

Material Flow Analysis of Maize Supply Chain in Thailand

Sureeporn Khonpikul^{1,*}, Napat Jakrawatana¹, Shabbir H. Gheewala^{2,3}, Jitti Mungkalasiri⁴
and Jeeranee Janrungautai⁵

¹School of Energy and Environment, University of Phayao, Phayao, 56000, Thailand

²The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Bangkok, Thailand

³Centre of Excellence on Energy Technology and Environment, PERDO, Bangkok, Thailand

⁴National Metal and Materials Technology Center (MTEC), National Science and Technology Development Agency (NSTDA), Pathumthani, 12120, Thailand

⁵Sustainability, Good Governance, and Corporate Communication (SGC), Charoen Pokphand Group, Bangkok, 10500, Thailand

* Corresponding author: Tel.: +6681-164-6089, Fax: +6654-466-690, E-mail address: changthongkeng@gmail.com

Abstract: Maize is an important material for feed production in Thailand. In the past 10 years, the demand of feed production has increased significantly, resulting in the increasing demand of maize. In this research, Material Flow Analysis was applied to track flows of raw materials and resources used in maize supply chain in Thailand in 2015. The study analysed the flow and loss of material and resources along maize supply chain to find the causes and hot spots of the losses in order to develop measures to reduce loss and create more production efficiency with less environmental impact of maize to feed production in Thailand. The results reveal that most of the loss occurred in the agriculture sector including nutrient and crop residues since most of the maize was grown in the hill area. Crop residues have a large potential to use as energy feedstock and reduce particulate matter emission from avoided open burning. Transferring of cultivation from hill area to the plains is necessary for reduction of loss and recovery of crop residues.

Keywords: Material Flow Analysis (MFA); Maize supply chain; loss; particulate matter; nutrient.

1. Introduction

Maize is an important material for feed production in Thailand. In the past 10 years, the demand of feed production has increased significantly, resulting in the increasing demand of maize. High price of maize and the characteristic of maize to be able to grow easily in several conditions brings about the expansion of maize to forest and hill areas causing several undesirable environmental impacts [1]. Previous studies regarding maize supply chain in Thailand have mainly focused on the economic and social aspects [2-5]. This study analyzed the flow and loss of material and resources along maize supply chain to find the cause and hotspot of the losses in order to create the measure to reduce loss and create more production efficiency with less environmental impact of maize to feed production in Thailand.

2. Approach and Methodology

The Material Flow Analysis (MFA) method was applied to track the flows of raw materials and resources used in the maize supply chain in Thailand in 2015 [6-7]. These flows are calculated using the mass balance principle, which is based on the law conservation of mass. The system boundary in this study covers all relevant sectors in the maize supply chain in Thailand consisting of agriculture (maize production), silo (Drying maize), animal feed (animal feed production), maize flour production and small animal farm. The data were obtained from the 2015 statistical records from the Office of Agriculture Economics, Land Development Department and Thai Feed Mill Association [8-9]. Moreover data from in depth interviews with almost 700 famers from 20 provinces, and silo owners and feed mill engineers in the region were used to develop the model.

3. Results and Discussion

MFA of overall maize supply chain in Thailand is shown in Fig. 1. The results showed that in 2015, over 150,000 tonne of fertilizers were used for maize production. However, over 60% of the fertilizers were lost through soil erosion and runoff as most of the maize cultivation was in hilly areas with high slope. In the maize cultivation process, 5.5 million tonne of maize was produced along with large amount of crop residues including 2 million tonne of maize cobs and 6 million tonne of maize stalks. Most of crop residues were not being utilized. Almost 70% of the stalks were burnt in the field causing smog pollution and only 30% was ploughed back into the soil. On the other hand, over 70% of the maize cobs were used as fuel for drying in the silos, the rest also being burnt in the field. The maize grain after grinding usually had 27% moisture content which after drying in the silos reduced to 14%. In the silo process, about 11% of mass as water vapor and 2% as dust and broken grain was lost from the process. Here, almost 4.7 million tonne of 14% moisture maize grain was produced and about 97% of dry maize grain used for feed mill.

MFA of maize supply chain that was grown in plain area and in hill area are shown in Figs. 2 and 3. Almost 70% maize cultivation was in the hill area. Most of the loss, especially nutrient and crop residues occurred in the agriculture sector as most of the maize was grown in the hilly areas. The terrain of the hill area made it difficult to manage loss because it is difficult to harvest and collect crop residue, thus it has to be burnt instead. Moreover, runoff and soil erosion on the slope area caused large amount of nutrient loss from soil. Transferring of cultivation from hill area to the plains area is necessary for reduction of loss and recovery of crop residues. In the part of loss in the silo and feed mill is small.

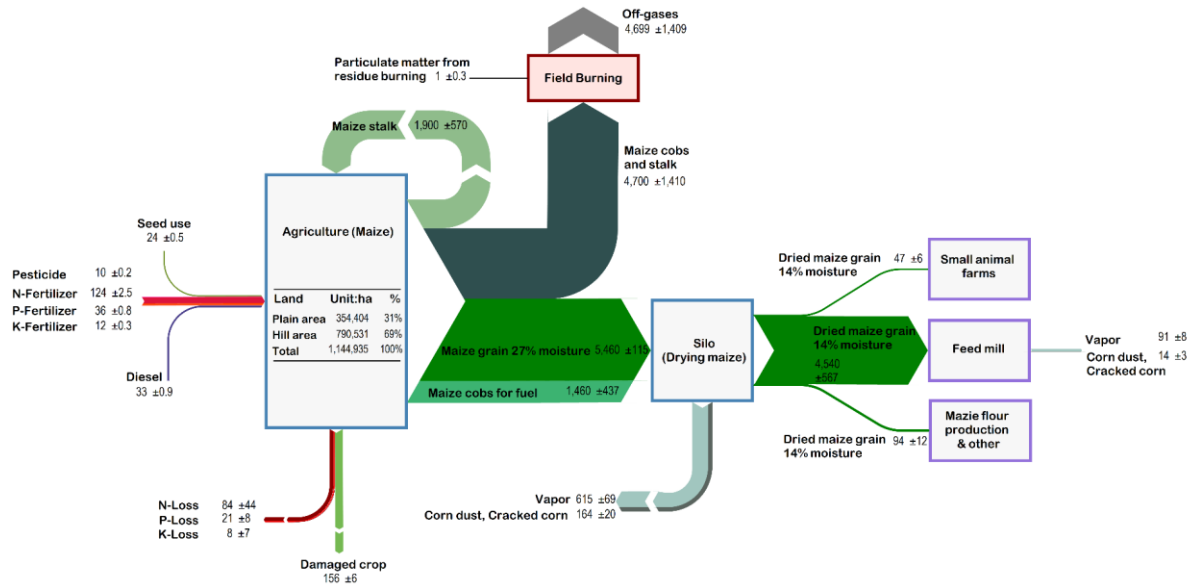


Figure 1. MFA of overall maize supply chain in Thailand (Unit: thousand tonne).

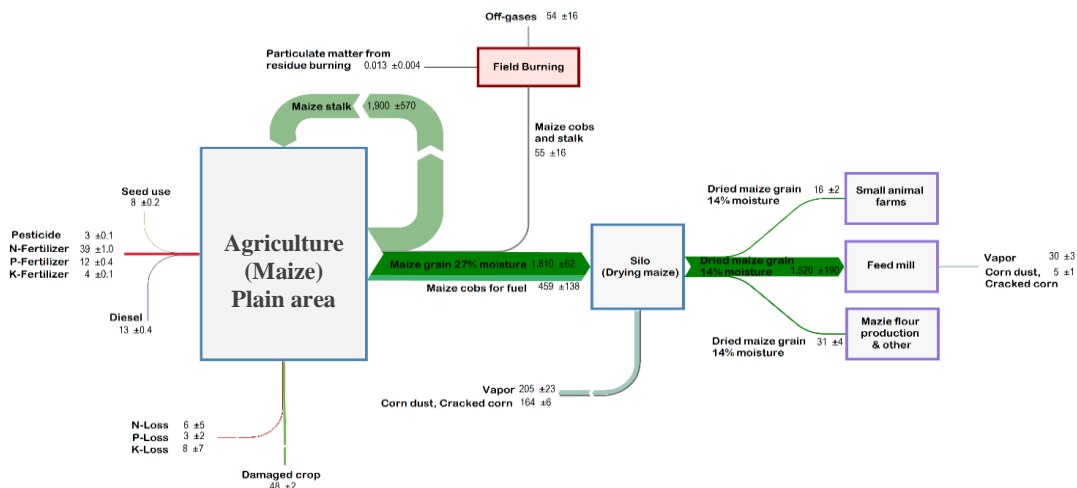


Figure 2. MFA of maize supply chain that was grown in the plain area (Unit: thousand tonne).

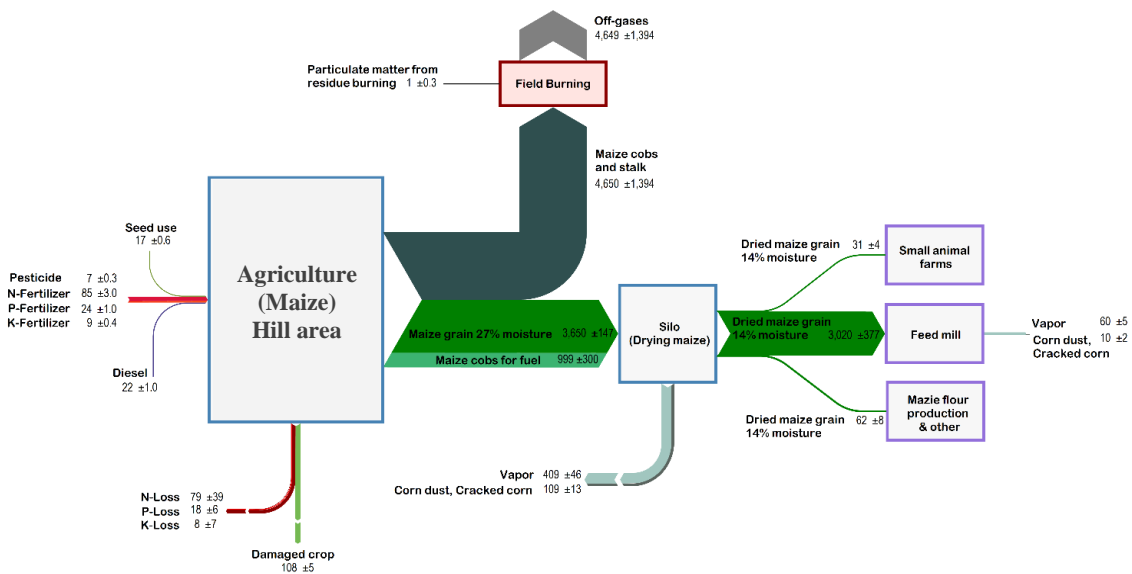


Figure 3. MFA of maize supply chain that was grown in the hill area (Unit: thousand tonne).

4. Conclusion

This study revealed the overall material flow of the maize supply chain in Thailand. Hotspots of the losses were pointed out. Maize cultivation is the main process responsible for the major losses in the form of nutrients and crop residues. The key measure to reduce loss and increase production efficiency is transferring of cultivation from hill areas to the plains as much as possible in order to reduce significant loss and increase eco-efficiency.

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