School of Agriculture, Food and Wine
Faculty of Sciences

THE UNIVERSITY OF ADELAIDE
AUSTRALIA

Research collaboration & capacity building in Tibet PRC

Associate Professor Annie McNeill

In the beginning ……

ACIAR project LWR2/1999/094

Improving the productivity and sustainability of rainfed farming systems for the western Loess Plateau of Gansu Province in China

Joint projects funded in China (MOST) & Australia DEST ISL)

Linking Australian science to unique perennial legume systems on the Loess Plateau, Western China (CH050063)

Australian Government

Department of Education, Science and Training


LUCERNE
AUSTRALIA

Lucerne seed & hay industries in China & Australia

Biol Fertil Soils (2011) 47:377–385
DOI 10.1007/s00374-011-0543-7

ORIGINAL PAPER

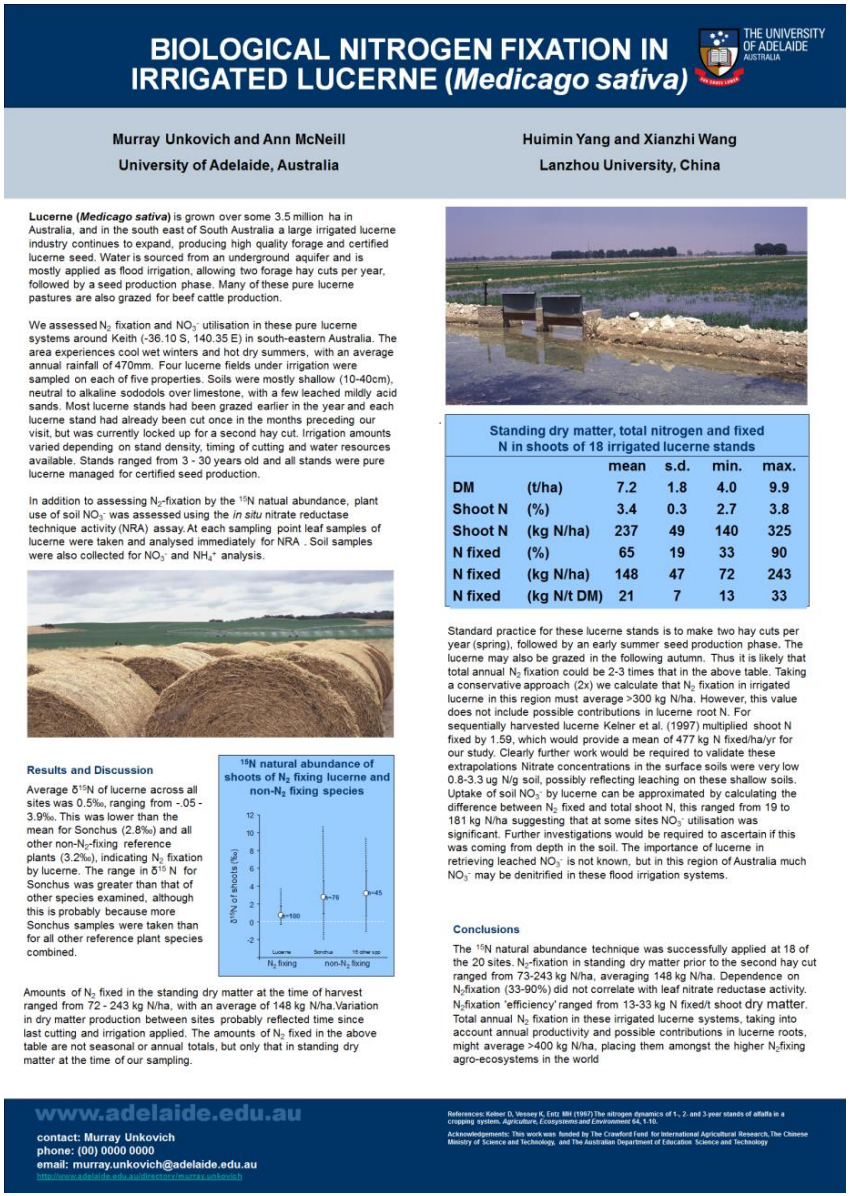
Symbiotic N_2 fixation and nitrate utilisation in irrigated lucerne (*Medicago sativa*) systems

Huimin Yang · Murray Unkovich · Ann McNeill · Xianzhi Wang

http://www.lucerneaustralia.org.au/

LUCERNE AUSTRALIA

Science-based practice change



BIOLOGICAL NITROGEN FIXATION IN IRRIGATED LUCERNE (*Medicago sativa*)

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Murray Unkovich and Ann McNeill
University of Adelaide, Australia

Huimin Yang and Xianzhi Wang
Lanzhou University, China

Lucerne (*Medicago sativa*) is grown over some 3.5 million ha in Australia, and in the south east of South Australia a large irrigated lucerne industry continues to expand, producing high quality forage and certified lucerne seed. Water is sourced from an underground aquifer and is mostly applied as flood irrigation, allowing two forage hay cuts per year, followed by a seed production phase. Many of these pure lucerne pastures are also grazed for beef cattle production.

We assessed N_2 fixation and NO_3^- utilisation in these pure lucerne systems around Keith (~36.10 S, 140.35 E) in south-eastern Australia. The area experiences cool wet winters and hot dry summers, with an average annual rainfall of 470mm. Four lucerne fields under irrigation were sampled on each of five properties. Soils were mostly shallow (10-40cm), neutral to alkaline sododols over limestone, with a few leached mildly acid sands. Most lucerne stands had been grazed earlier in the year and each lucerne stand had already been cut once in the months preceding our visit, but was currently locked up for a second hay cut. Irrigation amounts varied depending on stand density, timing of cutting and water resources available. Stands ranged from 3 - 30 years old and all stands were pure lucerne managed for certified seed production.

In addition to assessing N_2-fixation by the ^{15}N natual abundance, plant use of soil NO_3^- was assessed using the *in situ* nitrate reductase technique activity (NRA) assay. At each sampling point leaf samples of lucerne were taken and analysed immediately for NRA . Soil samples were also collected for NO_3^- and NH_4^+ analysis.

Results and Discussion

Average $\delta^{15}N$ of lucerne across all sites was 0.5‰, ranging from -.05 - 3.9‰. This was lower than the mean for Sonchus (2.8‰) and all other non-N_2-fixing reference plants (3.2‰), indicating N_2 fixation by lucerne. The range in $\delta^{15}N$ for Sonchus was greater than that of other species examined, although this is probably because more Sonchus samples were taken than for all other reference plant species combined.

^{15}N natural abundance of shoots of N_2 fixing lucerne and non-N_2 fixing species

Amounts of N_2 fixed in the standing dry matter at the time of harvest ranged from 72 - 243 kg N/ha, with an average of 148 kg N/ha.Variation in dry matter production between sites probably reflected time since last cutting and irrigation applied. The amounts of N_2 fixed in the above table are not seasonal or annual totals, but only that in standing dry matter at the time of our sampling.

Standing dry matter, total nitrogen and fixed N in shoots of 18 irrigated lucerne stands

		mean	s.d.	min.	max.
DM	(t/ha)	7.2	1.8	4.0	9.9
Shoot N	(%)	3.4	0.3	2.7	3.8
Shoot N	(kg N/ha)	237	49	140	325
N fixed	(%)	65	19	33	90
N fixed	(kg N/ha)	148	47	72	243
N fixed	(kg N/t DM)	21	7	13	33

Standard practice for these lucerne stands is to make two hay cuts per year (spring), followed by an early summer seed production phase. The lucerne may also be grazed in the following autumn. Thus it is likely that total annual N_2 fixation could be 2-3 times that in the above table. Taking a conservative approach (2x) we calculate that N_2 fixation in irrigated lucerne in this region must average >300 kg N/ha. However, this value does not include possible contributions in lucerne root N. For sequentially harvested lucerne Kelner et al. (1997) multiplied shoot N fixed by 1.59, which would provide a mean of 477 kg N fixed/ha/yr for our study. Clearly further work would be required to validate these extrapolations Nitrate concentrations in the surface soils were very low 0.8-3.3 ug N/g soil, possibly reflecting leaching on these shallow soils. Uptake of soil NO_3^- by lucerne can be approximated by calculating the difference between N_2 fixed and total shoot N, this ranged from 19 to 181 kg N/ha suggesting that at some sites NO_3^- utilisation was significant. Further investigations would be required to ascertain if this was coming from depth in the soil. The importance of lucerne in retrieving leached NO_3^- is not known, but in this region of Australia much NO_3^- may be denitrified in these flood irrigation systems.

Conclusions

The ^{15}N natural abundance technique was successfully applied at 18 of the 20 sites. N_2-fixation in standing dry matter prior to the second hay cut ranged from 73-243 kg N/ha, averaging 148 kg N/ha. Dependence on N_2fixation (33-90%) did not correlate with leaf nitrate reductase activity. N_2fixation 'efficiency' ranged from 13-33 kg N fixed/t shoot dry matter. Total annual N_2 fixation in these irrigated lucerne systems, taking into account annual productivity and possible contributions in lucerne roots, might average >400 kg N/ha, placing them amongst the higher N_2fixing agro-ecosystems in the world

www.adelaide.edu.au
contact: Murray Unkovich
phone: (00) 0000 0000
email: murray.unkovich@adelaide.edu.au
http://www.adelaide.edu.au/directory/murray.unkovich

References: Kelner D, Vessey K, Entz MH (1997) The nitrogen dynamics of 1-, 2- and 3-year stands of alfalfa in a cropping system. *Agriculture, Ecosystems and Environment* 64, 1-10.

Acknowledgements: This work was funded by The Crawford Fund for International Agricultural Research, The Chinese Ministry of Science and Technology, and The Australian Department of Education Science and Technology

Han FangHu, **Shen Yuying**, Wang Xi, Zhou Shaoping, Yang Jing, Geng Liying. (2009) Soil Nitrogen Mineralization in Alfalfa Pasture (Chinese with English abstract), Acta Prataculturae Sinica 18（2）11-17

Yang ZW, Shen YY, Xie TL. (2009) Effect of Biological Nitrogen Fixation Efficiency in Soybean under Different Levels of Nitrogen Supply (Chinese with English abstract), Acta Bot Boreali Occident Sinica 29（3）：574-579

Yang ZW, **Shen YY**, Xie TL. Effect of Biological Nitrogen Fixation Efficiency in Soybean under Different Levels of Nitrogen Supply (Chinese with English abstract), Acta Bot Boreali Occident Sinica, 2009 (3):

Yang HM, Unkovich M. Wang XZ. **McNeill AM**, (2011) Nitrogen fixation in irrigated lucerne hay and seed production systems in South Australia Biology and Fertility of Soils 47, 377-385

ZOU Yali , **SHEN Yuying, UNKOVICH Murray**,**HAN Fanghu**,GAO Chongyue ,Temperature and moisture effects on soil nitrogen mineralization of 3- and 8-year lucerne. Proceedings of the 2nd China-Japan-Korea international grassland conference, 2006, Lanzhou, China.

Wang Xianzhi, Shen Yuying, Xie Tianling, **Murray Unkovich**. Tillage systems and biological nitrogen fixation of soybean (Glycine max). In: Multifunctional Grasslands in a Changing World Proceedings of the 1st Joint Meeting of International Grassland Congress and the International Rangeland Congress, 2008, Hohhot, China. p391

Unkovich M. Yang HM, McNeill AM, Wang XZ. Nitrogen fixation in irrigated lucerne (Medicago sativa) systems assessed using 15N natural abundance In: Multifunctional Grasslands in a Changing World Proceedings of the 1st Joint Meeting of International Grassland Congress and the International Rangeland Congress, 2008, Hohhot, China. Vol 1 p335

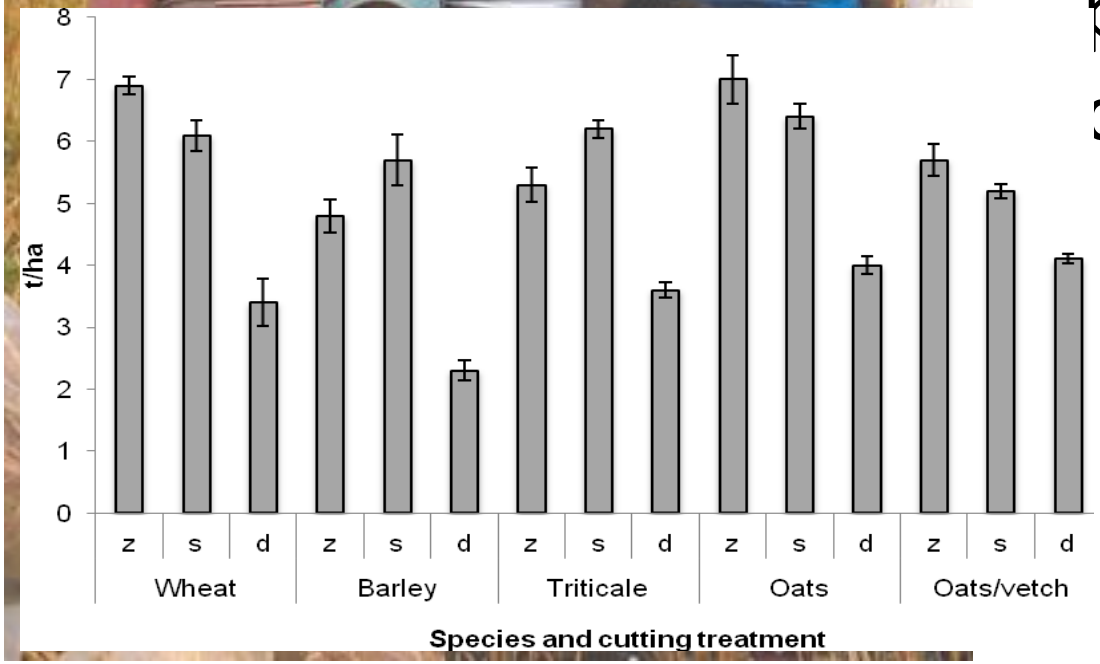
Han FH, YY Shen. N mineralization in soil from 5- and 9-year lucerne stands on the Loess Plateau, In: Multifunctional Grasslands in a Changing World Proceedings of the 1st Joint Meeting of International Grassland Congress and the International Rangeland Congress, 2008, Hohhot, China.

LPS/2006/119:Integrated crop and dairy systems in Tibet Autonomous Region, PR China

Final report: http://aciar.gov.au/publication/FR2014-04

Improved welfare, nutrition and productivity of cattle in Tibet; Options for forage in Australian systems

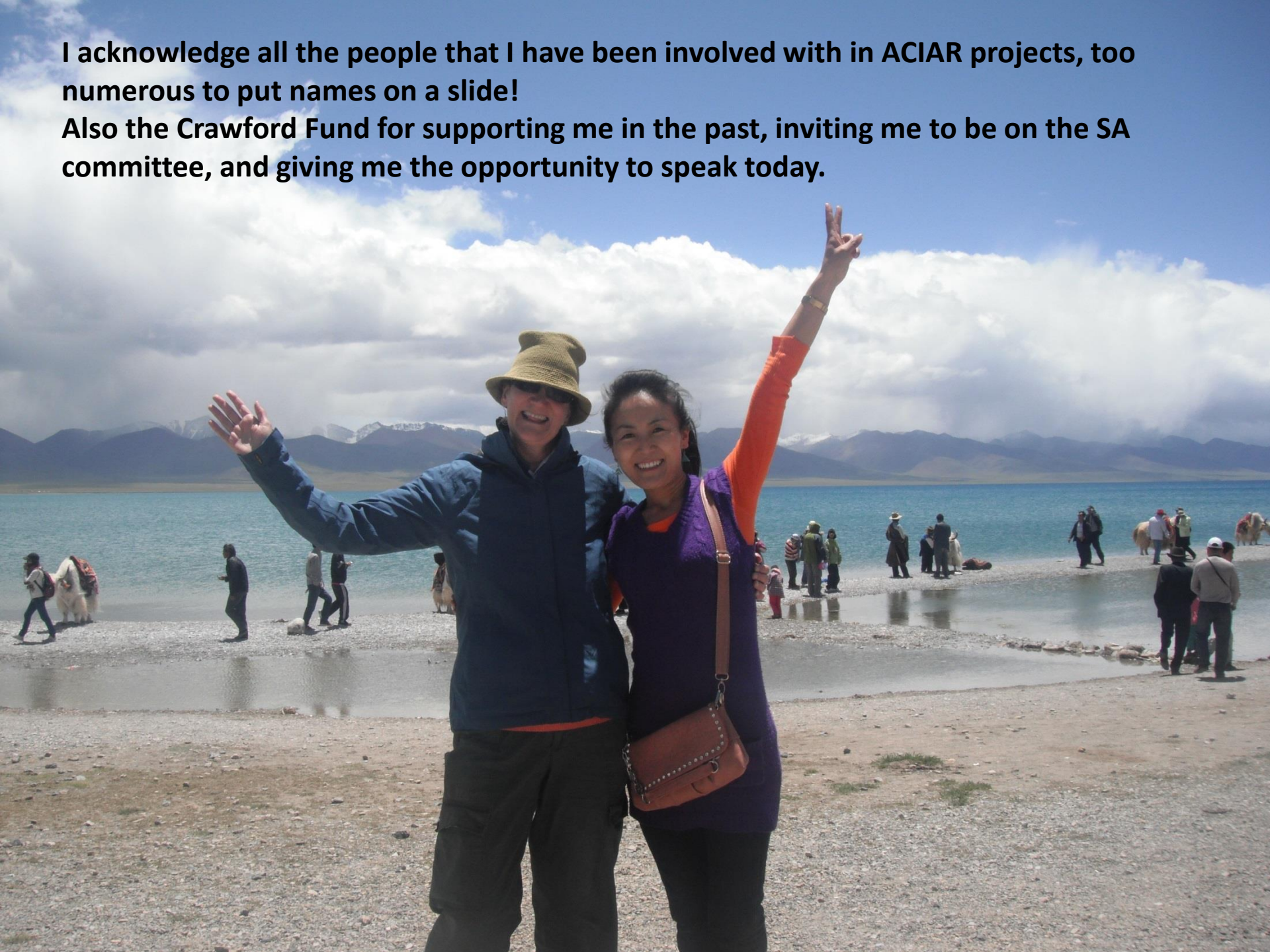
ACIAR John Allwright Fellows & Charles Sturt Uni Masters Graduates: Xiangba Zhuoga and Wang Li



Bonnie Flohr
UA graduate and
AYAD - the ACIAR project enabled her to explore the potential for grazing cereals in Tibet

UA graduates taking their agronomy training and experiences to a different environment ……

… becoming familiar with the industry base….
socio-economic modelling (CAEG Tibet Model).


I acknowledge all the people that I have been involved with in ACIAR projects, too numerous to put names on a slide!
Also the Crawford Fund for supporting me in the past, inviting me to be on the SA committee, and giving me the opportunity to speak today.