Curriculum Vitae of PI: Lin Ma

1. EDUCATION

- September, 2006 – June, 2010, PhD candidate of joint project by Agricultural University of Hebei and China Agricultural University, China (Cum laude). Supervisor(s): Prof. Wenqi Ma and Prof. Fusuo Zhang.

  Major: soil science.

  Tittle of thesis: Mechanism and management strategies of nitrogen flow in the food chain of China.

- September, 2003 – July, 2006, MSc degree in Agronomy, Joint educational programme by Agricultural University of Hebei and China Agricultural University, China (Cum laude). Supervisor(s): Prof. Wenqi Ma and Prof. Fusuo Zhang.

  Major: plant nutrition.

  Tittle of thesis: Research on China's Nutrients Flows and Cycles model (CNFC model)

- September, 1999 – July, 2003, BSc degree in Agronomy, College of horticulture, Agricultural University of Hebei, China. Supervisor(s): Prof. Shuxing Shen, Prof. Xueping Chen.

  Major: horticulture

  Tittle of thesis: Selection of nitrogen fertilizer tolerant variety in eggplant production

2. PROFESSIONAL EXPERIENCE

- July, 2014 – , Professor of Center for Agricultural Resources Research, Institute of Genetic and Developmental Biology, Chinese Academy of Sciences
- July, 2010 – June, 2014, Postdoc of environmental science center, Wageningen University & Research Centre, the Netherlands.

3.HONORS AND ACADEMIC AWARDS (2009-2013）

Our group initiated from July 2014, therefore we did not get any funding between 2009 and 2013.

4. MAJOR RESEARCH INTERESTS，SELECTED RESEARCH PROJECTS, research background, major research achievements, current research and future directions

Nitrogen (N) and phosphorus (P) are essential nutrients for the growth and development of plants and animals, and are hence critical for the production of sufficient nutritional food for the increasing world population. However, the increased use of N and P for food production, especially during the last decades has also resulted in increased losses of N and P to atmosphere and water systems with severe environmental impacts regionally. The scientific and societal debates about 'resource use' have focused on alteration of the world's N and P cycles represents a major emerging challenge for the twenty-first century. Therefore, there is a need to increase the understanding of how human's activities affect nutrient flows in food the production and consumption chain. There is also a need for improved management strategies to increase nutrient use efficiency and decrease nutrient losses from the food chain.

Lin Ma has extensive knowledge on the integrated assessment of nutrient flows in food production and consumption chains. He has developed a model (NUFER — Nutrient flows in Food chains, Environment and Resources use), for understanding the relationship between food security, nutrient losses and resource use in the food chain of China. His research includes database and model development, scenario analyses and integrated assessment of nutrient management options at regional and national level. He developed a food pyramid for the first time, which provides a visual symbol, with food production at the base (relatively large amounts of nutrients) and food consumption by humans at the top (a small fraction of nutrients ends up in food consumption). It is uniquely integrative for assessing nitrogen (N) and phosphorus (P) flows in the food chain at regional and national level.

Major findings and achievements were:

(1) An assessment of main development in nutrient management in China during past decades showed that various promising nutrient management concepts and technologies have been developed and tested in crop production already by universities and research institutes. However, adoption of these concepts and technologies in farmers'practice is still negligible. More coherent national policies and institutional structures are required for the research-extension-education chain to be able to address the challenges ahead. There is a need for shifting the research focus from nutrient management in crop production at field and farm levels to nutrient management in the entire food production and consumption chain at regional and national levels (Ma et al., 2013 JEQ).

(2) The 'food chain' approach was developed for the purpose of my thesis to study N and P flows in the food production and consumption chain. The food pyramid approach was developed as a hierarchically structured and multilevel analytic framework, with food production at the base and food consumption at the top. The concept helps to visualize and understand the low nutrient use efficiency of the current food production – consumption chain, and the high N and P cost of the current food in China. A set of indicators were developed to assess N and P flows in the food chain (Ma et al., 2010 JEQ).

(3) Total inputs of 'new' N and P into the food chain in 2005were 48.8 and 7.8 Tg, respectively. New N (and P) was defined as the total input of N (and P) from outside the food chain, via fertilizers, deposition, biological N fixation, harvested grass from natural grassland, fish from unmanaged water bodies, and imports of feed and food from abroad. Only 4.4 Tg N and 0.6 Tg P reached households as food. The average N and P use efficiencies in the food chain was 9% for N and 7% for P in 2005. Most of the imported N was lost to the environment, i.e., 23 Tg N to atmosphere, and 20 Tg N and 3.0 Tg P to water bodies (Ma et al., 2010 JEQ).

(4) The N and P cost of food proved to be one of the core indicators, it is defined as the amount of new N and P (in kg) used in the crop and animal production and

food processing compartments for the delivery of 1 kg N and P in the food entering households. Between 1980 and 2005, the mean N cost of food in China increased from 6 to 11 kg kg^{-1}. The mean P cost of food increased from 5 to 13 kg kg^{-1} (Ma et al., 2012 STOTEN).

(5) Between 1980 and 2005, N use efficiency in crop production decreased from 32 to 26%, mainly because of the increased use of N fertilizer which was heavily subsidies by the government. In contrast, NUE increased in animal production from 8 to 16%, because of improved animal breeds and animal feeding. In the whole food chain NUE decreased from 16 to 9%. Similarly, PUE decreased in crop production from 59 to 36%, increased in animal production from 16 to 17%, and decreased in the whole food chain from 19 to 7%. The main reasons for the decreasing use efficiencies of the food chain for N (NUEf) and P (PUEf) are (i) changes towards a diet with more animal-derived protein, (ii) over fertilization in crop production, and (iii) decoupling of crop and animal production, which has led to less recycling of manure nutrients to crop land (Ma et al., 2012 STOTEN).

(6) Total N losses to water and atmosphere almost tripled between 1980 (14.3 Tg) and 2005 (42.8 Tg). Estimated P losses to water systems increased from 0.5 Tg in 1980 to 3.0 Tg in 2005. Ammonia (NH_3) emissions and N and P leaching losses (including runoff, erosion and direct manure discharges) were the major loss pathways. There were significant regional differences in N and P losses in the period 1980-2005. Losses increased greatly in South, East and Central China. Changes over time were relatively small for West and North China. Regions with high N and P losses are in the Beijing and Tianjin metropolitans, Pearl River Delta, and Yangzi River Delta. The food chain analysis approach indicated that the changes in NUE and PUE in crop and animal production are complex. Increases of NUE and PUE over time in animal production may be completely nullified when the necessary recycling of N and P in animal manure is neglected (Ma et al., 2012 STOTEN).

(7) The case study on N and P flows in the food chain of Beijing during a period of rapid urban expansion and economic growth, revealed the importance of structural

changes in the food production and consumption chain. The input of 'new' N to the food chain of Beijing metropolitan increased from 180 to 281 Gg between 1978-2008, and from 33.5 to 50.4 Gg for P. A total of 66% of the N input and 85% of the P input was wasted in 2008 and diffusively accumulated in soils, landfills and waterways (via crop residues, animal excreta, human excreta and household wastes). Total N losses increased 2.9 folds, and P losses increased even 37 folds. Recycling wastes and residues and expelling animal production from the peri-urban areas are possible options to increase NUE and PUE and decrease N and P losses in Beijing metropolitan. It is important to link the N and P cycles of urban and rural systems, so as to attain a more sustainable development of metropolitans (Ma et al., 2014 GEC).

(8) Possible future changes in the N and P flows in the food chain were also explored. In the business as usual (BAU) scenario towards 2030, consumption of N and P fertilizers in China increased both by 25%, and N and P losses increased by 47 and 71%, respectively, compared to 2005. Scenarios with changes in human diet (less meat, more vegetables, fruits and cereals) and increased imports of animal products indicated that fertilizer consumption and N and P losses decreased relative to BAU. The scenario analyses showed that a combination of balanced fertilization in crop production, precision feeding in animal production and improved manure management are the most effective management options for increasing the N and P use efficiency in the food chain. The scenarios also indicate that imports of N and P in animal feed could be halved, and total N and P losses reduced, if diets would follow the official Chinese food dietary guidelines (including a decrease of the consumption of animal-derived food). If the increasing demand of animal products will be fulfilled by import from other countries, fertilizer N and P consumption in China may decrease by 12%, and nutrient losses by 30% for N and 42% for P relative to the BAU scenario (Ma et al., 2013 EST).

In summary, the food chain and food pyramid approach for analysing nutrient flows at regional and national levels is a novel and effective concept for the quantitative

assessment of N and P use efficiencies and losses in different compartments of the food chain. Application of the food chain approach and the NUFER model can help policy makers in China to plan food production and consumption chains, and thereby manage N and P flows in this chain at regional level.

Lin Ma initiated a new research group named COFER group (Coupling of Food, Environmental impact and Resource use). This is a relatively young group in the Center, founded in 2014. The research topics of this group are: (1) food security and food chain approach, (2) nutrients flows and their environmental impacts in soil, water and atmosphere and, (3) mitigation of greenhouse gas emissions in agriculture. The future research directions are (1) designing sustainable agriculture and food systems, (2) integrated assessment of an innovation in the food chains/systems, (3) synergies and trade-offs with mitigation options in crop and animal production.

5. Funding and laboratory personnel (2009-2013)

5.1 Funding

Our group initiated from July 2014, therefore we did not get any fundings between 2009 and 2013.

5.2 Laboratory personnel

Group leader: Prof. Lin Ma

Junior researcher: Dr. Liwei Gao

PhD candidates: Zhanqing Zhao, Mengchu Guo, Xiaohui Chen, Mengru Wang, and Peipei Yang

MSc students: Xuanji Chen

6. SELECTED PUBLICATIONS, PATENTS GRANTED , VARIETIES OBTAINED, major invited international conference talks (2009-2013)

6.1 Publications

1) Chen X.P., Cui , Mingsheng Fan, Vitousek P., Zhao M., Ma W.Q., Wang Z.L., Zhang W.J., Yan X.Y., Yang J.C., Deng X.P., Gao Q., Zhang Q., Guo S.W., Ren J., Li S.Q, Ye Y.L., Wang Z.H., Huang J.L., Tang Q.Y., Sun Y.X., Peng X.L., Zhang J.W., He M.R., Zhu Y.J., Xue J.Q., Wang G.L., Wu L., An N., Wu L.Q., **Ma L.,** Zhang W.F., Zhang F.S. Producing more grain with lower environmental costs, **Nature**, 2014 (received).

2) **Ma, L.,** Guo J.H., Velthof G.L., Li Y.M., Chen Q., Ma W.Q, Oenema O., Zhang F.S. Urban expansion and it impacts on nitrogen and phosphorus flows in the food chain: A case study of Beijing, China, period 1978 – 2008, **Global Environmental Change**, 2014 (received)

3) **Ma L.**, Wang F. H., Zhang W. F., Ma, W. Q., Velthof G.L., Qin W., Oenema O., Zhang F.S., Environmental assessment of nutrient management options for the food chain of China. **Environmental Science & Technology**, 2013, 47 (13), 7260-7268.

4) **Ma L.**, Zhang W. F., Ma W.Q., Velthof G.L., Oenema O., Zhang F.S., An analysis of developments and challenges in nutrient management in China. **Journal of Environmental Quality**, 2013, 42 (4): 951-961.

5) Bai Z.H., **Ma L**., Oenema O., Chen Q., Zhang F.S., Nitrogen and phosphorus use efficiencies in dairy production in China. **Journal of Environmental Quality**, 2013, 42 (4): 990-1001 **(first co-author)**.

6) Hou Y., **Ma L.**, Gao Z. L., Wang F. H., Sims J. T., Ma W. Q., Zhang F. S., Nitrogen and phosphorus flows and losses in the food chain in China, 1980-2010. **Journal of Environmental Quality** 2013, 42 (4): 962-971 **(first co-author).**

7) Li Y.X., Zhang W.F., **Ma L**., Huang G. Q., Oenema O., Zhang F.S., Dou Z.X. An analysis of China's fertilizer policies and its impacts on the industry, **Journal of Environmental Quality** 2013, 42 (4): 972-981.

8) Yan Z.J., Liu P.P., Li Y.H., **Ma L.**, Alva A., Dou Z.X., Chen Q., Zhang F.S., Phosphorus in China's intensive vegetable production systems: over-fertilization, soil enrichment, and environmental implications. **Journal of Environmental Quality** 2013, 42 (4): 982-989.

9) Sims J. T., **Ma L.**, Oenema O., Dou Z. X., and Zhang F. S. Advances and Challenges for Nutrient Management in China in the 21st Century. **Journal of Environmental Quality** 2013, 42 (4): 947-950.

10) Gu, B., Leach, A.M., **Ma, L.**, Galloway, J.N., Chang, S.X., Ge, Y., Chang, J., Nitrogen Footprint in China: Food, Energy, and Nonfood Goods. **Environmental Science & Technology** 2013, 47 (16), 9217–9224.

11) **Ma, L.,** Velthof G. L., Wang F.H., Qin W., Zhang W.F., Liu Z., Zhang Y., Wei J., Lesschen J.P., Ma W.Q., Oenema O., Zhang F.S. Nitrogen and phosphorus use efficiencies and losses in the food chain in China at regional scales in 1980 and 2005. **Science of the Total Environment** 2012, 434: 51-61.

12) Ma W.Q, **Ma L.**, Li J. H., Wang F. H., Sisákc I., Zhang F. S., Phosphorus flows and use efficiencies in production and consumption of wheat, rice, and maize in China, **Chemosphere**, 2011, 84 (6): 814-821.

13) Wang F. H., Sims J.T., **Ma L.,** Ma W. Q., Dou Z. X., Zhang F. S, The phosphorus footprint of China's food chain: implications for food Security, natural resource management, and environmental quality, **Journal of Environmental Quality**, 2011, 40 (4): 1081-1089.

14) Li, H., Huang, G. Meng Q., **Ma L.,** Yuan L., Wang F., Zhang W., Cui Z., Shen J., Chen X., Jiang R., Zhang F. Integrated soil and plant phosphorus management for crop and environment in China. A review, **Plant and soil**, 2011, 349 (1): 157-167.

15) Xiang Y. J., Wang F. H., Qin W., **Ma L.** (Corresponding author)**,** Zhang W. F., The enlightenment of United State nutrient management regulations to China (in Chinese), World agriculture, 2011, 383 (3): 51-55.

16) Zeng U., Xiang Y. J., **Ma L.** (Corresponding author), Zhang W. F., The enlightenment of European Union nutrient management regulations to China (in Chinese), World agriculture, 2011, 384 (4): 39-43.

17) Ma L., Ma W.Q., Velthof G.L., Wang F. H., Qin W., Zhang F. S., Oenema O., Modeling nutrient flows in the food chain of China, **Journal of Environmental Quality**, 2010, 39 (4): 1279-1289.

18) Wang, F.H., Dou, Z.X., **Ma, L.,** Ma, W.Q., Sims, J.T., Zhang, F.S., Nitrogen mass flow in China's animal production system and environmental implications. **Journal of Environmental Quality** 2010, 39 (5), 1537-1544.

19) **Ma L.,** Wei J., Wang, F.H., Ma, W.Q., Zhang, F.S., Analysis on the feature of nitrogen flow in food chain system in China (in Chinese with English abstract). Journal of Natural Resources 2009, 24 (12): 2104-2114.

20) Zhang,Y., Dore A., **Ma, L.**, Liu,X.J., Ma W.Q., Cape,J.N., Zhang, F.S., Agricultural ammonia emissions inventory and spatial distribution in the North China Plain. **Environmental Pollution** 2009, 158 (7): 490-501.

21) Gao, L. W., **Ma, L**., Zhang, W. F., Wang, F. H., Ma, W. Q., Zhang, F. S., Estimation of nutrient resource quantity of crop straw and its utilization situation in China (in Chinese with English abstract). Transactions of the Chinese Society of Agricultural Engineering 2009, 25 (7): 173-179.

22) Gao, L.W., **Ma, L.**, Zhang, W.F., Wang, F.H., Ma, W.Q., Zhang, F.S., Analysis on the Quantities and Utilization of Crop Straw and its Nutrient in Huang-Huai-Hai Region (in Chinese with English abstract). Chinese Agricultural Science Bulletin 2009, 25, 186-193.

23) **Ma, L**., Wei, J., Wang, F.H., Gao, L.W., Zhao, L., Ma, W.Q., Zhang, F.S., Studies on nitrogen flow in food chain among regions based on MFA and model-A case of Huang-Huai-Hai Plain (in Chinese with English abstract). Acta Ecologica Sinica 2009, 29, 475-483.

24) Wei, J., **Ma, L.**, Ma, W.Q., Lu, G., Zhao, L., Influence of urbanization on N cycle of farmland of various periods in China (in Chinese with English abstract). Journal of Agricultural University of Hebei 2009, 32, 6-9.

25) Zhao, L., Wei, J., **Ma, L.**, Wang, F.H., Ma, W.Q., The Assessment and Comparison on Animal Manure Pollution Risk of Different Breeding Patterns in Hebei (in Chinese with English abstract). Journal of Agro—Environment Science 2009, 28, 544-548.

26) Wei J., **Ma L.,** Yang Y.R., Ma W. Q., The influence of urbanization on nitrogen emission to water in food consumption system of China (in Chinese with English abstract). Acta Ecologica Sinica 2009. 29 (11): 6035-6041.

6.2 List of presentations in international conferences/meetings/workshops

1) Oral presentation: N and P flows in food chain in China using NUFER model. 3rd International Workshop on Nutrient Management: Technology and Policy, 2010, September 23-26, Beijing, China.
2) Poster presentation: Integrated assessment of nutrient management options in the food chain in China: effects on nutrient use efficiencies and losses. 4th International Nutrient Management Symposium, 2011, August 21-24, Delaware, USA.
3) Oral presentation: Nitrogen and phosphorus cycling in the food chain at regional scale in China. Workshop Nutrient Cycling and Management, 2011, November 05, Wageningen, the Netherlands.
4) Poster presentation: Nitrogen flows in the food chain of the Beijing metropolitan in 1978-2008. Urban Environmental Pollution Conference, 2012, June 17-20, Amsterdam, the Netherlands.
5) Oral presentation: Integrated assessment of nutrient management options in the food chain of China. 17th International Nitrogen Workshop "Nitrogen - the Future", 2012, June 27-29, Wexford, Ireland
6) Oral presentation: Nutrient flows in the food chain in China. Nutrient Management Seminar, 2012, November, 07, Wageningen, the Netherlands.
7) Oral presentation: The NUFER model to assess nutrient flows in the food chain in China. Workshop of pollution management in China: Nutrient export from land to sea, 2013, March 26, Wageningen, the Netherlands.
8) Oral presentation: Future scenarios of nitrogen and phosphorus flows in the food chain of China. Nutrient Management Workshop, 2013, June 18, Beijing, China.

7. Editorial duties

No

8. Conference (Co)organization

1) 3rd International Workshop on Nutrient Management: Technology and Policy, 2010, September 23-26, Beijing, China.
2) 4th International Nutrient Management Symposium, 2011, August 21-24, Delaware, USA.

3) Workshop Nutrient Cycling and Management, 2011, November 05, Wageningen, the Netherlands.

4) Nutrient Management Seminar, 2012, November 07, Wageningen, the Netherlands.

5) Nutrient Management Workshop, 2013, June 18, Beijing, China.