A TENDENCY TOWARDS USING AUTOMATIC MACHINE AND
COMPUTER TECHNIQUES FOR FEEDING AND MANAGING
LIVESTOCK IN DEVELOPING COUNTRIES

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ABSTRACT

In general, the condition of animal husbandry in developing countries at beginning was small-scale farm due to lacking of capital investment. However, this situation has been changed following the gross domestic product (GDP) increased in such countries. Becoming rich and demanding protein of people were the two important phenomena that happened in developing countries after their industry taking off. The livestock unit in each farm were increased consequently. Some farmers, who had capital shortage or land limitation, were gave up livestock business. The more GDP increased in developing countries, the more livestock unit increased in their farms. Finally, small or median agro-enterprises will take over the market share of livestock business gradually in developing countries.

Increasing productive efficiency on livestock business is related to increase the income or profit of farm. When farm or small agro-enterprise has over 300 heads of cattle. Raising cattle in confinement pen and feeding them by machine become a primary task of this farm or company due to labor-saving. Total mixed ration (TMR) is a balance nutrient formation for cattle production. TMR can help cattle to approach the best growth performance at different stage, when manager combine TMR with group feeding scheme. The capacity of TMR truck depends on the number of cattle on same crib or farm. Agricultural by-products is another issue to decrease the feed cost on cattle production. Seasonal agricultural by-products, transportation fee, silo equipment, cattle number, pesticide remain and good balance formula are the most important factors affecting agricultural by-products utilization on cattle production.

Computer techniques and customize software are two assistance tools for managing cattle on large agro-enterprise company in future trend. Radio frequency identification (RFID) technique and its application prevail wildly on people livelihood at this moment. RFID technique can be used to manage large herd of cattle for weight collecting, disease curing, pedigree recording and safety beef suppling easily. The price of RFID equipment may be expensive right now. However, RFID equipment can save managing time on a large cattle herd and ensure safe beef from farm to table precisely.

Keywords: Automatic Machine, Computer Techniques, Livestock, Developing Countries.

INTRODUCTION

From the viewpoint of beef cattle business evolution in Taiwan, the capital and scale of beef cattle farms were very small in Taiwan 60 years ago. Most of the farmers raised their beef cattle as a part time job at that time. However, the policy of developing industry increased the growth rate of GDP in Taiwan. Eventually, the number of cattle on the farms declined followed by the GDP increased in Taiwan. Cattle unit on the farms increased almost twice as much as from 2007 to 2015 (Table 1). Family business or small agro-industrial enterprises replaced the tradition beef cattle farms for increasing farm productivity, reducing beef production cost, creating a new beef brand, and suppling safe beef. This developed story of beef cattle business in Taiwan can be copied or happened in the other developing countries in Asia.

Beef Cattle Situation in Taiwan

Beef cattle, dairy bull and water buffalo were the three most important beef sources in Taiwan (Table 2). The strategy of beef cattle developed was less concerned than that of in dairy cattle due to the milk suppling police. There are 834 farms and 34,000 heads of cattle for supplying beef in Taiwan right now. However, there is a big
margin between beef supplying and demanding in Taiwan. Most of the beef was imported from foreign countries. The fresh beef only occupied 7% market share in Taiwan at this moment (Table 3).

Beef cattle consumed most of agricultural by-products and Pangola hay in Taiwan. While dairy cattle consumed Alfalfa hay, Timothy hay, Napier grass and corn silage. There were many agricultural by-products could be utilized all year around for beef production in Taiwan. The main dairy bull raised system in Taiwan is three-stage feeding system, which was conducted by some dairy bull cooperatives. Dairy bull cooperatives collected one-week-old young bull calves from dairy farm by contract. The price of calve was about 70 to 240 USD, which depended the price of cattle on the market. When dairy bull calve reached 250 kg of body weight, they were sold to or sent to another feedlot. At that feedlot, they were fattened till they reached 550 kg of body weight for slaughter.

Beef cattle and buffalo raising systems were different from farms depended on land size and feed resource. Most of the buffalo were grazed on the county side or hillside in the eastern part of Taiwan especially in Hualien County. Some of the buffalo were being fattened by concentrate before slaughter. Nevertheless, most beef cattle were raised on the confinement pen, while some beef cattle were raised on small pasture had shed and crib for fattening at last three month stage. No matter what kinds raising system on beef production, the traceability technique has been used for safe beef production during the last couple years in Taiwan. Furthermore, exclusive beef selling shop is just in the initial stage on beef market in Taiwan.

Table 1. The number of cattle farms declined followed by GDP increased in Taiwan

<table>
<thead>
<tr>
<th>Years</th>
<th>Number of cattle farms</th>
<th>Number of cattle</th>
<th>Cattle unit in farm</th>
<th>GDP in Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>3,266</td>
<td>137,127</td>
<td>42.0</td>
<td>15,401</td>
</tr>
<tr>
<td>2008</td>
<td>3,153</td>
<td>133,950</td>
<td>42.5</td>
<td>15,388</td>
</tr>
<tr>
<td>2009</td>
<td>2,964</td>
<td>133,713</td>
<td>45.1</td>
<td>14,398</td>
</tr>
<tr>
<td>2010</td>
<td>2,816</td>
<td>140,002</td>
<td>50.0</td>
<td>16,650</td>
</tr>
<tr>
<td>2011</td>
<td>2,641</td>
<td>144,312</td>
<td>55.0</td>
<td>17,982</td>
</tr>
<tr>
<td>2012</td>
<td>2,472</td>
<td>146,186</td>
<td>59.0</td>
<td>18,125</td>
</tr>
<tr>
<td>2013</td>
<td>2,379</td>
<td>147,398</td>
<td>62.0</td>
<td>18,872</td>
</tr>
<tr>
<td>2014</td>
<td>2,227</td>
<td>145,739</td>
<td>65.4</td>
<td>19,724</td>
</tr>
<tr>
<td>2015</td>
<td>2,115</td>
<td>149,379</td>
<td>70.6</td>
<td>19,653</td>
</tr>
</tbody>
</table>


Source: Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C.

Table 2. The number attle and their farms for beef production in Taiwan

<table>
<thead>
<tr>
<th>Years</th>
<th>Number of farms</th>
<th>Number of heads</th>
<th>Buffalo number</th>
<th>Beef cattle number</th>
<th>Dairy bull number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>846</td>
<td>35,187</td>
<td>3,243</td>
<td>11,327</td>
<td>19,945</td>
</tr>
<tr>
<td>2013</td>
<td>815</td>
<td>34,456</td>
<td>2,772</td>
<td>12,109</td>
<td>20,306</td>
</tr>
<tr>
<td>2014</td>
<td>790</td>
<td>34,190</td>
<td>2,239</td>
<td>12,981</td>
<td>19,236</td>
</tr>
<tr>
<td>2015</td>
<td>830</td>
<td>34,274</td>
<td>2,128</td>
<td>12,838</td>
<td>19,224</td>
</tr>
<tr>
<td>2016</td>
<td>834</td>
<td>34,515</td>
<td>1,810</td>
<td>13,630</td>
<td>18,834</td>
</tr>
</tbody>
</table>


Table 3. The market share of beef consumption in Taiwan

<table>
<thead>
<tr>
<th>Years</th>
<th>Domestic (Metric Ton)</th>
<th>Imported (Metric Ton)</th>
<th>Market Share (%)</th>
<th>Imported value (million USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>6,187</td>
<td>82,636</td>
<td>7.5</td>
<td>49.1</td>
</tr>
<tr>
<td>2013</td>
<td>6,693</td>
<td>92,817</td>
<td>7.2</td>
<td>61.4</td>
</tr>
<tr>
<td>2014</td>
<td>6,874</td>
<td>98,955</td>
<td>6.9</td>
<td>69.4</td>
</tr>
<tr>
<td>2015</td>
<td>6,875</td>
<td>96,426</td>
<td>7.1</td>
<td>69.8</td>
</tr>
</tbody>
</table>

Good choice for using agricultural by-products to feed cattle

Taiwan is a 36,000 km² island covered by mountains in the west subtropical region of the Pacific Ocean. The weather is appropriate for growing agricultural products all year around. Therefore, there are plenty of agricultural by-products available for feeding cattle in Taiwan. Agricultural by-products can replace concentrate for reducing the cost of cattle production, and solving environmental pollution came from accumulation of agricultural by-products in the field or in processing factories. Hence, beef cattle production in Taiwan was thriving due to getting agricultural by-products easily and cheaply in the past time. Nevertheless, some agricultural by-products might contain toxin, pesticide residue, proteinase and cyanic ions which affected growth performance of cattle. Meanwhile, the variety of agricultural by-products decreased due to the harvest method changed or associated crop decreased in Taiwan. Right now only a few agricultural by-products, which are soya products, brewer’s grain and distiller’s sorghum grain, can be used economically in Taiwan. Most of beef cattle farms used a movable mixer truck to feed their cattle. Generally, cattle can consume up to 15 kg of wet brewer’s grain or wet distiller’s sorghum grain compared with 2 kg consumption volume of goats in Taiwan (Table 4). Chen, et al. (2001) used different levels of Tofu pomace, which is commonly used as feed ingredients in Taiwan, to feed dairy lactating cows by TMR system. The result showed that dairy cow, which consumed 10 kg high digestible Tofu pomace, increased dairy crude income by 0.7 USD per cow compared with other groups (Table 5). Fan, et al. (2016) used Copra meal to feed Alpine and Saanen lactating goats. The result showed that adding Copra meal into the dairy goat ration did not affect the concentrations of fat, protein and total solid of milk but effectively decreased the milk urea nitrogen. Copra meal could be an available feedstuffs for lactating goat in Taiwan. The suitable recommended ratio in diet dry matter is suggested to be 16% (Table 6).

Table 4. The main agricultural by-products consumption by cattle and goats in Taiwan

<table>
<thead>
<tr>
<th>Items</th>
<th>Cattle intake daily (kg)</th>
<th>Goats intake daily (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soya cake pomace</td>
<td>-----</td>
<td>0.3-0.5</td>
</tr>
<tr>
<td>Dry peanut vines</td>
<td>5-10</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>Bagasse</td>
<td>3-5</td>
<td>-----</td>
</tr>
<tr>
<td>Wet bamboo shoot shell</td>
<td>5-10</td>
<td>-----</td>
</tr>
<tr>
<td>Wet brewer’s grain</td>
<td>10-15</td>
<td>1.0-2.0</td>
</tr>
<tr>
<td>Wet distiller’s sorghum grain</td>
<td>10-15</td>
<td>1.0-2.0</td>
</tr>
</tbody>
</table>


Table 5. Effects of dietary tofu pomace levels on milking performance of Holstein cows

<table>
<thead>
<tr>
<th>Items</th>
<th>Levels of TFP in diets, kg (as fed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Dry matter intake, kg/d</td>
<td>21.5</td>
</tr>
<tr>
<td>Milk production, kg/d</td>
<td>22.1</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.47</td>
</tr>
<tr>
<td>Protein, %</td>
<td>3.17</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.62</td>
</tr>
<tr>
<td>Total solid, %</td>
<td>11.9</td>
</tr>
<tr>
<td>Somatic cell count, 10⁹/ml</td>
<td>322</td>
</tr>
</tbody>
</table>

Although, agricultural by-products were good for beef production. It is necessary to understand that there were several restrictions on agricultural by-product utilization by cattle (Su, 1996).

1. The factors affecting using agricultural by-products on individual farms

There are abundant of agricultural by-product in many developing countries. If farmers have a small cattle unit around their house. It is easy to use their available agricultural by-products to feed their cattle. However, if farmers or small agro-enterprise companies have a large herd of cattle on their farm. They can purchase agricultural by-products to feed their cattle by seasonal. In general, the price of agricultural by-products depends on the distance of transportation fee and the quantity of production during particular periods of the year. Farmers need to decide what kind agricultural by-products are the cheapest feedstuffs on that specific season. Meanwhile, they also need to decide how much quantity of agricultural by-products can reach the biggest benefit on one single order.

2. Analyzed center or Research center for agricultural by-product utilization

When talking about agricultural by-products utilization on cattle raising in developing countries, it needs to establish a laboratory for analyzing the nutritional of agricultural by-products by government. The Taiwan Livestock Research Institute has a laboratory which can help farmers to analyze the content of agricultural by-products. The concentration of heavy metal, pesticide remain, and nutrient composition of agricultural by-products can be analyzed in here. The nutrient content of agricultural by-products has been published to all farmers in Taiwan. Techniques from TLRI helped farmers to calculate the suitable ration formula, contained seasonal agricultural by-products, for cattle raising (Su, 1996).

3. The machine mixed agricultural by-products with other feedstuff to form a total mixed ration

In spite of having agricultural by-products and ration formula, farmers or small agro-enterprise companies still needed a mixer to mix all feedstuff together. The procedure of mixed ingredient together could supplied same nutrient content equally within one bite for ruminants. The component of this mixed ration could stabilize rumen fermentation and caused the growth performance of ruminant in the optimum condition.

It has been proved that cattle can be fed with total mixed ration successfully. Nevertheless, goats sometimes failed on total mixed ration feeding system due to the behavior of picking concentrate at summer time in Taiwan. One of the experiments has been conducted in Heng-Chun Branch. Results showed that dairy goats consumed total mixed ration had higher dry matter intake, milk protein percentage and lower somatic cell count than that of goats consumed concentrate and forage separation (Table 7).

4. Silo equipment for agricultural by-products preservation

Finally, as concerned rumen fermentation stabilization, the ration of ruminant cannot be changed too fast or by weekly. Therefore, large cattle farms or small agro-enterprise companies need to have a silo to preserve agricultural by-products as much as possible. There were several silo equipment have been used in Taiwan for cattle or goat raising successes. A plastic barrel silo, preserved 100 kg to 500 kg of agricultural by-products, has been developed and popularized on small goat farms by TLRI researchers. Meanwhile, two types of plastic sausage silo bag, preserved 20 ton to 150 ton of agricultural by-products, also been developed and popularized on large goat farms and large cattle farms by the same team in TLRI (Table 8). The concrete type of silo would not suggest to use on agricultural by-products preservation due to high capital invested of silo and high water content of agricultural by-products.

### Table 6. Effects of Copra meal in diets on dry matter intake and milking performance of lactation goats

<table>
<thead>
<tr>
<th>Items</th>
<th>Ratio of Copra meal in diets</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter intake, kg/d</td>
<td>2.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.96&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.94&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.76&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.09</td>
</tr>
<tr>
<td>Milk production, kg/d</td>
<td>2.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.59</td>
<td>0.15</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.16</td>
<td>0.06</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.75</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.66</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.68</td>
<td>0.03</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.32&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.16&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.20&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.14&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.04</td>
</tr>
<tr>
<td>Total solid, %</td>
<td>10.82</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.68</td>
<td>0.08</td>
</tr>
<tr>
<td>Milk urea nitrogen, mg/dl</td>
<td>40.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>34.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>36.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.3</td>
</tr>
</tbody>
</table>

<sup>a,b</sup> Means in the same row with different superscripts differ significantly (P < 0.05).

Table 7. Effects of different agricultural by-products in ration on the growth performance and production cost of beef cattle in Taiwan

<table>
<thead>
<tr>
<th>Items</th>
<th>Ration ingredient</th>
<th>Cattle performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>By-products</td>
<td>Concentrate or Silage</td>
</tr>
<tr>
<td>Concentrate</td>
<td>----</td>
<td>70%(C)</td>
</tr>
<tr>
<td>Dry peanut vines</td>
<td>84%</td>
<td>16%(C)</td>
</tr>
<tr>
<td>Bagasse³</td>
<td>30%</td>
<td>70%(C)</td>
</tr>
<tr>
<td>Bagasse⁴</td>
<td>25%</td>
<td>75%(C)</td>
</tr>
<tr>
<td>Bagasse</td>
<td>6%</td>
<td>69%(S)</td>
</tr>
<tr>
<td>Feather meal⁵</td>
<td>8%</td>
<td>72%(S)</td>
</tr>
<tr>
<td>Brewer’s grain silage⁶</td>
<td>46%</td>
<td>46%(C)</td>
</tr>
</tbody>
</table>

¹ Feed cost per kg live weight gain was calculated on the price of ingredient before 2000.
² NTD exchange to USD by divided 31.
³ Bagasse silage adding rice wine residual.
⁴ Bagasse silage adding cellulolytic enzyme.
⁵ Feather meal hydrolysis product.
⁶ Corn and brewer’s grain silage.


Table 8. Feed intake and milk production of dairy goat fed with TMR or CFS

<table>
<thead>
<tr>
<th>Items</th>
<th>TMR</th>
<th>CFS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM intake, kg /day</td>
<td>2.08</td>
<td>2.0</td>
<td>0.21</td>
</tr>
<tr>
<td>Average dairy milk production, kg/head (3%FCM)</td>
<td>2.71</td>
<td>2.53</td>
<td>0.37</td>
</tr>
<tr>
<td>Average milk fat, %</td>
<td>2.72</td>
<td>2.69</td>
<td>0.32</td>
</tr>
<tr>
<td>Average milk protein, %</td>
<td>2.91</td>
<td>2.77</td>
<td>0.17</td>
</tr>
<tr>
<td>Average milk lactose, %</td>
<td>4.63</td>
<td>4.58</td>
<td>0.04</td>
</tr>
<tr>
<td>Average milk solid, %</td>
<td>10.35</td>
<td>9.52</td>
<td>0.1</td>
</tr>
<tr>
<td>Somatic cell count,10⁴/ml milk</td>
<td>73.6⁶</td>
<td>158.9⁵</td>
<td>31.6</td>
</tr>
</tbody>
</table>

⁵Means with the different superscript differ significantly.
⁶TMR: total mixed ration
⁷CFS: computerized feeding concentrate and forage fed separately.

Source: Su, et.al. 2002a.

The successful example of farm level livestock feeding agricultural by-products in Taiwan

Although there were many agricultural by-products in Taiwan, the brewer’s grain and the distiller’s sorghum grain became the most important agricultural by-products due to alcohol drinking population increased in Taiwan. Farmers always bought 8 to 20 tons of fermented grain residue from beer or alcohol factories at one time. Most of fermented grain residue was being stored in piles, without any covers, nearby livestock pen. In addition to livestock could not consume fermented grain residue completely within days. Eventually, there were more than 20% fermented grain residue spoiled in the past time. Therefore, improving preservation method by silage making and utilizing agricultural by-products efficiently became a very important work for ruminant nutrition in Taiwan. The successful example of farm level livestock feeding agricultural by-products was carried out for promoting the profit of cattle or goat production during the past decade in Taiwan.

The idea was utilized the characteristic of whole dry corn. Whole dry corn grain could absorb the juice of brewer’s grain, distiller’s sorghum grain or any juicy agricultural by-products. Through an appropriate and an economic preservation method, corn became a reconstitute corn and a cooked corn. This method not only improved the digestibility and degradability of corn, but also kept silage in good quality and condition for a long
time (Table 9 to Table 12). This technology could decrease the cost of cattle or goat production to 20% or 25% (Su and Yang; 1998a, 1998b, 1998c, 2000a, 2000b, 2001) and got the same carcass characteristic and meat quality from the control ration (Su et. al., 2002b). Nevertheless, juicy agricultural by-products should be added into corn with other ingredients freshly for keeping fermented grain silage in good condition. Changed preservation containers or changed the ration ingredients can be adopted by this method in developing countries.

Table 9. The total cost of corn-brewer’s grain silage preserved by different methods

<table>
<thead>
<tr>
<th>Silo types</th>
<th>Ton</th>
<th>Feed cost¹ (USD/Ton)</th>
<th>Making cost¹ (USD/Ton)</th>
<th>Total cost (USD/Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large sausage bag</td>
<td>150</td>
<td>92.9</td>
<td>5.5</td>
<td>98.4</td>
</tr>
<tr>
<td>Small sausage bag</td>
<td>20</td>
<td>98.4</td>
<td>8.1</td>
<td>106.5</td>
</tr>
<tr>
<td>Barrel type</td>
<td>0.1~0.5</td>
<td>101.9</td>
<td>12.9</td>
<td>114.8</td>
</tr>
</tbody>
</table>

¹ Grain’s price based on 1994 and 1998 market price in Taiwan.
² NTD exchange to USD by divided 31.

Table 10. The composition of corn-brewer’s grain silage

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet basis</td>
<td>%</td>
</tr>
<tr>
<td>Brewer’s grain, wet</td>
<td>50.0</td>
</tr>
<tr>
<td>Corn, whole dry grain</td>
<td>41.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>7.0</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.4</td>
</tr>
<tr>
<td>Salt</td>
<td>0.5</td>
</tr>
<tr>
<td>Premix</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Table 11. The dry matter degradability of ensiled-corn and corn grain in the rumen

<table>
<thead>
<tr>
<th>Incubation times</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ensiled-corn</td>
</tr>
<tr>
<td>Hours</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>40.4 ± 3.40</td>
</tr>
<tr>
<td>4</td>
<td>82.7 ± 0.90</td>
</tr>
<tr>
<td>8</td>
<td>84.9 ± 1.50</td>
</tr>
<tr>
<td>12</td>
<td>86.1 ± 0.91</td>
</tr>
<tr>
<td>24</td>
<td>88.4 ± 3.40</td>
</tr>
<tr>
<td>36</td>
<td>91.3 ± 1.40</td>
</tr>
<tr>
<td>48</td>
<td>93.5 ± 0.63</td>
</tr>
</tbody>
</table>
Source: Yang, et. al. 1998.

Table 12. The growth performance and feed cost of goats fed with corn-brewer’s grain silage and
Feeding agricultural by-products to cattle can reduce the methane production

It was clear that raising cattle could produce greenhouse gas to warm up the temperature of the earth environment. When cattle grazed on pasture, the concentration of methane or nitrous oxide increased due to plant fiber breakdown into glucose units and feces fermented inside the soil. The concentration of methane production of cattle were being affected by the percentage of fiber concentrate in the ration. Evidence showed that replaced 35% concentrate or 30% corn silage with 30% distiller’s sorghum grain to feed Taiwan yellow cattle in an airtight barn, the concentration of methane production by the distiller’s sorghum grain group had a lower value than that of in another two groups (Table 13) (Shiu, et. al. 2012).

<table>
<thead>
<tr>
<th>Items</th>
<th>Treatments</th>
<th>Concentrate</th>
<th>Corn-distiller’s sorghum grain silage</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of animal</td>
<td></td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Average daily gain (kg)</td>
<td></td>
<td>0.135</td>
<td>0.134</td>
<td>0.151</td>
</tr>
<tr>
<td>Feed intake (kg)(DM)</td>
<td></td>
<td>0.86</td>
<td>0.87</td>
<td>0.98</td>
</tr>
<tr>
<td>Feed efficiency (DM)</td>
<td></td>
<td>6.40</td>
<td>6.50</td>
<td>6.50</td>
</tr>
<tr>
<td>Feed cost (USD/100 kg)</td>
<td></td>
<td>14.0</td>
<td>12.9</td>
<td>24.2</td>
</tr>
<tr>
<td>Cost (USD/kg weight gain)</td>
<td></td>
<td>1.35</td>
<td></td>
<td>1.79</td>
</tr>
</tbody>
</table>

<sup>a</sup>Means within same rows with different superscripts differ significantly (P<0.05).

<sup>1</sup> Feed cost based on the price of grain in 1998.

<sup>2</sup> NTD exchange to USD by divided 31.


### Table 13. The production of methane from Taiwan yellow cattle by different rations

<table>
<thead>
<tr>
<th>Items</th>
<th>Groups</th>
<th>Concentrate</th>
<th>Corn silage</th>
<th>distiller’s sorghum grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane at zero hour(ppm)</td>
<td></td>
<td>2.52 ± 0.55</td>
<td>2.21 ± 0.75</td>
<td>2.02 ± 0.85</td>
</tr>
<tr>
<td>Methane at first hour(ppm)</td>
<td></td>
<td>11.26 ± 1.72</td>
<td>9.43 ± 2.42</td>
<td>7.80 ± 2.35</td>
</tr>
<tr>
<td>Methane at second hour (ppm)</td>
<td></td>
<td>14.21 ± 1.26</td>
<td>12.39 ± 1.84</td>
<td>13.03 ± 2.26</td>
</tr>
<tr>
<td>Methane at third hour(ppm)</td>
<td></td>
<td>19.91 ± 2.18</td>
<td>16.37 ± 2.43</td>
<td>15.08 ± 1.94</td>
</tr>
</tbody>
</table>

**RFID utilization on cattle management in Taiwan**

Radio frequency identification (RFID) techniques had been developed for military purpose in World War One. Recently, RFID techniques have a big progress due to advancement of electron and microscopy techniques. The tag of RFID can store useful data and can be read or rewrote by scanner or reader. Therefore, RFID techniques have been prevailed on storehouse or barcode manager business.

Generally, it is too tedious on cattle management by labor. Creating a new manage method by using RFID technique for cattle production may be a good idea for the next decades. It is easy to grab the body weight of poultry. Nevertheless, it is more difficult to collect the body weight from cattle. Although, traditional electronic weight scale have been prevailed on the cattle farm for decades in Taiwan. However, using traditional electronic weight scale still has several disadvantages included labor cost, more time and unsafe data recorded by labor. Therefore, the routine work of weighting each cattle and saving their weight value in computer file become a heavy work. The RFID weight system was composed of RFID tag, weight scale, PDA,
wireless network, server and customization software. Recently, three RFID cattle managing experiments have been conducted in Taiwan from 2008-2014. It has been proved that using RFID weight scale system and customization cattle management software for dealing with cattle manage on large cattle farm offered valuable benefits on labor saving and data security. It is obvious that using RFID technique to assist managing the cattle herd will going to prevail sooner or later on the cattle farm in the future.

1. Utilization RFID weight scale to collect body weight of cattle

As far as concerned large cattle breeding farms, the most important item on cattle managing was their weight collection. However, this work might cause the stress of cattle. And, it might jeopardize on cattle or operator. Using a new technique of RFID weight scale for getting the cattle managing data could improve animal fare, data precisely, production efficiency, and food safety. Therefore, application RFID weight scale system on the ruminant breeding farm had been conducted by TLRI researchers.

One customized weight scale, which had been developed for grabbing weight value easily, saving labor and keeping weight value security, was used for cattle breeding programs in the southernmost part of Taiwan. Thirty two heads of cattle have been weighted by RFID weight scale system and by traditional electronic (TE) weight scale. In this investigation, time saved of operated weight scales and collected weight value in computer file completely were two important goals for evaluating the efficiency of using the RFID weight scale system on cattle farms. The average weight value of this cattle herd was around 412.9 kg. When cattle walked through the RFID weight scale corridor one by one, the RFID weight scale system reads the tag of cattle. Cattle weight value was displayed on the PDA or computer screen immediately. The result showed that seconds of operating RFID weight scale system or TE weight scale for collecting cattle weight individually were 3.0 vs. 6.9, respectively. However, it was observed and recorded that operated TE weight scale needed at least another four extra seconds for typing a weight value from the worksheet in a computer file. Therefore, the total amount seconds of weighting cattle were 3.0 vs. 10.9, respectively. Eventually, it seemed that using RFID weight scale system for cattle weight value collection in such small herds had 72.8% more efficient on time saving than that of in using the TE weight scale. The observation data proved that the RFID weight scale system could be used on large cattle farms for saving labor and keeping data accuracy (Table 14) (Su. et. al. 2012).

Table 14. Time saving on cattle weight collected by different weight scales

<table>
<thead>
<tr>
<th>scale</th>
<th>n</th>
<th>Time spend, sec/head</th>
<th>labor key-in, sec/head</th>
<th>Total time, sec/head</th>
<th>Time saving, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFID</td>
<td>32</td>
<td>3.0 ± 1.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0</td>
<td>3.0</td>
<td>72.5</td>
</tr>
<tr>
<td>TE</td>
<td>32</td>
<td>6.9 ± 3.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4</td>
<td>10.9</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup> Means within the same column with different superscripts differ (P < 0.05).
<sup>b</sup> RFID: radio frequency identification weight scale system; TE: traditional electronic weight scale.
Source: Su. et. al. 2012.

2. Utilization RFID techniques to collect body weight and number head of buffalo

The data collection of body weight and heads of buffalo could be easily obtained by connecting RFID weight scale, RFID multiple scanners and PDA with special software. The result showed that the percentage of RFID ear tag damage or falling down was 3.7% and 9.4%, respectively, after tagged in the ear of buffalo five months later due to their shrub-like behavior. The distance for scanning RFID ear tag by PDA was about 1.5 to 2 meters. The software for PDA was designed to operate alone or connecting server by wireless. The RFID weight scale could weight buffalo automatically, and transferred data back to sever. The stability and accurate of body weight data collection were 100% precisely. The RFID multiple scanner was put on the gate lintel about 3 meters high. When a buffalo herd walked through below the RFID multiple scanners, all the number of buffalo could be detected and showed on the computer screen right away. When a herd of buffalo under the twenty heads, the percentage of the data accuracy was 95%-100% due to some younger buffalo trepidation behavior (Table 15) (Chuang and Su, 2013).
3. Utilization RFID multiple scanner system to manage buffalo grazed on pasture

Grazing cattle needed more labor to take care. The RFID tag, RFID multi-target sensing system, solar electric fence and image recognition system coordinated with the infrared scanner were being combined together to build an automatic rotational grazing system for saving labor time on the buffalo grazed in Hualien propagation station TLRI-COA in Taiwan. The number of buffalo head and the condition of grazing pasture could be easily obtained and monitored by the customized software. The results showed that the grass growth rate, the mean of air temperature and the humidity of soil could be recorded in the scanned area easily. Based on the automatic scanner system and automatic rotational grazing system, not only the grass yield could be monitored, but also the buffalo rotating on pasture could be managed more efficiently (Chuang and Su, 2014).

### CONCLUSION

As concerned beef demand, livestock production efficiency and environmental problem, feeding and managing cattle by using automatic machine and computer techniques will go to trend into developing countries in the future. Someone may be cavil about that it needs huge capital investment to set up automatic machine and computer technique system for raising livestock in developing countries. But the price of these equipment will go to decline following by the human techniques advancement. From the viewpoint of beef cattle business developed in Taiwan, the author forecast that raising cattle by machinery and high techniques will going to prevail in developing countries in the future.

### REFERENCES


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<table>
<thead>
<tr>
<th>Tagged month</th>
<th>After 5 months</th>
<th>After 6 months</th>
<th>After 7 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage, %</td>
<td>5.7%(3/53)</td>
<td>1.9%(1/53)</td>
<td>0%(0/53)</td>
</tr>
<tr>
<td>Falling down, %</td>
<td>13.2%(7/53)</td>
<td>7.5%(4/53)</td>
<td>7.5%(4/53)</td>
</tr>
<tr>
<td>Raising on shrub area, %</td>
<td>50.0%(3/6)</td>
<td>16.7%(1/6)</td>
<td>------</td>
</tr>
</tbody>
</table>

Source: Chuang and Su, 2013.


