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Economic Effect of Local Feed Utilization in Korea

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Abstract

Rice straw is the principal forage for Korean cattle. Limited supply of domestic forage forces Korea to depend on imported forage. Utilizing locally available domestic feed as an alternative would lead to self-sufficiency and stability in cattle farm management. Locally available feed can be utilized as forage. The challenge of collecting local feed has been overcome by machines that have been developed to harvest feed. Local feed can be completely consumed in the production regions, thus reducing transportation costs and increasing price competitiveness. Hitherto, studies have focused on feed technologies and price competitiveness, among other factors, while the substitution of forage has not been examined. This study conducts a quantitative analysis to estimate the extent to which local feed can replace existing forage. We find that local feed is cheaper, and abundantly available, and can thus replace high-quality forage.

Keywords: *Forage, Korean cattle, Local feed, Rice straw.*

1. Introduction

Forages are absolute factor in the production of Korean beef along with the price stabilization and have large impact on profit to the farming industry. In 2016, the proportion of forages expenses of Korean beef is 38.2% which is almost equal in comparison of expenses of buying livestock of 38.6%. Even in the Korean breeding beef the expenses of forage take up 45.8%, the portion of forage expenses is absolute in most production. Korea depend mostly on imports forage both TMR and grain based which can affect the risk of changes in international grain prices and exchange rates, and thus can significantly affect the risk of changes in food prices. This affects the income of Korean beef farmers, and it is urgently needed to provide stable feed for the sustainability of the Korean beef industry.

But the self-sufficient import of forage in Korea is 980 thousand tons which price is 441/KR billion in 2014. Imported forage which farmer's purchase price in 2017 are Alfalfa is 600KR/kg, Timothy is 650KR/kg, Ryegrass & Tall Fescue are 550KR/kg and rice straw is 370KR/kg on average, it is 450KR/kg(Korea Forage Institute, 2017). Therefore local feed, a local product, needs to be replaced to increased production of domestic

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forage, in order to reduce the cost of purchasing feed from Korean beef farmers. In particular, a drastic increase in domestic forage is due to problems such as the income of farmers of producing forage and the expansion of farming land, which are desperately needed for alternation.

Local feed is a cyclical agricultural product that uses what remains after agricultural production which refers to alternative feed made to promote environmental protection and safety of farming households. But the designation of local feed is no yet officially defined yet (RDA NICS, 2015).

The government has been efforts to improve the self-sufficiency rate of forage for the sustainability of the Korean beef industry also. The government strives to increase production of forage crops, utilize rest areas, select alternative crops, and provide rice straw transportation to stabilize prices. However, the rise in the price of Korean beef will become more depend on imported forage, which could make it difficult for Korean beef farmers to manage insecurity and increase profits. Despite of this situation, there are many reasons why Korean beef farmers depend on imported forage such as uniformity of quality and standards of domestic forage, the establishment of a sustainable supply system throughout the year, overcoming differences in imported forage and productivity, difficulties resulting from timely purchase, and differentiated prices. The rice straw, which currently represents Korean beef, is also being tried by the government to reduce the supply but has no definite effect yet.

The activation of local forage for Korean beef increases the self-sufficiency rate of forage, but does not limit the effect on the utilization of forage. It is also important to reduce waste of agricultural resources and improve the environment by recycling them in a cyclical manner. In particular, local feed utilization in the region replaces imported forage and it is also important in terms of cheap and safe forage supply to TMR forage. Replacing local feed also helps Korean beef farmers increase their income.

Most of the Korean beef research in Korea so far has been conducted with great interest and research in areas such as improving the quality of Korean beef, boosting prices and promoting consumption, and strengthening the competition in imported meat but analysis of the economic effects of local feed, an alternative food source that uses agricultural products are limited.

The purpose of this study is to Analysis the economic effects of local feed as well as to suggest ways to activate it.

2. Current Status of Local Feeds in Korea

Korean cattle can be divided into agricultural feed (including TMR and TMF feed), forage, and other supplemental feed. Local feed refers to the use of locally produced agricultural products as forage for Korean beef. Thus, local feed is limited to alternatives to domestic forage.

The Control of Livestock and Fish Feed Act (MAFRA, 2016) provides a wide range of documents, food processing by-products, fruits, nuts, and other byproducts of the food manufacturing industry therefore legal problems in replacing agricultural by-products with local feed have been solved. However, it is only applicable to farm households that are still smaller than 4 tons.

The cost of disposing of potato-based products in Korea is 250 KR/kg, and even considering that potato-based products from food companies are 800 tons/month, it is worth 24 billion KR/ year. So, replacing them with local feeds can reduce the recycling and production costs of resources. In addition, agricultural products such as tofu, beer boxes, and mushroom growth media were able to reduce feed costs by 20 percent and increase income by 30 percent in Korean beef farms tested using fiber-based feed (Livestock Daily News, 2014).

Table 1 indicates that agricultural and food products can be recycled to local feed and which also includes many agricultural by-products, some showing exactly where they occurred and the quantity.

Table 1. Major agricultural by-products that can be utilized as forage

No.	Classification	Name of crops	Name of parts	Generation amount/year (M/T)
1	Agricultural byproducts	Garlic	Garlic stalk	93,934
2		Sweet potato	Sweet potato and stalk	280,089
3		Bean	Bean stalk	154,067
4		Sorghum	Sorghum stalk	None
5		Potato	Potato stalk	130,939
1	Food byproducts	Bean	Tofu residue	44,044
2		Wheat	By-products of noodles	116,385
3		Alcohol	Alchoholic meal, Brewer's grains	464,343
4		Bean	Soy sauce cake	28,518

Source: RDA (2015).

Table 2 shows that most of the agricultural by-products are incinerated. There are prerequisites for utilizing this as a local feed. The reason for the use of local feed is that collection is not normalized, generation is intermittent, difficulty in storage after collection, and poor quality specification are not preferred by Korean beef farmers. However, the collection issue is not necessarily so when it comes to the collect of agricultural vinyl. Also, in the case of stem plants, such as melon and cucumber, local feed utilization is low due to difficulties in recovery due to the support of stems and vinyl straps.

Table 2. Disposal of major agricultural by-products that can be utilized as forage

No.	Name of crops	Name of parts	Disposal methods
1	Garlic	Garlic stalk	Incineration
2	Corn	Corn stalk	Incineration
3	Potato	Sweet potato and stalk	Some → edible, the else → incineration
4	Bean	Bean stalk	Bean pod → forage, the else → incineration
5	Sorghum	Sorghum stalk	Incineration

Source: Choi (2012).

Table 3 shows the type of imported feed in Korea. Except for the types of grass used for feed, oats, wheat hay, and sugarcane hay can be replaced with local feed according to policy direction. In particular, it is possible to substitute local feed because of the already developed harvesting machines such as wax, barley, and reeds (RDA NICS, 2016).

Table 3. Major imported forage that can be replaced by local feed

No.	Classification	Kinds of Forage
1	Graniferous hay	Oat hay, Rye hay, Sugar cane hay
2	Graniferous silage	Corn silage and etc.
3	Graniferous straw	Wheat straw, Barley straw, Reed, Ryegrass stalk and etc.
4	Legume	Alfalfa hay, Alfalfa cube, Alfalfa pellets and etc.

Source: RDA (2016).

Important issues with local fed (including domestic rice straw) are standards include quality, standardization, and moisture (RDA NICS, 2012). At the same time, Table 4 sets the classification rules according to the request that the quality level of feed should be determined to differentiate the price. The highest rating factors are moisture, followed by relative feed value, and crude protein and crude ash. But Table 4 has not yet established a quality grade for local feed, so if the quality and specifications are set according to this, local feed can play a role sufficiently as an alternative feed.

Table 4. Quality rating standard of domestic forage

Items (score)	Standards for valuation		Valuation (score)				
Moisture (50)	Moisture content (0% or more – Under 0%)	Points	50 pt	45 pt	40 pt	35 pt	30 pt
		Silage	55 – 60	60 – 65	65 – 70	70 – 75	75 –
		Haylage	40 – 42	42 – 44	44 – 46	46 – 48	48 – 50
		Hay	– 16	16 – 17	17 – 18	18 – 19	19 – 20
Relative Food Value (RFV) (30)	Food value (NDF, ADF, and etc.)	Points	30 pt	26 pt	22 pt	18 pt	14 pt
		Point	115 –	100 – 115	85 – 100	70 – 85	– 70
Crude protein (10)	Crude protein content	Points	10 pt	8 pt	6 pt	4 pt	2 pt
		%	12 –	10 – 12	8 – 10	6 – 8	– 6
Crude ash (10)	Foreign material mixing (soil)	Points	10 pt	8 pt	6 pt	4 pt	2 pt
		%	– 7	7 – 9	9 – 11	11 – 13	13 –

Source: RDA (2015).

When Korean beef farmers choose alternative forage, there are many types of forage that make relative feed an important choice. Table 5 is a quality grade based on the relative value of feed, and the price of feed also depend on the value of the other feed and prefers high-grade feed. If local forage value is applied to local forage value, replacement rate will be increased in response to Korean beef farmers' demand and it will be cheaper to supply it to farmers (RDA NICS, 2015).

Table 5. Hay-centered forage quality ratings based on relative feed value (RFV)

Classification	Special	1st Class	2nd Class	3rd Class	4th Class	5th Class	Offgrade
RFV	151 –	150 – 125	124 – 103	102 – 87	86 – 75	74 – 60	– 60

2.1 An Economic Analysis of the Local Feed Utilization

For local feed to be used as a feed for Korean beef, the degree of activation varies depending on the substitution. If local feed is completely replaceable with domestic and imported feed in terms of quality, it is possible for local feed to be completely replaced with domestic and imported feed, and between full and incomplete replacement. At the same time, if both domestic and imported feed could be completely replaced in terms of price, local feed should be replaced by local feed if it is not possible to replace complete feed with domestic and imported feed respectively, and the local feed must be considered together.

Thus for the replacement of local feed, if local feed is fully replaceable with domestic product and imported feed, if local feed is more than 80 points in quality or if the value of relative feed is higher than 80 points in quality, it can be completely replaced. Conversely, it would be almost impossible to replace a grade of 50 points or less, or if the value of the relative feed is lower than grade 3. However, local feed also has food value and price competitiveness so it can be replaced to some extent. Considering these problems, it is possible to draw equivalent curve of Korean beef imports and local feed as shown in Figure 1.

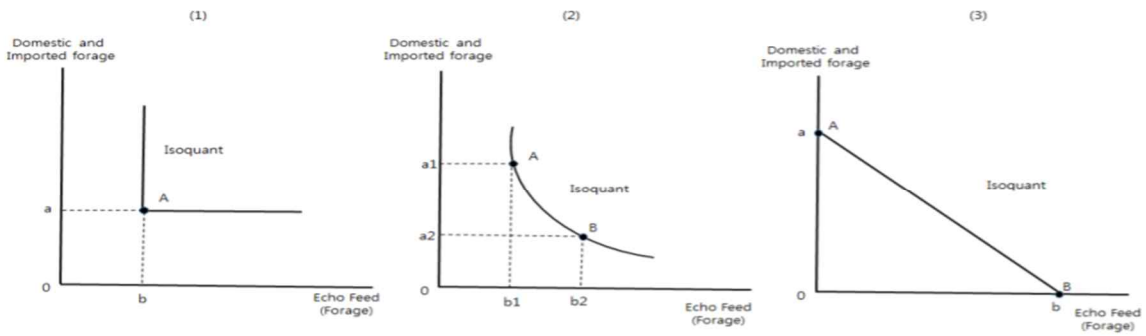

Fig. 1. Relationship of local feed with domestic and imported forage respectively.

In Figure 1, the replacement of feed is infinite at a certain scale, as domestic and imported feed are normal compared to local feed in terms of quality and price, respectively. So it does not replace the local feed until it reaches the 'a' level, but it will no longer be possible to increase productivity as a result. So, when the level of 'a' or 'b' is reached, it is completely replaced. (2) depend on the amount of Marginal Rate of Technical Substitution(MRTS). Depending on the size of the slope of the MRTS, the quality of each domestic product, imported feed, and local feed are replaced by 'a1' and 'b1' at contact A. In this case, the alternative elasticity exists between 0 and ∞, and (2) is realistic and subject to analysis. (3) Where alternative elasticity is zero, domestic feed and imported feed are completely separated and cannot be substituted. Therefore, MRTS is the size of the slope that meets the equivalent curve.

2.2 The Marginal Rate of Technical Substitution (MRTS) and Elasticity of Local Feed

Substitution of domestic, imported and local feed is an important factor in increasing the self-sufficiency rate of feed and the cost of purchasing feed to Korean beef farmers, resulting in stable management and increased farm income. Therefore, the replacement rate is determined and the replacement elasticity is obtained to analyze the economic effects of the replacement local feed. However, to analyze this, some statistics for Korean beef farmer's forage amount are assumed since time series or cross section data are not essential, and some statistics are not available In addition, feed prices should be considered only as they fall outside the scope of this study, although the value of feed nutrition is one of the important factors and there may be differences between feed and feed.

2.3 The Marginal Rate of Technical Substitution (MRTS) between Local forage and Local feed

Considering the marginal productivity of domestic feed prices, rate of supply price change, quality level, and competition with import price, it is difficult to expand production in a short period of time. Therefore, replacing local forage with local feed would provide the necessary feed for farmers. For this purpose, regular Korean beef cattle size can provide equivalent grain lines for Korean beef production as shown in Fig. 1, and determine the ratio of domestic use and local feed to local food. Fig (1) is an expression that obtains MRTS of Korean beef produced for domestic consumption and local feed. The replacement relationship between domestic usage and local feed is an important determinant of purchase, without price changes. Korea's total supply of forage in 2015 amounted to 4,476,000 tons, 246,000 tons of grass, 2,231 tons of straw, and 1,999,000 tons of grain crops. In the case of Korean beef cattle, straw is substituted for domestic research, and feed crops and grasses are used for milk cow. Thus, the domestic price of Korean beef is based on rice straw, but also includes barley and straw, which are distributed similar to rice straw. Thus, the alternative relationship can be identified by the alternative adaptability with the local feed. And, ' F_j' are domestic feeders such as rice straw, barley, and straw, and local feed fi are sweet potato shoots, potato shoots, and soybeans.

$$\text{marginal replacement rate}(MRTS_{F_i,F_j}) = -\frac{\text{Increase in Local forage}(F_i)}{\text{Increase in Local Feed}(F_i)} = \frac{\text{Limit production of Local Forage}(MP\ F_i)}{\text{Limit production of Local Feed}(MP\ F_i)} \quad (1)$$

2.4 Marginal Replacement Rate between Imported Forage and Local Feeds

As shown in Table 3, there are many different types of imported feed and different countries. Among the import forages, oat hay, rye hay, straw, barley, reeds and ryegrass stems can be replaced by local feed in Korea. The marginal replacement rate for imported storage and local feeds is also assumed as in the case of domestic usage. The marginal replacement rate of the import forage and local feed can be expressed as shown in formula (2). The marginal replacement rate for imported forages and local feeds is to determine which ratio of imported forage and local feeds can be substituted for number of Korean beef at a constant rate. Depending on the shape of the equivalent curve of Korean beef production, MRTS also changes the replacement of imported forage

with local feed. And in here where Fi is the same as before at the local feed and F3 is the rice stalk of the ryegrass.

$$\text{marginal replacement rate}(MRTS_{Fj,Fi}) = -\frac{\text{Increase in Imports}(Fj)}{\text{Increase in Eco Feed}(Fi)} = \frac{\text{Import Production}(MP_{Fj})}{\text{Limit production of Eco Feed}(MP_{Fi})} \quad (2)$$

2.5 Alternative Elasticity between Local Forage and Local Feed

Alternative elasticity is obtained to determine the replacement amount between domestic forage and local feed. Alternative elasticity assumes a constant size of Korean beef farm and represents the replacement of domestic feed and echo feed as elasticity. In other words, it is a means to determine how much Korean beef's domestic feed and echoed feed can replace. Thus, equation (3) shows this. In the equation Fj are domestic feeds such as rice straw, barley, and straw, and Fi are local feed such as sweet potatoes, potato shoots, and beans.

$$\text{Alternative Resilience of Domestic Feed and Local Feed}(\sigma do) = \left(\frac{\text{Changes in Demand for Domestic Forage}}{\text{Local Feed Demand Change}}\right) / \left(\frac{\text{Domestic Demand for Domestic Forage}}{\text{Local Feed Demand}}\right) / \left(\frac{\text{Marginal Replacement rate rete of Change}_{Fi}}{\text{Marginal Replacement Rate}(MRTS_{Fi,Fi})}\right) \quad (3)$$

The denominator of equation (3) is the rate of change of MRTS and shows how the percentage of slope change of equivalent curve changes in Korean beef production, the numerator represents the rate of change in the MRTS of domestic feed and local feed. Thus $\sigma do=\infty$ is equal to (1) in Fig.1, and if $\sigma do= \cup$ than it is equal to (3). At the same time is also equal to $0<\sigma do<\infty$ and it is same with (2). In general, if domestic and local feed belong to the same feed and there is an alternative relationship $0<\sigma do<\infty$ will be right equation. Subsequent analyses also consider (2).

For analysis, domestic feed is targeted at rice straw, barley, and straw, and local feed targets sweet potato shoots, potato shoots, and beans. These local feeds have solved technical problems such as collection and storage, and at the same time, dedicated machines for collection are being introduced, making production more efficient than other local feeds. Unlike milk cow, the Nuptial cattle or rearing calf, which feeds are mostly rice straw, barley straw, and straw., In some cases, it was also considered that rather than the nutritional value of the feed, the role of the feed to solve the physiological problems of the Korean Beef. Equation (3) can estimate how sensitive the price of domestic feed and farmhouse receiving price of local feed varies. Thus, change of marginal rate of substitution /marginal rate of substitution approach in proportion to local feed price and relative price. This is shown in Equation (4).

$$\text{Price Change rate Domestic research changes and alternative resilience of Local Feed}(\sigma_{ds}) = \left(\frac{\text{Changes in Domestic Roughage Rates}}{\text{Local Feed Variation}}\right) / \left(\frac{\text{Domestic Pickling}}{\text{Local Feed}}\right) / \left(\frac{\text{Changes in Price of Domestic Forage}}{\text{Local Feed Price Change}}\right) / \left(\frac{\text{Domestic Price}}{\text{Local Feed Price}}\right) \quad (4)$$

Equation (4) utilizes the price already traded in the market instead of MRTS to identify elasticity, solving the difficulties of analyzing feed demand and reducing errors in the home, as the retail price of Korean beef farmers is analyzed based on the retail price, it is judged to be realistic. Therefore, the price of feed used in the

analysis shall be the price of domestic rice, barley, and straw in October 2017. Local feed is based on sweet potato-based, potato-based and soy, but these local feed prices are assumed to be lacking in substantial transaction data. Transactions such as sweet potato sprouts are mostly incinerated, except for food, and potato sprouts and soybeans are also free, assuming the lowest cost.

2.6 Alternative Elasticity between Local Forage and Local Feed

This means that Korean beef farmers are approaching a local feed as replacement for imported forage. Alternative feeds use the ryegrass stem. There are various types of imported feed and there are differences in quality and price. Also, the use of high-quality, high-priced imported feed from Korean beef cattle is only targeted at the ryegrass stalks, as it is expected to avoid Korean beef farmers. In particular, the price of ryegrass stems is the cheapest at 300 won/kg of imported feed, so it was judged that an alternative would be possible if the conditions were met such as echo feed and price were met. Procedure for obtaining alternative elasticity between the imported feed and the local feed is as follows in Equation (5). Fi and F3 are the same as before.

$$\text{alternative resilience of imported raw materials and and Local Feed}(\sigma_{do}) = \left(\left(\frac{\text{Imported Grain Forage Demand and Change}}{\text{Local Feed Demand Change}}\right) / \left(\frac{\text{Imports of Imported Grain}}{\text{Local Feed Demand}}\right)\right) / \left(\frac{\text{Marginal Replacement Rate of Change}}{\text{Marginal Replacement Rate}}\right) \quad (5)$$

The denominator of equation (3) is the rate of change of the marginal replacement rate and shows how the slope change (%) of the equal curve changes in Korean beef production. So $\sigma do=\infty$ is equal to (1) in Fig.1, and if $\sigma do=\cup$ than it is equal to (3). At the same time is also equal to $0<\sigma do<\infty$ and it is same with (2). In general, if domestic and local feed belong to the same feed and there is an alternative relationship $0<\sigma do<\infty$ will be right equation. Use formula (5) for alternative elasticity of imported feed and local feed. And Use formula (5) for alternative elasticity of imported feed and local feed. Equation (5) can estimate how sensitive the prices of imported feed and farm prices of local feed vary. Thus, change of marginal rate of substitution /marginal rate of substitution approach in proportion to local feed price and relative price. This is shown in Equation (6).

$$\sigma im = \left(\left(\frac{\text{Important Inspection Requirements Demand Change}}{\text{Local Feed Demand Change Amount}}\right) / \left(\frac{\text{Imported Requesting Quantity}}{\text{Local Feed Requirement}}\right)\right) \left(\left(\frac{\text{Important Insolved Rechargeable}}{\text{Local Feed Price Change}}\right) / \left(\frac{\text{Imported Acid Reservoir Price}}{\text{Local Feed Price}}\right)\right)$$

$$\text{price change rate consulta exchange of consultation of consultation and consultation of the Local Feed} = (\sigma_{im}) \quad (6)$$

3. Analysis Result

Korean beef industry is not simple and there are various types of feed and price differences. Korean beef farmers are also categorized into Breeding cattle farm, Meat bowls farm and commercial farms. Also the Korean beef are also categorized rearing calf, Breeding cattle, Meat bowls and the amount of feed paid varies depending on the breeding stage. For this reason, it is difficult to accurately understand the feed supply by type of breeding and stage, and the purchase price is not easy depending on Korean beef farmers. Some farmers

produce their own feed, others rely on it, and others do their own production and purchase at the same time. They also use high class local forage, domestic feed, imported feed, and some local feed. Therefore, it is difficult to obtain the flexibility of Korean beef cattle's feed and the reality is impossible. To analyze the alternative relationship between domestic and imported survey fees and local feed considering the current status of Korean beef farms, the assumptions are established as follows.

Assume 1: Assume the magnitude of marginal productivity of the feed.

Assume 2: Raw materials are based on prices in 2017.

Assume: Local feed prices are also assumed.

For reference, there are two types of way to collect local feed, which are agricultural by-products. The first is the policy of preserving collection costs, such as collecting agricultural vinyl, second, it is collected by social companies for the purpose of raising income for senior citizens in rural areas. There are two main types of agricultural products that social companies collect. Considering the above assumptions, we measure the substitution effect of domestic and imported feed and local feed. The marginal replacement rate of domestic feed and local feed was used in equation (1). The results were obtained for sweet potato sprout, potato sprout and soy sprout feeds, which can be used as local feed. The results are as shown in Table 6.

Table 6. Marginal rate of substitution of domestic rice straw with local feed

Classification	Result 1	Result 2	Result 3
Marginal productivity of domestic rice straw	0.1	0.15	0.2
Marginal rate of substitution of sweet potato stalk	−2.0	−3.0	−4.0
Marginal rate of substitution of potato stalk	−3.3	−5.0	−6.7
Marginal rate of substitution of bean stalk	−10.0	−15.0	−20.0

Note: 1) Marginal productivity(MP) of domestic rice stalk is assumed to three kinds and that of local feed is fixed.
2) This is the result of that the MP of sweet potato stalk is assumed as 0.05, the MP of potato stalk is assumed as 0.03 and the MP of bean stalk is assumed as 0.01.

Table 6 assumes the marginal productivity of domestic rice straws as 0.1, 0.15, and 0.2 and the marginal productivity of sweet potato shoots as 0.05. The result shows a marginal replacement rate of 2.0, 3.0, and 4.0 kg of sweet potatoes with 200% sweet potatoes, 300% 3.0 kg, and 400% of Korean rice. The greater the marginal productivity of Korean rice straw, the more sweet potato shoots are needed. According to the results, it is possible to replace for Korean beef feeds with rice straw if sweet potato sprouts are paid at least 2.0 kg to 4.0 kg. Likewise, assuming the marginal productivity of potato order is 0.03, it appears to be 3.3, 5.0 and 6.7, which is lower in replacement rate than sweet potato. If the limit was 0.01, the college was found to be 10.0, 15.0 and 20.0, which is exactly 10 times higher than the maximum rice straw.

Table 7. Marginal rate of substitution of domestic barley straw with local feed

Classification	Result 1	Result 2	Result 3
Marginal productivity of domestic barley straw	0.09	0.1	0.15
Marginal rate of substitution of sweet potato stalk	−1.8	−2.0	−3.0
Marginal rate of substitution of potato stalk	−3.0	−3.3	−5.0
Marginal rate of substitution of bean stalk	−9.0	−10.0	−15.0

Note: This is the result of that the MP of sweet potato stalk is assumed as 0.05, the MP of potato stalk is assumed as 0.03 and the MP of bean stalk is assumed as 0.01.

Table 7 calculates the marginal replacement ratio between the barley and local feed under the same

conditions as in Table 6. The marginal replacement rate for sweet potato products, assuming the marginal production of barley is 0.05, appears to be 1.8, 2.0 and 3.0, indicating that sweet potatoes need 1.8 to 3.0 times more for domestic barley. Similarly, assuming the marginal productivity of the potato sequence is 0.03, it is 3.0, 3.0, 5.0 and requires more than the sweet potato sequence, and it is required to be up to 5.0 to 3.0 times. In the case of soybeans, the marginal productivity is assumed to be 9.0, 10.0 and 15.0, compared to barley, replacing soybeans 9.0, 10.0 and 15x, respectively.

For last, the marginal replacement rate between straw and echo feed is shown in Table 8. Assuming the marginal productivity of domestic straws is 0.08, 0.09, 0.12, the limit productivity of sweet potato shoots is 0.05, the sweet potato order is 1.6, 1.8 and 2.4 times higher than the straw. Assuming the limit productivity of the potato sequence is 0.03, the marginal replacement rate is 2.7, 3.0, and 4.0, and the straw and bean fields need 8.0 to 12 times more.

Table 8. Marginal rate of substitution of domestic wheat straw with local feed

Classification	Result 1	Result 2	Result 3
Marginal productivity of domestic wheat straw	0.08	0.09	0.12
Marginal rate of substitution of sweet potato stalk	−1.6	−1.8	−2.4
Marginal rate of substitution of potato stalk	−2.7	−3.0	−4.0
Marginal rate of substitution of bean stalk	−8.0	−9.0	−12.0

Note: This is the result of that the MP of sweet potato stalk is assumed as 0.05, the MP of potato stalk is assumed as 0.03 and the MP of bean stalk is assumed as 0.01.

Table 9 shows the marginal replacement rate between the imported irradiation fee, ryegrass stem and the local feed. The marginal replacement rate for sweet potato shoots is -2.6 times and -4.0 and -5.2, which is required for imported ryegrass stems from 2.6 to 5.2 times. The marginal replacement rate for potato-based and potato-based products is -4.2, -6.7 and -8.7, which is higher than four times and is higher than sweet-potatoes. In the case of soybeans, the marginal replacement rate is high -13.0, -20.0.

Table 9. Marginal rate of substitution of imported forage with local feed

Classification	Result 1	Result 2	Result 3
Marginal productivity of imported ryegrass stalk	0.13	0.2	0.26
Marginal rate of substitution of sweet potato stalk	−2.6	−4.0	−5.2
Marginal rate of substitution of potato stalk	−4.3	−6.7	−8.7
Marginal rate of substitution of bean stalk	−13.0	−20.0	−26.0

Note: This is the result of that the MP of sweet potato stalk is assumed as 0.05, the MP of potato stalk is assumed as 0.03 and the MP of bean stalk is assumed as 0.01.

Next, the MRTS between domestic feed and eco feed will be identified. MRTS is the ratio of variation in the input ratio of domestic feed to eco feed divided by the marginal replacement rate of domestic feed with eco feed. Therefore, it is assumed that the rate of change of input ratio between domestic feed and eco feed are the same. The ratio of marginal replacement rate to the relative price ratio of domestic feed and eco feed could be determined by using the rate of change of the relative price ratio. An alternative elasticity of Korean rice straw and sweet potato shoots is to examine the sensitivity of buying eco feeds. First in Table 10 shows the elasticity of domestic rice straws and sweet potato shoots at 2.0 won per kilogram and 2.78 won per kilogram or 20 won per kilogram. In other words, if other conditions such as quality, nutritional content, and standards are constant, alternative elasticity is 2.0. Also, if the price of sweet potatoes decreases, alternative elasticity

will increase. Potato and soybeans were cheaper than sweet potatoes, giving them greater alternative elasticity. This means that Korean beef farmers who use rice straw can replace sweet potato shoots, potato shoots and soybeans if they are supplied very cheaply.

Table 10. Elasticity of substitution of domestic rice straw with local feed

Classification	Result 1	Result 2	Result 3
Input ratio change of rice straw-sweet potato stalk	1.00	1.00	1.00
Change rate of replacement price ratio (rice straw-sweet potato stalk)	0.50	0.36	0.18
Elasticity of substitution of rice straw-sweet potato stalk	2.00	2.78	5.56
Change rate of replacement price ratio (rice straw-potato stalk)	0.45	0.27	0.20
Elasticity of substitution of rice straw-potato stalk	2.22	3.70	5.00
Change rate of replacement price ratio (rice straw-bean stalk)	0.27	0.18	0.09
Elasticity of substitution of rice straw-bean stalk	3.70	5.56	11.11

Note: This is the result that price of Rice Straw is assumed as 110 won/kg, Price of sweet potato stalk is assumed as 60, 40, 20 won/kg, price of potato stalk is assumed as 50, 30, 20 won/kg, and price of bean stalk is assumed as 30, 20, 10 won/kg. But, price of rice straw is the actual trading price.

Table 11 shows alternative elasticity between domestic and local feeds, which is 1.33, 2.0, and 4.0 for domestic barley price of 80 KR/kg. This is the same as the replacement elasticity of sweet potato sprouts when the sweet potato net price is 40 KR/kg for the domestic barley straw price. Alternative elasticity varies depending on sweet potato pure price and alternative elasticity is greater than lower price. Alternative elasticity of potato sequence is 1.60 to 4.00 indicating that if barley and local feed do not differ in price, alternative elasticity can be substituted by supplying them at a large and low price. The price of soybeans is cheaper and more resilient than other local feeds.

Table 11. Elasticity of substitution of domestic barley straw with local feed

Classification	Result 1	Result 2	Result 3
Input ratio change of barley straw-sweet potato stalk	1.00	1.00	1.00
Change rate of replacement price ratio (barley straw-sweet potato stalk)	0.75	0.50	0.25
Elasticity of substitution of barley straw-sweet potato stalk	1.33	2.00	4.00
Change rate of replacement price ratio (barley straw-potato stalk)	0.63	0.38	0.25
Elasticity of substitution of barley straw-potato stalk	1.60	2.67	4.00
Change rate of replacement price ratio (barley straw-bean stalk)	0.38	0.25	0.13
Elasticity of substitution of barley straw-bean stalk	2.67	4.00	8.00

Note: This is the result that price of barley straw is assumed as 80 won/kg, price of sweet potato stalk is assumed as 60, 40, 20 won/kg, price of potato stalk is assumed as 50, 30, 20 won/kg, and price of bean stalk is assumed as 30, 20, 10 won/kg. But, price of barley straw is the actual trading price.

Table 12 shows alternative elasticity of domestic straw and local feed, the price of wheat is not different from the price of sweet potato which shows low alternative elasticity. However, if the price of sweet potato sprouts is supplied at 20 won/kg, the price of 3.5 can be obtained and replaced with sweet potato order. Potato-soon is cheaper than sweet potatoes, so alternative elasticity is high and soybeans are larger than other local feed. Therefore, the price of local feed is an important factor in the purchase of Korean beef farmers, and the lower the price, the more useful it is.

Table 12. Elasticity of substitution of domestic wheat straw with local feed

Classification	Result 1	Result 2	Result 3
Input ratio change of wheat straw-sweet potato stalk	1.00	1.00	1.00
Change rate of replacement price ratio (wheat straw-sweet potato stalk)	0.86	0.57	0.29
Elasticity of substitution of wheat straw-sweet potato stalk	1.17	1.75	3.50
Change rate of replacement price ratio (wheat straw-potato stalk)	0.71	0.43	0.29
Elasticity of substitution of wheat straw-potato stalk	1.40	2.33	3.50
Change rate of replacement price ratio (wheat straw-bean stalk)	0.43	0.29	0.14
Elasticity of substitution of wheat straw-bean stalk	2.33	3.50	7.00

Note: This is the result that price of wheat straw is assumed as 70 won/kg, price of sweet potato stalk is assumed as 60, 40, 20 won/kg, price of potato stalk is assumed as 50, 30, 20 won/kg, and price of bean stalk is assumed as 30, 20, 10 won/kg. But, price of wheat straw is the actual trading price.

Table 13 calculates alternative elasticity from imported forage which is ryegrass stem that can compete with local feed. The sweet potato spouts appears to be between 5.0 and 15.0, and the substitution effect varies depending on the price. As alternative elasticity is increased in potato and bean, it is deemed that imported ryegrass stems can be completely replaced according to local feed policy. This means that the replacement of local feed is fully possible. The problem is how to supply as local feed at low cost. Especially, the way to provide standardized local feeds at almost negligible prices is that government supports small farming households in the region or income support policies for senior citizens.

Table 13. Price change response of imported ryegrass stalk with local feed

Classification	Result 1	Result 2	Result 3
Input ratio change of imported ryegrass stalk (IRS)-sweet potato stalk	1.00	1.00	1.00
Change rate of replacement price ratio (IRS-sweet potato stalk)	0.2	0.13	0.07
Elasticity of substitution of IRS-sweet potato stalk	5.0	7.5	15.0
Change rate of replacement price ratio (IRS-potato stalk)	0.17	0.1	0.07
Elasticity of substitution of IRS-potato stalk	6.0	10.0	15.0
Change rate of replacement price ratio (IRS-bean stalk)	0.1	0.07	0.03
Elasticity of substitution of IRS-bean stalk	1.0	15.0	30.0

Note: This is the result that price of imported ryegrass stalk is assumed as 300 won/kg, price of sweet potato stalk is assumed as 60, 40, 20 won/kg, price of potato stalk is assumed as 50, 30, 20 won/kg, and price of bean stalk is assumed as 30, 20, 10 won/kg. But, price of imported ryegrass stalk is the actual trading price.

4. Conclusion

There are no technical problems in replacing local feed with domestic or imported feed to improve the self-sufficiency rate of domestic feed and income to Korean beef farmers. The analysis results are showed that domestic rice straws, barley straws, straws and sweet potato shoots, potato shoots, and soybeans were also effective in replacement elasticity. Considering the amount of local feed produced in Korea, it is possible to achieve self-sufficiency of domestic feed as well as reduce imported feed. In case of Korean beef farmers, paying local feed to breeding or breeding cattle can solve the physiological problems of Korean beef and reduce production costs. The supply of competitive local feed will greatly help Korean beef farmers. However, the problem requires a means to activate local feed continuously. The licensing issue, which is a constraint on the use of local feed, has been resolved by the revision of the feed management law, which requires the registration of the food manufacturing industry if local feed is sold as feed(Livestock Daily News, 2016). Other problems are local feeders, quality and specification issues, and supply plans. These problems are addressed

by the agricultural technology center while the quality and specifications are covered by the idle labor force, and the standards are based on the feed rating system and the quality standards inspection method. In addition, in case of a mountain collection, a cost-based allowance for disposal would be available. The use of idle labor by collection is helpful for the rural economy and benefits from the resource circulation. Therefore, cheap and standardized local feed is easy for Korean beef farmers to use. Such an inexpensive supply of local feed allows Korean beef farmers to pursue economies of scale by expanding their size as well as obtain replacement effects for their feed. This is because replacing with a local feed reduces the total production cost and lowers the Marginal cost, which creates room for expansion.

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