Evaluation of nitrogen balance at different scale in Hokkaido dairy farming

Juri MOTOKI[1], Yoshitaka UCHIDA[2]
jurimotoki@eis.hokudai.ac.jp

[1]Graduate School of Global Food Resources, Hokkaido University
[2] Research Faculty of Agriculture, Hokkaido University
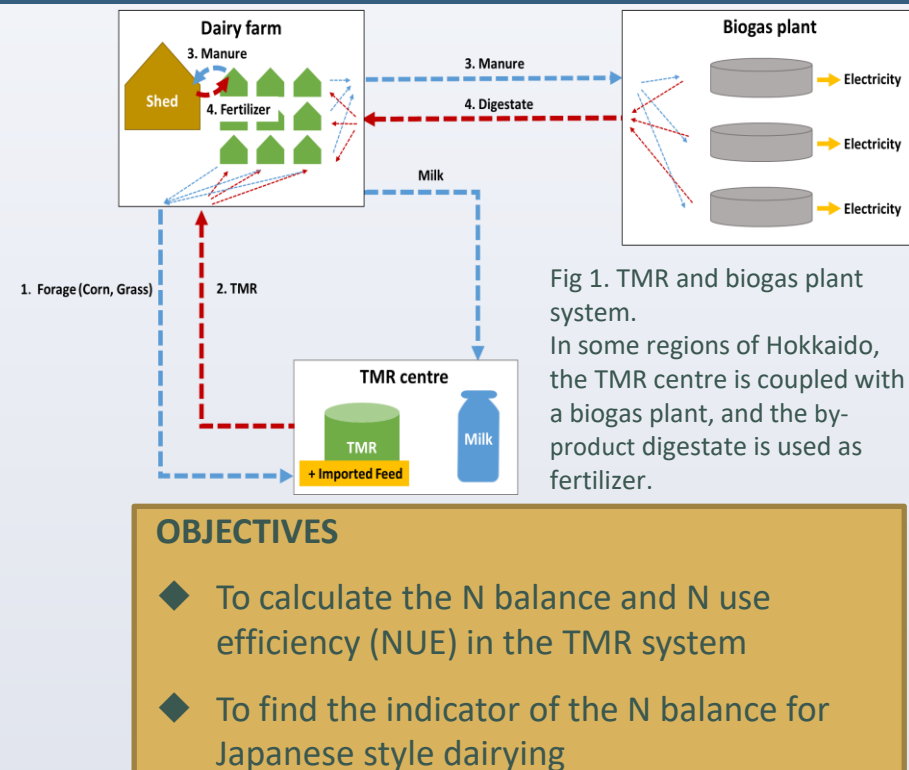
INTRODUCTON

New dairy system in Hokkaido, Japan [TMR system]

- The farms which joining TMR (total mixed rations) systems grow (1)corn and grass on their fields. However, harvesting and utilization are done as a community basis.

- TMR centre make high nutrient feed (= (2)TMR) by mixing forage and imported feed and sell to farms.

- The (3)manure which was produced in each farm is centred in three biogas plants and the by-product (4)digestate and fertilizer were sprayed to farms.

- The N flow within the farm become more complicated (Fig 1).

Fig 1. TMR and biogas plant system.
In some regions of Hokkaido, the TMR centre is coupled with a biogas plant, and the by-product digestate is used as fertilizer.

OBJECTIVES

- ◆ To calculate the N balance and N use efficiency (NUE) in the TMR system
- ◆ To find the indicator of the N balance for Japanese style dairying

MATERIALS AND METHODS

- Farms on different parts of Hokkaido was targeted (Fig2) .

a. TMR centre composed of 19 dairy farms (TMR-based farms)

b. 17 family-based farms (For 16 farms, data was from previous study (Toda. 2015))

- Through interviews and the analyses of the bills, following "factors" will be evaluated for their variability.

  a. Milk production and quality
  b. Feed import/export
  c. Fertilizer and manure import/export
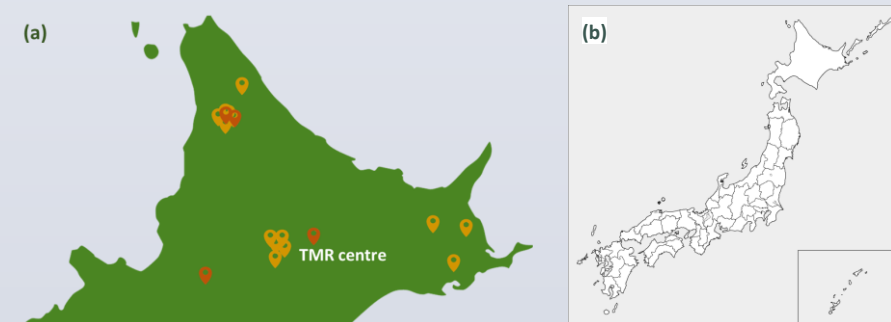 d. Animal movements
  e. Bedding

Fig 2. (a) Farm selection. The data of 16 farms were collected in 2015 (yellow). Other 3 farms and TMR centre were in 2018 (orange). Within 3 farms in 2018, 2 farms were same in 2015. (b) Map of Japan
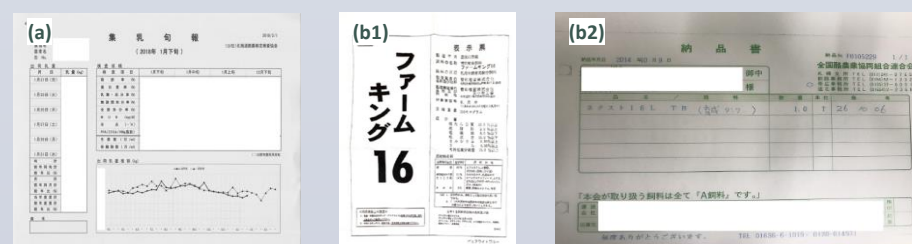

Fig 3. data samples
(a). Monthly report of milk quality analysis published by Hokkaido Dairy Milk Recording & Testing Association.
(b1). Picture of feed package. Crude protein and ingredients are written. (b2). The bill of feed. The amount of feed per bag and the number of bags are recorded.

RESULTS

N balance and whole farm NUE

- The whole farm N surplus ranged -163 - 701kg N/ha (median = 40.5 kg N/ha). The whole farm NUE ranged 20 - 171% (median = 66%).

- TMR centre had larger N inputs and outputs although whole farm NUE was within the desirable range (50 - 90%).

- The most important factor that affect to N surplus was **feed N**.

- Feed NUE (the percentage of feed N conversion into milk) ranged 20-109% (median = 40.5%). 14 farms out of 19 were above average value (more than 30%). (Chase. 2003).
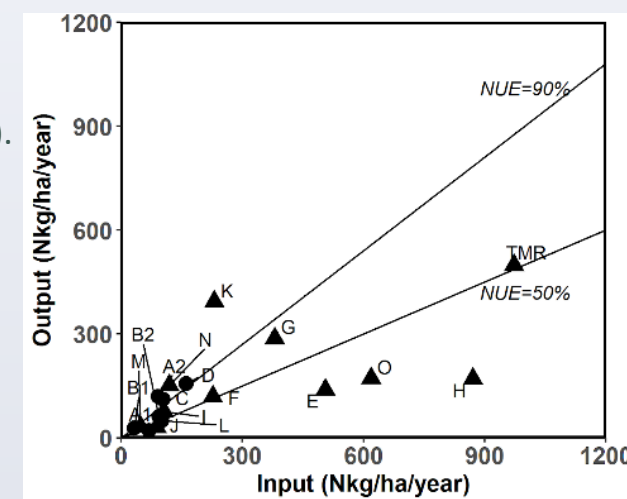

Fig3. N balance and NUE. They were calculated based on annual N inputs and outputs. Family-based farms were represented as A to O and TMR centre was TMR.

Comparison between TMR-based farms and family-based farms

- **TMR-based farms had higher milk production per cow** and **stocking rate** than family-based farms (Fig.5).

- **Feed NUE of TMR system was lower** than family-based farms; 21% , which is defined as very low.
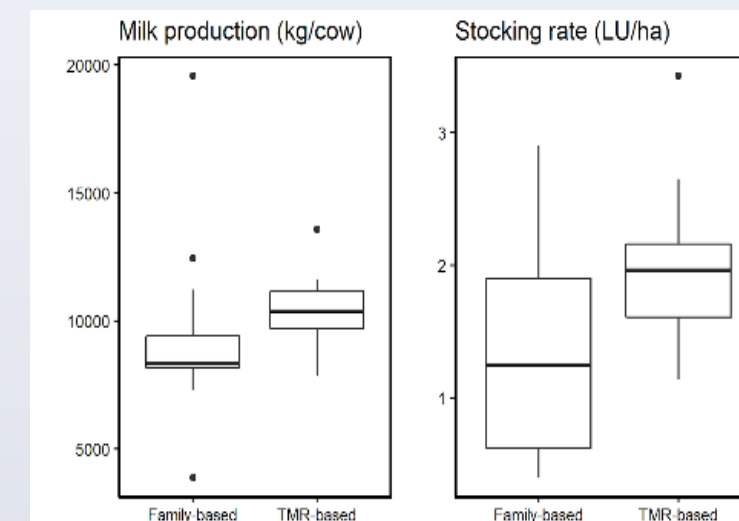

Fig 4. Comparison between TMR-based farms and family-based farms. Milk production (kg per cow) and stocking rate (Livestock unit per ha) were higher in TMR-based farms.

DISCUSSION

N surplus and whole farm NUE

- Hokkaido dairy farms had smaller N surplus and higher whole farm NUE compared with other countries. The whole farm N balance and NUE values ranged 200kg N/ha and 20-40%, respectively, in other countries (de Klein et al 2016).

- Gourley et al. (2012) showed that stocking rate was positively correlated with the N balance. The average stoking rate was 1.3 (cow/ha) in this study, smaller than other countries.

Comparison between TMR system and family-based farms

- Against the high whole farm NUE, Feed NUE was low in TMR system. In TMR-based farms feed N intake (cow^{-1} day^{-1}) was 735 g N while global average was 409 g N (Powell et al. 2013). TMR-based farms seems to be feeding too much. Excess feed N might excreted in urine.

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