E. and R. H. Boath.** 1982. Farmer-back-to-farmer: a Model for  
292 Generating Acceptable Agriculture Technology. *Agr. Admin.* 11:127-137.
- 293 **Rogers, E. M.** 2003. *Diffusion of Innovations.* Fifth Ed., New York Press, New York.
- 294 **Sariubang, M. dan D. Pasambe.** 2005. *Sistem Integrasi Jagung-Sapi Potong di*  
295 *Kabupaten Takalar Sulawesi Selatan. Proseeding Seminar Nasional Teknologi*  
296 *Peternakan dan Veteriner. Bogor, 10-11 November 2005. Puslitbang Peternakan,*  
297 *Departemen Pertanian.* 198-208.
- 298 **Valbuena D, O. Erensteinb, S. Homann-Kee Tuic, T. Abdoulayed, L. Claessense,**  
299 **A.J. Duncang, B. Gérarda, M. C. Rufinoh, N. Teufeli, A. van Rooyencand,**  
300 **M.T. van Wijkh.** 2012. Conservation agriculture in Mixed crop-livestock  
301 systems: Scoping crop residue trade-offs in sub-saharan Africa and South Asia.  
302 *Field Crops Res.* 132:175-184.

303 **Wubeneh, N. G. and J. H. Sanders.** 2006. Farm-level adoption of sorghum  
304 technologies in Tigray Ethiopia. *Agricultural systems* 91:122-134.  
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 <sup>ns</sup>
Business experience(year)	6.36	4.94	5.54	3.31	0.270 <sup>ns</sup>
Family member (person)	4.09	1.21	3.67	1.13	0.914 <sup>ns</sup>
Number of cattle (head)	3.86	1.17	2.98	0.75	0.000 <sup>**</sup>
Wide of rice areal (ares)	49.68	33.37	27.38	18.29	0.003 <sup>**</sup>
Education level (person)					
- low ( $\leq$ junior high school)	36		43		
- senior high school	7		9		
- university	1		0		
Total of farmers	44		52		

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

308

309 **Table 2.** Farmer's reasons to using crop residues 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

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

312

313 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

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

316

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

Varaibel	B	SE	Wald	P-Value
Age (X1)	-0.006	0.028	0.048	0.827 <sup>ns</sup>
Work perception (X2)	1.918	0.859	4.988	0.026*
Farmer experience (X3)	0.039	0.099	0.154	0.695 <sup>ns</sup>
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 <sup>ns</sup>
Constant	-13.990	3.498	15.993	0.000**

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

## PERBAIKAN ARTIKEL SETELAH KOMENTER REVIEWER

TASJ-1820

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

3

4                                   **ABSTRACT**

5     The utilization of crop residue as a feed is very important because the arable land area is  
6     relatively limited. We examined the influence of adoption of crop residue product as a  
7     feed. The research was conducted in Maros district by using survey methods from  
8     March to August 2015. The number of respondents was 96 farmers scattered throughout  
9     the districts of Bantimurung and Camba as centers of rice, corn plant, and  
10    cattle. Questionnaires were used to collect data conducted by a trained enumerator.  
11    Survey was arranged using a logistic regression model to identify socioeconomic factors  
12    which have influenced the adoption of crop residue as a feed. Work perception (X2),  
13    contact with extension workers (X4), rice cultivated areas (X5), number of livestock

14 (X6), subjective norm (X7), and difficulty (X8), as socio-economic variables,  
15 influenced by the adoption of crop residue as a feed; however, the variables age (X1),  
16 farmer experiences (X3), and the number of family members (X9) have no effect on the  
17 adoption of this technology. Extension workers play an important role in increasing the  
18 adoption of technology by using rice and corn straws as a feed. Likewise, not only the  
19 number of livestock, but also the good perception of the farmers increased along with  
20 the increase of feed availability, such as utilization of rice and corn straws.

21 Keywords: adoption, crop residue, fodder, maros

22

23

## INTRODUCTION

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

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

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

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

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

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

75

76

## MATERIALS AND METHODS

77

### Data Collection

78

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

88

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

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

#### 96 **Statistical Analysis**

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

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

$$114 \quad Y = \ln \left( \frac{p_i}{1-p_i} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 +$$

$$115 \quad \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \varepsilon$$

116 Where:  $Y$  is the opportunity adoption of the utilization of straw as feed ( $p_i = 0$  indicates  
 117 no adoption,  $p_i = 1$  indicates adoption);  $\beta_0$  is intercept;  $\beta_1 - \beta_7$  is regression coefficients

118 of the dependent variables;  $X_1$  is age, expressed of the length of reviews their life  
119 (year);  $X_2$  is work perception, as a dichotomous variable, where 1 denotes the main  
120 work as being a-beef cattle farmer, and 0 otherwise;  $X_3$  is farmer expressed experience,  
121 reported as the length of their experience as a beef cattle farmer (years);  $X_4$  is contact  
122 with extension workers, expressed as the number of contacts with extension workers  
123 (frequency in 2015);  $X_5$  is rice cultivated area, expressed as the number of hectares (ha);  
124  $X_6$  is number of livestock, expressed as the number of livestock intensively reared  
125 (heads);  $X_7$  is subjective norm, expressed as the perception of beef cattle farmers  
126 towards what should be done in view of the their community based on their position  
127 (score);  $X_8$  is technology difficulty, expressed as difficulty in using crop residues feed  
128 by, beef cattle farmers: 1 if the agrees that it is difficult, or 0 if otherwise; and  $X_9$  is  
129 family size, expressed as number of farmers' family (individual).

## 130 RESULTS

### 131 Farmer Characteristics

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

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

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

142 or herbage production. Second, corn-straw increased with the increased in harvesting  
143 season. Third, the number of livestock 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 be harvested 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 extension  
165 workers, number of livestock, rice cultivated area, social norms and perceptions on the

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

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

#### 176 DISCUSSION

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

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

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

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

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

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



238 **CONFLICT OF INTEREST**

239 The authors declare there is no conflict of interest

240

241 **REFERENCES**

- 242 **Atmiş, E., H.B. Günşen, B.B. Lise, & W. Lise.** 2009. Factors affecting forest  
 243 cooperative's participation in forestry in Turkey. *Forest policy and economics*  
 244 11:102-108.
- 245 **Baba, S., S.N. Sirajuddin, A. Abdullah, & M. Aminawar.** 2014. Barrier to adoption  
 246 of integration of maize-livestock in Maros, Gowa and Takalar Regency. *JITP*  
 247 Vol. 3 No. 2: 114-120.
- 248 **Bodorkos, B.&G. Pataki.** 2009. Linking academic and local knowledge: community-  
 249 based research and service learning for sustainable rural development in  
 250 Hungaria. *J. Clean. Product.* 17:1123-1131.
- 251 **Bremer, L.L., K.A. Farley, & Lopez-Carr David.** 2014. What factors influence  
 252 participation in payment for ecosystem services programs? An evaluation of  
 253 Ecuador's Socio Paramo program. *Land Use Pol.* 36:122-133.
- 254 **Direktorat Jenderal Peternakan.** 2015. Data Populasi Ternak di Indonesia. Dirjen  
 255 Peternakan, Kementerian Pertanian Republik Indonesia, Jakarta.
- 256 **Feola G. & C.R. Binder.** 2010. Towards and improved understanding of farmer's  
 257 behavior: The integrative agent-centered (IAC) framework. *Ecological*  
 258 *Economics* 69: 2323-2333.
- 259 **Giller, K.E., E. Witter, M. Corbeelsand, &P. Titttonell.** 2009. Conservation  
 260 agriculture and smallholder farming in Africa: the heretics'view. *Field Crops*  
 261 *Res.* 114:23-34.

- 262 **Hauser, M., M. Lintdner, S. Prehler, & L. Probst.** 2016. Farmer participatory  
263 research: why extension workers should understand and facilitate farmer's role  
264 transitions. *Journal of Rural Studies* 47:52-61.
- 265 **Haryanto, B.** 2009. Inovasi teknologi pakan ternak dalam sistem integrasi Tanaman-  
266 Ternak bebas limbah mendukung upaya peningkatan produksi daging.  
267 *Pengembangan Inovasi Pertanian* 2:163-176.
- 268 **He, J., Z. Zhou, H. Weyerhaeuser, & J. Xu.** 2009. Participatory technology  
269 development for incorporating non-timber forest products into forest restoration  
270 in Yunnan, Southwest China. *Forest Ecology and Management* 257:2010-2016.
- 271 **Mudzeni, C.P., L.M. Taderera, A. Tigere, C.S. Kapembeza, S. Moyana, M.**  
272 **Zimondi, E.T. Derembwe, & E. Dahwa.** 2014. Adoption of urea treatment of  
273 maize stover technology for dry season supplementation of cattle in Wedza,  
274 Zimbabwe. *Livestock Research for Rural Development*. Volume 26, Article  
275 #160. Retrieved March 14, 2018, from  
276 <http://www.lrrd.org/lrrd26/9/mudz26160.htm>
- 277 **National Statistical Bureau – BPS.** 2014. Statistik Indonesia.  
278 <https://www.bps.go.id/publication/2014/05/05/8d2c08d9d41aa8c02fad22e7/statistik-indonesia-2014.html>  
279
- 280 **National Statistical Bureau – BPS.** 2015. Statistik Padi Kabupaten Maros Tahun  
281 2014. Badan Pusat Statistik Kabupaten Maros, Maros.
- 282 **Supaporn, P., T. Kobayashi, & C. Supawadee.** 2013. Factors affecting farmer's  
283 decisions on utilization of rice straw compost in Northeastern Thailand. *J. Agr.*  
284 *Rural Develop. Trop. Subtrop.* 114-1:21-27.

- 285 **Parmawati, R., Mashudi, A. Budiarto, Suyadi, & A.S. Kurnianto.** 2018.  
286 Developing sustainable livestock production by feed adequacy map: A case  
287 study in Pasuruan Indonesia. *Tropical Animal Sci. Journal.* 41:67-76.
- 288 **Ralevic P., S.G. Patiland, &G. van Loon.**2010. Integrated agriculture production  
289 systems for meeting household food, fooder and fuel security. *J. Sust, Agric.*  
290 34, 878-906.
- 291 **Reimer, A.P., D.K. Weinkauf, & L.S. Prokopy.** 2012. The Influence of perceptions  
292 of practice characteristics: An examination of agriculture best management  
293 practice adoption in two Indiana watersheds. *J. Rural Studies* 28:118-128.
- 294 **Rhoades, R.E.& R.H. Boath.** 1982. Farmer-back-to-farmer: a Model for Generating  
295 Acceptable Agriculture Technology. *Agr. Admin.* 11;127-137.
- 296 **Rogers, E. M.** 2003. *Diffusion of Innovations.* Fifth Ed., New York Press, New York.
- 297 **Valbuena D, O. Erensteinb, S. Homann-Kee Tuic, T. Abdoulayed, L. Claessense,**  
298 **A.J. Duncang, B. Gérarda, M.C. Rufinoh, N. Teufeli,A. van Rooyencand,**  
299 **&M.T. van Wijkh.** 2012. Conservation agriculture in Mixed crop-livestock  
300 systems: Scoping crop residue trade-offs in sub-saharan Africa and South Asia.  
301 *Field Crops Res.* 132:175-184.
- 302 **Winarsoh, B. & E. Basuno.** 2013. Pengembangan pola integrasi Tanaman-Ternak  
303 merupakan bagian upaya mendukung usaha pembibitan sapi potong dalam  
304 negeri. *For. Penelitian Agroekonomi* 31:151-169.
- 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 <sup>ns</sup>
Business experience(year)	6.36	4.94	5.54	3.31	0.270 <sup>ns</sup>
Family member (person)	4.09	1.21	3.67	1.13	0.914 <sup>ns</sup>
Number of cattle (head)	3.86	1.17	2.98	0.75	0.000**
Wide of rice areal (ares)	49.68	33.37	27.38	18.29	0.003**
Education level (person)					
- low ( $\leq$ junior high school)	36		43		
- senior high school	7		9		
- university	1		0		
Total of farmers	44		52		

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's reasons to using crop residues as feed

<b>Reason of adoption</b>	<b>Score*</b>	<b>Rank</b>
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

<b>Reason of non-adoption</b>	<b>Score</b>	<b>Rank</b>
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 <sup>ns</sup>
Work perception (X2)	1.918	0.859	4.988	0.026*
Farmer experience (X3)	0.039	0.099	0.154	0.695 <sup>ns</sup>
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 <sup>ns</sup>
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

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# ARTIKEL YANG PUBLISH SETELAH PERUBAHAN

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

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### ABSTRACT

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

**Keywords:** technology adoption; crop residue; fodder; Maros

### INTRODUCTION

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

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

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

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

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

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

## MATERIALS AND METHODS

### Data Collection

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

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

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

### Statistical Analysis

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

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

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

Where:  $Y$  was the opportunity for adoption or the utilization of straw as feed ( $\pi=0$  indicated no adoption,  $\pi=1$  indicated adoption);  $\beta_0$  was intercept;  $\beta_1$ - $\beta_9$  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 <sup>ns</sup>
Business experience (year)	6.36	4.94	5.54	3.31	0.270 <sup>ns</sup>
Family member (person)	4.09	1.21	3.67	1.13	0.914 <sup>ns</sup>
Number of cattle (head)	3.86	1.17	2.98	0.75	0.000 <sup>**</sup>
Wide of rice areal (are)	49.68	33.37	27.38	18.29	0.003 <sup>**</sup>
Education level (person)					
Low ( $\leq$ junior high school)		36		43	
Senior high school		7		9	
University		1		0	
Total of farmers		44		52	

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

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

Reason of adoption	Score <sup>a</sup>	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 <sup>m</sup>
Work perception (X2)	1.918	0.859	4.988	0.026*
Farmer experience (X3)	0.039	0.099	0.154	0.695 <sup>m</sup>
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 <sup>m</sup>
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.

#### REFERENCES

- Atmiş, E., H.B. Günşen, B.B. Lise, & W. Lise. 2009. Factors affecting forest cooperative's participation in forestry in Turkey. *Forest policy and economics* 11:102-108. <https://doi.org/10.1016/j.forpol.2008.10.002>
- Baba, S., S.N. Sirajuddin, A. Abdullah, & M. Aminawar. 2014. Barrier to adoption of integration of maize-livestock in Maros, Gowa and Takalar Regency. *JITP Vol. 3 No. 2*: 114-120.
- Bodorkos, B. & G. Pataki. 2009. Linking academic and local knowledge: community-based research and service learning for sustainable rural development in Hungary. *J. Clean. Product.* 17:1123-1131. <https://doi.org/10.1016/j.jclepro.2009.02.023>
- Bremer, L.L., K.A. Farley, & Lopez-Carr David. 2014. What factors influence participation in payment for ecosystem services programs? An evaluation of Ecuador's Socio Paramo program. *Land Use Pol.* 36:122-133. <https://doi.org/10.1016/j.landusepol.2013.08.002>
- Direktorat Jenderal Peternakan. 2015. Data Populasi Ternak di Indonesia. Dirjen Peternakan, Kementerian Pertanian Republik Indonesia, Jakarta.
- Feola G. & C.R. Binder. 2010. Towards and improved understanding of farmer's behavior: The integrative agent-centered (IAC) framework. *Ecol. Econ.* 69:2323-2333. <https://doi.org/10.1016/j.ecolecon.2010.07.023>
- Giller, K.E., E. Witter, M. Corbeelsand, & P. Tittonell. 2009. Conservation agriculture and smallholder farming in Africa: the heretics' view. *Field Crops Res.* 114:23-34. <https://doi.org/10.1016/j.fcr.2009.06.017>
- Hausser, M., M. Lintdner, S. Prehler, & L. Probst. 2016. Farmer participatory research: why extension workers should understand and facilitate farmer's role transitions. *J. Rural Stud.* 47:52-61. <https://doi.org/10.1016/j.jrurstud.2016.07.007>
- Haryanto, B. 2009. Inovasi teknologi pakan ternak dalam sistem integrasi Tanaman-Ternak bebas limbah mendukung upaya peningkatan produksi daging. *Pengembangan Inovasi Pertanian* 2:163-176.
- He, J., Z. Zhou, H. Weyerhaeuser, & J. Xu. 2009. Participatory technology development for incorporating non-timber forest products into forest restoration in Yunnan, Southwest China. *For. Ecol. Manage.* 257:2010-2016. <https://doi.org/10.1016/j.foreco.2009.01.041>
- Mudzengi, C.P., L.M. Taderera, A. Tigere, C.S. Kapembeza, S. Moyana, M. Zimondi, E.T. Derembwe, & E. Dahwa. 2014. Adoption of urea treatment of maize stover technology for dry season supplementation of cattle in Wedza, Zimbabwe. *Livestock Research for Rural Development.* Volume 26, Article #160. <http://www.lrrd.org/lrrd26/9/mudz26160.htm>
- National Statistical Bureau - BPS. 2014. Statistik Indonesia. <https://www.bps.go.id/publication/2014/05/05/8d2c08d9d41aa8c02fad22e7/statistik-indonesia-2014.html>
- National Statistical Bureau - BPS. 2015. Statistik Padi Kabupaten Maros Tahun 2014. Badan Pusat Statistik Kabupaten Maros, Maros.
- Supaporn, P., T. Kobayashi, & C. Supawadee. 2013. Factors affecting farmer's decisions on utilization of rice straw compost in Northeastern Thailand. *J. Agr. Rural Develop. Trop. Subtrop.* 114-1:21-27.
- Parnawati, R., Mashudi, A. Budiarto, Suyadi, & A.S. Kurnianto. 2018. Developing sustainable livestock production by feed adequacy map: A case study in Pasuruan Indonesia. *Trop. Anim. Sci. J.* 41:67-76. <https://doi.org/10.5398/tasj.2018.41.1.67>
- Ralevic P., S. G. Patiland, & G. van Loon. 2010. Integrated agriculture production systems for meeting household food, fodder and fuel security. *J. Sust. Agric.* 34: 878-906. <https://doi.org/10.1080/10440046.2010.519203>
- Reimer, A.P., D.K. Weinkauf, & L.S. Prokopy. 2012. The Influence of perceptions of practice characteristics: An examination of agriculture best management practice adoption in two Indiana watersheds. *J. Rural Stud.* 28:118-128. <https://doi.org/10.1016/j.jrurstud.2011.09.005>
- Rhoades, R.E. & R.H. Boath. 1982. Farmer-back-to-farmer: a model for generating acceptable agriculture technology. *Agr. Admin.* 11:127-137. [https://doi.org/10.1016/0309-586X\(82\)90056-5](https://doi.org/10.1016/0309-586X(82)90056-5)
- Rogers, E. M. 2003. *Diffusion of Innovations.* Fifth Ed., New York Press, New York.
- Valbuena D, O. Erensteinb, S. Homann-Kee Tuic, T. Abdoulayed, L. Claessense, A.J. Duncang, B. Gérard, M.C. Rufinoh, N. Teufeli, A. van Rooyencand, & M.T. van Wijk. 2012. Conservation agriculture in Mixed crop-livestock systems: Scoping crop residue trade-offs in sub-saharan Africa and South Asia. *Field Crops Res.* 132:175-184. <https://doi.org/10.1016/j.fcr.2012.02.022>
- Winarsoh, B. & E. Basuno. 2013. Pengembangan pola integrasi Tanaman-Ternak merupakan bagian upaya mendukung usaha pembibitan sapi potong dalam negeri. *For. Penelitian Agroekonomi* 31:151-169. <https://doi.org/10.21082/fae.v31n2.2013.151-169>