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NEWSLETTER
VOLUME 25: NUMBER 2, 2010

I hope you enjoy this issue of the newsletter – it is once again packed with lots of interesting and topical items. Part two of Dr Yin Chan's article "Increasing soil organic carbon of agricultural land" can be found on page 2. People are more and more interested in pasture cropping and on page 7 there is a practical and useful article on how pasture cropping might be incorporated into current farming systems by Geoff Millar and Warwick Badgery from Industry & Investment Orange.

Given that this year is the 25th year of our organisation, I have been re-reading past conference proceedings and newsletters. In the process I have found a number of papers which are particularly relevant or topical today so over the year I will be reprinting these papers in upcoming editions of the newsletter. The first of these papers is on page 13 "The Greenhouse Effect on Grassland Production" which first appeared in the 5th Conference Proceedings in 1990. The author Dr Roger Gifford has also added his thoughts on the topic today in "How has the story developed in 20 years since 1990" on page 19.

We are still progressing with our upgrade of the website so don't forget to check out the site (www.grasslandnsw.com.au). Recently an events calendar has been added to the page, so members will be able to see upcoming events at a glance for the month. If you have events that should be added to the calendar please let Linda Ayres (linda.ayres@industry.nsw.gov.au) know. The newsletter will also be getting an update next edition so look out for the exciting changes.

Lastly I hope to see many of you at the conference at Dubbo in July.

Cheers
Carol Harris, Editor

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Increasing Soil Organic Carbon of Agricultural Land – Part 2

Dr Yin Chan, Industry & Investment NSW

Management practices that reduce soil organic carbon

Some management practices, such as fallowing, cultivation, stubble burning or removal and overgrazing can reduce SOC by reducing inputs to the soil, increasing the decomposition of soil organic materials, or both.

Cultivation: Cultivation operations can expose SOC and increase losses by decomposition and erosion. Historically, excessive cultivation using inappropriate implements resulted in soils being 'over-worked', and the consequent loss of SOC has caused many land degradation problems such as erosion and soil structural decline.

Fallowing: In the past, keeping the soil bare was a common practice. Fallowing was maintained by repeated cultivation for weed control. SOC declines rapidly under fallowing because of the increased decomposition of organic matter due to the cultivation operations as well as the higher soil moisture conditions prevailing in the fallowed soils.

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Management practices that increase soil organic carbon

There are a wide range of management options and farming practices that can increase SOC levels by either increasing inputs or decreasing losses, e.g. stubble retention (Table 2). Inputs can also be increased by direct additions of organic materials, composts, manure and other recycled organic materials.

Practices leading to increased productivity of crops & pastures: In theory, any management practice that can increase production from an area of land should lead to increased SOC storage because of the increase in carbon inputs. Farmers are familiar with practices such as fertiliser application, improved rotations, improved cultivars and irrigation which can lead to large yield increases. Productivity increases can also be achieved by crop intensification practices such as double cropping, opportunity cropping and multiple cropping. However, it should be noted that some of the yield increasing practices involve the use of fertilisers and irrigation water which require large energy consumption and therefore increase carbon dioxide emission.

Conservation farming – This is rapidly gaining worldwide acceptance as a farming practice to improve soil and water conservation. In cropping cultivation is either reduced (reduced tillage) or completely eliminated (no-tillage) and stubble (crop residue) is retained. Reduced tillage reduces carbon losses (from both reduced cultivation and reduced fossil fuel usage) and stubble retention increases carbon inputs to the soil; both of these lead to SOC increases.

Use of organic amendments – These are manure, plant debris, composts and biosolids from sewage which are applied to agricultural soils. They are all high in organic carbon and therefore represent additional carbon inputs to the system. Some of these recycled organics also contain a high plant nutrient content and can act as organic fertilisers, reducing the use of inorganic fertiliser. They are important for organic farming systems.

Table 2 Management practices that can increase soil organic levels of agricultural soils

Management category	Management practices to increase soil carbon
Crop Management	Soil fertility enhancement Better rotation Erosion control Irrigation
Conservation tillage	Stubble retention Reduced tillage No-tillage
Pasture management	Fertiliser management Grazing management Earthworm introduction Irrigation Improved grass species Introduction of legumes Sown pasture Introduction of perennial pasture
Organic amendments	Animal manure Green manure Recycled organics

Some results from the Wagga Wagga long-term trial

In Wagga Wagga, a trial commenced in 1979 to examine crop yield and soil health (including soil carbon) under a range of cultivation and stubble management practices as well as rotations. After 20 years of monitoring, the results show that under continuous wheat cropping using the traditional practice of stubble burning and cultivation (3 scarifications), SOC was lost at the rate of nearly 400 kg/ha/yr. From the long-term trial results, the impact of different management practices can be estimated. For instance, no-tillage helped to save 169 kg C/ha/yr compared to traditional tillage, whereas stubble retention helped to save 108 kg C/ha/yr compared to stubble burnt. A crop/pasture rotation sequestered more carbon than continuous cropping. The most C conserving system was wheat/sub clover pasture (1:1) with the wheat under no-till and stubble retention, where SOC was increasing at a rate of 185 kg C/ha/yr. These long-term trial results highlight the importance of management practices in determining the SOC level and show that by using the right management practices we can turn a farm from a C source to a C sink.

Farming systems to increase soil organic carbon

The improved management options (Table 2) are all proven practices that may be readily incorporated into existing farming systems to improve agronomic performance, conserve water and reduce erosion. They can also result in higher crop yields. Increased SOC results from a greater return of organic matter into the soil in the form of stubble and root matter (stubble retention), and reduced losses from cultivation and runoff. Therefore, the adoption of farming systems that can increase SOC is a win-win situation. In addition to mitigating climate change, systems that increase SOC are also more productive, more profitable and more sustainable.

However, the effectiveness of a particular management practice in increasing soil carbon is site specific and dependent on local factors such as climate, soil types and management skill. In soil carbon sequestration, as we are interested only in the net carbon change, simple low-energy options such as conservation farming, grazing management and better rotation are particularly attractive.

Role of pasture in farming systems – current research project

In southern NSW, pasture is an integral component of farming systems. In the pasture/crop rotation system, the pasture helps to restore nitrogen fertility and soil structure. However, there is little information on the ability of the different pastures and the effect of management of the pasture on the soil carbon levels. A new project has been started to fill in this knowledge gap. Soil carbon levels of different pasture treatments from two long-term trials in Wagga Wagga and additional paired sites across the region will be used to compare soil carbon levels for a range of pasture types and pasture management. The comparisons will include different pastures (annual vs. perennial; native vs. sown) and different pasture management practices (grazing and nutrient management). From the results, soil carbon models will be developed to predict soil carbon sequestration under different pastures in different parts of the region over time.

Increasing soil organic carbon of agricultural land is an Industry & Investment NSW Primefact (No 735) and been reprinted in part in this newsletter with the permission of the author. Part one of this article was published in Volume 25
Number 1 of the Grassland Society of NSW newsletter in 2010.

Want to learn more about the potential to store carbon in the soil under pastures?

Dr Yin Chan has just released a booklet called "*A farmer's guide to increasing soil organic carbon under pastures*".

According to Dr Yin Chan the publication will better inform farmers of the facts about soil carbon in agriculture so they can make sense of the many, but often confusing claims appearing in the media. The booklet includes basic information on soil carbon and provides a practical guide to soil carbon under pasture for farmers who want to increase their soil carbon levels.

Copies of *A farmers guide to increasing soil organic carbon under pastures* are available at www.dpi.nsw.gov.au/info/carbon-farmers-guide or from your nearest Industry & Investment NSW office.

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Greater Taree
CITY COUNCIL

Does pasture cropping fit into my farm?

G.D. Millar and W.B. Badgery, Industry & Investment NSW, Orange.

Since its conception in the 1990's in central NSW, pasture cropping has evolved into various forms as it has been used by farmers away from its initial area of development. To help avoid confusion, we have defined the three major forms of pasture cropping systems (Badgery and Millar 2009) as:

Pasture cropping (PC) – winter cereal crops are sown into summer active (C_4) perennial pasture (such as Redgrass or Warrego grass), usually after the first frost. This activity is done primarily for grain production with weed control when moisture appropriate.

Perennial intercropping (PI) – similar approach to pasture cropping but pastures are predominately temperate, such as lucerne in a degraded/weedy form.

Advanced sowing/no kill cropping (AS)– dry sowing of winter cereal with discs into pastures of varying types, before autumn rain and with no herbicide. This activity is done to improve feed quantity and quality.

To help determine whether these systems offer appropriate options for farmers, NSW Industry and Investment researchers have developed a checklist for pasture cropping systems. This checklist includes rainfall distribution, pasture species present, paddock history and management objectives. While pasture cropping systems are promoted as low input, low risk farming systems, producers need to be aware that the following checklist needs to be addressed before embarking on a successful pasture cropping system.

Rainfall distribution

Pasture cropping systems were developed in Central NSW where monthly rainfall distribution is even. These systems utilize rain as it falls, so if summer fallows are required for winter cereal crop production, then crop production is likely to fail more regularly and pasture cropping systems will not perform as well as conventional cropping systems. However, if the soil has a low soil moisture holding capacity (for example sandy soils), pasture cropping systems may be appropriate as conventional cropping is unlikely to store any more moisture.

Pasture species present

PC utilizes the complementary growth patterns of a summer growing pasture with a winter growing cereal, minimizing the competition between the pasture and the crop. Summer active or C_4 pastures are predominately native pastures, and include Redgrass, Warrego grass, Kangaroo grass, and Windmill grasses, or the sown subtropical grasses Gatton panic, and Rhodes grass.

PI involves sowing a winter active cereal into a C_3 or temperate pasture such as the introduced lucerne and phalaris, or native Wallaby grass. These species will compete with the sown crop for both nutrients and soil moisture when the crop is actively growing. The more degraded the temperate pasture (such a low plant density or low biomass), there will be less competition between the cereal and the pasture, and PI may be successful. However, as the temperate pasture becomes more degraded, weed control becomes increasingly important.

Because AS is essentially dry-sowing an annual grass into a pasture, if the selected paddock has a high annual grass content, then AS will not be successful because of the competition from the already present annual grasses. If there are no annual species present, AS may provide additional feed providing rainfall is effective post-sowing.

Paddock history

Fertilizer input history and overall soil fertility play important roles in the economic success of pasture cropping systems.

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On paddocks with high input history and good soil fertility, pasture cropping systems can be profitable with low inputs. However, repeated low input cropping does run the risk of “mining” the soil resources, with the continued success of such systems in subsequent years unknown.

On paddocks with low input history, as is often the case with native pastures, cereal performance is closely related to soil nitrogen. The majority of the N used in crop growth is from N mineralized from previous plant and crop residues, which occurs at the greatest rate over summer. Summer active grasses will use nitrogen that mineralizes over this period, and even with increased fertilizer levels there is often not sufficient soil N leached to depth, which is where moisture is often used from in the later stages of crop growth, for optimum growth. The end result is decreased crop yields in pasture cropping systems compared to conventional crops.

Management objectives

Management objectives (production and Natural Resource Management - NRM elements) need to be clearly defined to help decide when pasture cropping systems are more appropriate than conventional cropping or other pasture management techniques. In some situations profit and NRM objectives may be complementary, but in others there may be a trade-offs between short-term profitability and longer-term NRM objectives that are difficult to economically quantify.

If economic grain production is an objective, appropriate nutrition and weed control are essential, especially as degraded pastures often have a large weed population. Because of the lack of a planned summer fallow, opportunity grain production is an option, and may be best suited to a grazier wanting to do some cropping, than a for a full-time grain producer. Because of the lack of a planned summer fallow in PC and PI, the decision to plant a crop or not can be made quite late in the “sowing window”, without the economic costs of fallow preparation and loss of usable forage. However, this is not the case of AS, as the cereal is dry-sown before the autumn break.

If increasing the amount of forage available with minimal soil and ground cover disturbance is a management objective, then pasture cropping systems may provide an option. However, if the pasture already has a dominant annual grass population, pasture cropping systems will not be successful. Research has shown no detrimental effects of pasture cropping systems on Redgrass pasture and lucerne production, but to be economically successful, this forage needs to be efficiently utilized.

Do pasture cropping systems have a role in regenerating pastures? The research evidence to date is inconclusive,

but there have been no negative effects on C4 perennial grass recruitment. However, appropriate grazing management has been shown to be effective systems in rejuvenating perennial pastures.

How often should I pasture crop? Continual low input pasture cropping will lead to "mining" of the soil resources. While research has shown that continuous PC or PI can be successful, continual cropping does run the risk of cereal-borne diseases affecting grain yields. Farmers who wish to undertake pasture cropping systems on their farms need to evaluate where the activity should take place as part of a long-term farm plan and paddock rotation.

References

Badgery WB and Millar GD (2009) Pasture cropping. Primefact 875, New South Wales Department of Primary Industries, Orange. http://www.dpi.nsw.gov.au/agriculture/field/pastures/management/production-management/pasture-cropping

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Guidelines for robotic milking

Moving into an automatic milking system (AMS) will be much easier from now on, with the release of FutureDairy's Management Guidelines for pasture-based AMS farms.

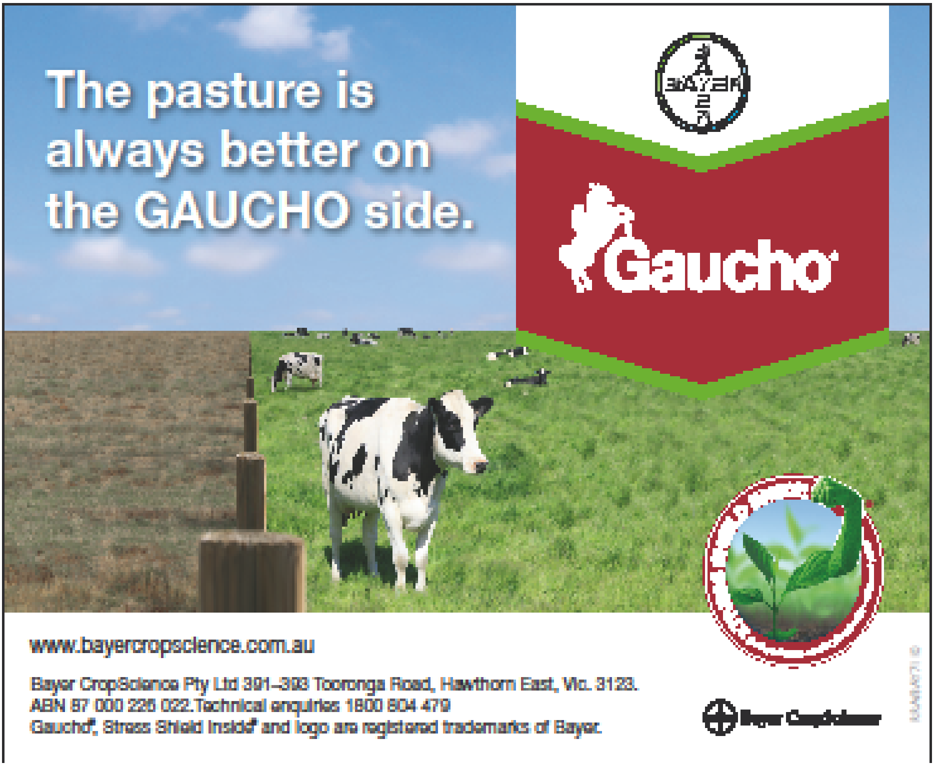
Dr Kendra Kerrisk, who leads FutureDairy's automatic milking program, said the switch to robotic milking has the potential to dramatically improve labour and lifestyle but it does involve some changes to the management system.

"The guidelines provide the practical information needed to adapt a dairy management system to suit an AMS," said Dr Kerrisk.

Dairy farmers can be confident that following the Guidelines will work, as they are based on both scientific research and experience under commercial conditions.

The independent research, carried out by Dr Kerrisk and her team at the AMS Research Farm at Camden, NSW, has shown that an AMS operating under commercial conditions can achieve efficient pasture utilisation, which is the key to on-going profitability for Australian dairy farms.

The AMS Guidelines can be downloaded from the web: www.futuredairy.com.au. For more information, contact Dr Kendra Kerrisk 02 4636 6327.



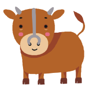
Australian Society of Animal Production

28th Biennial Conference

'Livestock production in a changing environment'

University of New England, Armidale NSW

July 11-15 2010



For more information - www.asap.asn.au/asap28/

Would you prefer to receive an electronic version of the newsletter?

Members of the Society now have the option of receiving their newsletter in electronic form – members who elect to take this option will get an email alert announcing that the newsletter is available at the website plus a link to the newsletter.

To receive your newsletter this way, please email your email address to the Secretary at secretary@grasslandnsw.com.au

A printed newsletter will continue to be sent to members who do not wish to take up this option.

Grassland Society of NSW - Conference Update

The 2010 conference to be held in Dubbo in July will focus on "*Adapting mixed farms to future environments*". The conference is to be held over two days, 28 and 29th July at the Dubbo RSL Club.

The first day will showcase practical experiences of landholders who have increased profitability as well as making environmental improvements on their properties.

A number of day tours including information on prime lamb marketing, integrating live stock and cropping, forage shrubs, animal behaviour & livestock management and genetic variation in methane emission in cattle will also be given.

The second day will provide technical and useful information on the impacts of climate change on pasture & livestock productivity, increasing soil organic carbon under pastures as well as understanding regional patterns in soil carbon. In addition, a number of presentations will look at the management of prolonged drought & extreme climatic events, new pasture varieties, diet quality and precision sheep management.

Further information can be found on the NSW Grassland website http://grasslandnsw.com.au or contacting conference organisers cathy.waters@industry.nsw.gov.au or kathi.hertel@industry.nsw.gov.au

NOTICE OF ANNUAL GENERAL MEETING OF THE GRASSLAND SOCIETY OF NSW

Date: Tuesday, 27 July at 6.30pm
Venue: Dubbo RSL Club
Corner of Wingewarra and Brisbane Streets, Dubbo

Editors Note: The following article by Dr Roger Gifford has been reprinted from the Grassland Society of NSW 5TH Annual Conference Proceedings from 1990 (Queanbeyan). Given the predicted impact 'climate change' will have on pasture production I thought that it was well worth revisiting this article. Dr Gifford has also kindly added an addendum to the original article giving his perspective of the last 20 years.

The Greenhouse Effect on Grassland Production

Roger Gifford, CSIRO Division of Plant Industry, Canberra

This paper examines likely global atmospheric changes, and their relative magnitude and certainties; then the most probable effect these will have on plant production; and finally, the possible end result on agricultural, and particularly grassland production.

Global Changes

Several billion years of vegetation growth has caused at least a 10-fold reduction in atmospheric CO_2 level, and concurrently has increased O_2 from zero to the current level of about 21%. Agriculture started about 10 000 years ago, soon after CO_2 concentration began to increase from 200 ppm to about 300 ppm during the last glacial retreat. Before industrialisation commenced in the 19th century, atmospheric CO_2 concentration was about 280 ppm. Following the razing of 15-20% of the world's forests and the large scale use of fossil fuels, it has increased by 25% to over 350 ppm. Over the last decade, CO_2 concentration increased by about 0.5% pa. and is accelerating as the rate of increase in fossil fuel increases.

Global average temperature is expected to increase with CO_2 and other greenhouse gases calculations show that the “plant-effective” temperature (i.e. above the base temperature for growth) should be increasing at a rate of 0.2 – 0.3% pa. However, in any specific region, greenhouse-dependent temperature change is as yet unpredictable, and even in terms of the global average an increasing trend attributable to greenhouse gases effects is not yet unequivocably detectable.

Rainfall is predicted using models to increase by 0.04 – 0.1% pa as CO_2 and the other trace gases increase. As with temperature, it is unlikely that rainfall increases will uniform across all regions.

To summarise, CO_2 increases should be in the order of 0.5% pa and fairly uniform over the globe. Concomitant temperature and rainfall changes are likely to be about one half and one fifth, respectively, of the CO_2 rate increase, in terms of
their plant-effective ranges and highly variable. However, a problem in predicting the future greenhouse effect is that, by the time temperature and rainfall have changed sufficiently to be discernible, CO_2 concentration will be much higher than it is now, and therefore prediction equations will have to be modified. Also, another confounding factor is the interaction between vegetation changes and consequent climate changes.

Although not accurate enough for specific regions, prediction equations for a future global warming and increased rainfall, as CO_2 equivalents rise, are however, supported by past palaeo-climate correlations. As temperature rose, so, the geologic records shows did rainfall and continental run-off.

But in terms of predicting future effects on grassland production, it should be pointed out that the amount known about the impact of CO_2, temperature and rainfall on grassland production ranks in reverse order to the magnitude and certainty of these changes. That is, we know much about how field productivity responds to rainfall, something about response to temperature, and very little about the responsiveness to CO_2.

Effect of global atmospheric changes on plant and grasslands production

Direct effect of CO_2

The acquisition of C by plants for photosynthetic conversion into carbohydrates, involves three major compromises:

Whenever CO_2 enters a plant through leaf stomata, water escapes.

- The enzyme Rubisco which fixes CO_2 into organic matter requires N; at least 25% of the plants N is tied up in Rubisco. Since most of the non-fertiliser N in soil was fixed using energy from the oxidation created by Rubisco in the first place, this is a high price to pay on top of inherently inefficient C-acquisition system in the biosphere.

- Rubisco is unable to distinguish between its key substrate, CO_2 and its key photosynthetic product O_2. The reaction that Rubisco catalyses with O_2 and produces phospoglycolate, a metabolite which is converted via photorespiration into a usable form with a concomitant loss of some of the recently fixed CO_2.

Now that man is realising some of the accumulated reduced C back into the atmosphere as CO_2 derived from fossil fuels, we should expect in principle that the increasing CO_2 has the potential to increase biosphere production by alleviating the constraints imposed by these three compromises.

Although the attainment of this potential may not be easy – e.g. in gradually evolving to cope with diminishing CO_2 and increasing O_2 over several billion years plants may now be unable to respond to the sudden increased CO_2 resulting from man's activities – I believe that already many field and crop plants should be responding positively to increasing atmospheric CO_2.

Interaction between increased CO_2 and other growth-limiting external factors

Although the short term effect of CO_2 on plant photosynthesis has been well explained by research this is inadequate to accurately predict long-term grassland yield responses to increased CO_2 for several reasons including:

- Possible altered competitive relationships with weeds, pests and diseases
- Other limiting factors such as water, radiation, soil fertility etc
- Possible effects on forage quality
- Climate change itself may affect responses to CO_2

However, although many agronomists and ecologists doubt that most crops, pastures and natural vegetation would exhibit long term responses to increased to CO_2, because other factors like water, fertility etc, are limiting, my own research indicates that in many cases efficient water use of scarce resources is limited by carbon availability to plants. The reasons are complex, but may involve the operation of CO_2 – sensitive plant processes other than photosynthesis.

One of these is the interaction of CO_2 with ethylene formation by plant tissues. For example, high concentrations (e.g. 10% by volume) of CO_2 can be used to improve fruit storage, probably by inhibiting ethylene production by the fruit. But even modest increases above the normal ambient level of CO_2 can effect ethylene production and action. Another possibility is that modest CO_2 increases may reduce respiration rates in plants, a phenomenon which has been measured in a number of experiments.

Interaction between increased CO_2 and temperature

There have been studies in various experiments with conflicting results suggesting three possibilities:

- Above a threshold temperature, the higher the temperature the greater the CO_2 responsiveness of growth. Below the threshold temperature, growth is inhibited by high CO_2.

- There is no response to increasing CO_2 below and above the broad rather flattened optimum range for photosynthesis.

- Increasing CO_2 increases growth across the whole normal range of crop growth temperatures.

The last option seems to be the most probable, as there is no obvious physiological explanation for negative effects of high CO_2 at low temperatures; in fact, there is evidence to the contrary.

Interaction between increased CO_2 and water

Experiments have shown that because CO_2 gain is accompanied by water loss (through stomata), water use efficiency for dry matter production is improved. However, quantification of this in field situations is complicated by the current inability to measure the feedbacks impinging on field transpiration affected by higher CO_2.

Other factors

Other growth limiting factors such as N and P may also interact with increased CO_2 in affecting plant growth. Research suggests that increased CO_2 may increase N use efficiency but extrapolation in the field situation is unclear. It could even be that a higher C:N ratio in plant residues could reduce N available for plant growth.

Nodulation of legumes is stimulated by high CO_2, so symbiotic N-fixation should increase. There are conflicting results from research into the effects of interaction between CO_2 and P on plant growth.

Concluding comments

From the material reviewed it is clear that we are not yet in a good position to construct accurate models of the combined impact of CO_2 concentration, temperature and rainfall change on pasture production. Even if the climate modellers were able to tell us regional specifics about how climate will change we could not use them accurately for production prediction. However, what I have said suggests that in general pasture production productivity is most likely to increase as a function of anticipated global change.

In those areas where pasture production occurs principally in cool months, moister warmer conditions will increase growth. Any summer growth of perennial pastures will tend to be increased by high CO_2 concentrations because the CO_2 stimulation is relatively strong in warmer drier conditions. Tropical pastures dominated by C_4 grasses are unlikely to benefit from elevated CO_2 except where they are growing with extreme drought. Where tropical legumes are significant to tropical pasture production it is expected that the elevated CO_2 will increase nitrogen fixation.

There is also the possibility of negative effects on dry matter production. For annual pastures the acceleration of the attainment of maturity owing to warmer conditions will have a tendency to reduce yield owing to quicker transition to flowering. If it turns out that the incidence of drought increases in some places then of course that will be a negative component to productivity. To some extent we can anticipate that the increased production will probably be at a lower protein content and this may be undesirable in some circumstances. Also to the extent that increased production leads to larger amounts of standing dry grass there may be a greater tendency for wild fires especially if summers are hotter.

The repercussions of these multifarious changes on trade and trade patterns are, I suggest, well beyond anybody's capability to predict. However, my suspicion is that any trade-related effects that do follow will be swamped by the repercussions of socio-political forces such as the massive political reorganisations and turmoil that we can expect in Europe over the next few decades and the burgeoning world population growth.

Finally, to summarise, a main thrust of this paper has been to demonstrate that direct CO_2 effects are likely to be of considerable significance to the agricultural impact of global atmospheric change, at least as great as that of average temperature and rainfall change. However, whereas the increase in CO_2 is uniform, smooth, steady and relatively predictable, change in temperature and rainfall patterns and other climatic attributes is unlikely to be uniform, smooth and steady and is as yet unpredictable in any given region. While overall warmer wetter conditions are expected, at any one location drier and even cooler conditions and different seasonal patterns are possible. Therefore surprises, and not necessarily welcome ones, may be in store for agricultural systems superimposed on the potential productivity gains from the carbon dioxide fertilising effect.

New members @ Committee Meeting of 21 April 2010

Daniel Lindsay (Armidale); Brendan Burley (Tullamore);
Jason Conn (Wellington); Josh White (Bathurst); Brendan Knight (Bathurst);
Paul Sales (Berry); and Mitch Highett (Orange)

ProGibb® SG Smartgrass Stimulates Winter Pasture Growth

"ProGibb SG has been proven to stimulate pasture growth and increase dry matter per hectare with no loss of feed quality" says Charles McClintock, Sumitomo Chemical Australia Regional Manager for Southern New South Wales.

Winter months are normally a time of reduced pasture growth due to cooler ambient and soil temperatures. In many regions of Australia, winter pasture availability determines enterprise stocking rates and hence whole farm profitability.

"One of the major benefits with using ProGibb SG on your pasture will be the reduced need for supplementary feeding due to increased pasture growth" says Mr. McClintock.

ProGibb SG is an easy to handle low dose granule formulation that can be applied by boom-sprayers. It is organically certified which means no withholding period and no residues in either meat or milk.

For further information on ProGibb SG contact your rural merchant or visit the Sumitomo Chemical Australia website: www.sumitomo-chem.com.au
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How has the story developed in the 20 years since 1990?

Roger Gifford, CSIRO Division of Plant Industry, Canberra

Now, in 2010, atmospheric CO_2 concentration has risen to 392ppm and its annual increase is still accelerating despite all the political and economic activities, such as the Kyoto Protocol, various emission trading schemes, tree planting projects, renewable liquid fuel production from plants etc. It is now increasing by over 2 ppm per year (more than 0.6%pa). The concentration of CO_2 in the atmosphere is globally uniform owing to thorough atmospheric mixing. Over the same 20 years the trend-line of global average temperatures has increased unequivocally by almost 0.4C – or almost 0.02C per year – which, on a global average basis, amounts to an increase of about 0.2% pa of plant-effective temperature above a 5C base-temperature for plant growth, as previously predicted. But that average smears across a lot of variability from place to place. For rainfall, the climate model prediction of increased global average rainfall is still not unequivocally discernable, largely because of the paucity of annual rainfall data over the ocean that covers 70% of the globe. But even over land the rainfall data trend analyses are equivocal. Whether or not the long dry period in SE Australia over the past decade can be attributed to a regional expression of greenhouse effect climate change is unclear; it is consistent with some computer models but not others.

It remains true that knowledge about the effects of CO_2, temperature and rainfall on plant productivity are in reverse order to the global average rates of greenhouse gas-driven change of atmospheric CO_2 (0.6%pa), plant-effective temperature (0.2%pa) and rainfall (probably not yet detectably different from zero). However, it is not only the averages of environmental variables that determine plant productivity but also the characteristics of the extremes of their variability. Whereas atmospheric CO_2 shows almost no variability, temperature does, and rainfall very much more so. While it is clear that gradual warming of the annual average temperature is decreasing the frequency of frosts and increasing the frequency of very hot days, it is not yet possible to discern whether the statistical patterns of variability around the means in either temperature or rainfall is changing with greenhouse effect warming.

The basic understanding of the CO_2 fertilising effect has not changed, even though numerous outdoor CO_2 enrichment experiments using free air CO_2 enrichment (FACE) technology and CO_2 enriched temperature gradient chambers in the field have now been undertaken since 1990. These field technologies have largely confirmed, with some exceptions, that findings from growth chambers and greenhouses can be transferred to the field in the short term. Unfortunately, translating that understanding into long term effects on plant productivity in the field remains problematic. This is partly because research funding is rarely on a long term basis, so we are stuck with short term experiments of just a few years. That does not allow for understanding the development over time of any feedbacks in the whole ecosystem that may weaken or enhance the initial stimulatory effect of elevated CO_2 on plant growth over the first few years. Potential phenomena that could weaken growth responses to elevated CO_2 over time include feedbacks within the plant (physiological acclimation), changes of species composition of pastures and crops (e.g. more weeds), and feedbacks within the soil – both chemical (e.g. nutrient cycling) and microbiological (e.g. mycorrhizal or pathogen changes). For example, a standard response of plant tissues, especially leaves, to growth in elevated CO_2 concentration is a reduction in protein content. This can in turn be expressed as an increase in the C:N ratio of plant litter that enters the soil. In the short term, as litter with a higher C:N ratio decomposes it tends to incorporate more soil-N into the humus formed thereby reducing the availability of N to plants resulting in a feedback reduction or elimination of the initial CO_2 stimulation of plant growth. In the longer term, however, it can be expected (as a reasonable hypothesis) that an increased C:N ratio of partly decomposed plant litter will foster N-fixation from the atmosphere by free-living N-fixing organisms, thereby redressing the whole system C:N balance and permitting

the primary positive CO_2 response to be expressed. Certainly, it continues to be found that symbiotic nitrogen fixation by N-fixing plants is fostered by elevated CO_2 as long as enough phosphate is available. Hence in pastures a longer term feedback is likely to be that elevated CO_2 concentration fosters the N-fixing legume component of pastures thereby making the pasture N-content stay balanced with the enhanced potential for carbon accumulation. However, it is difficult to prove that that is occurring.

One uncertainty that was being actively investigated in 1990 has been resolved. The observations being reported around that time that elevated CO_2 concentration can directly inhibit plant respiration is no longer supported.

The false observations were probably the result of experimental artefacts, which has since been ironed out.

Studies using CO_2 enriched temperature gradient chambers in SE Australia have shown that when both temperature and CO_2 are elevated for phalaris pasture there is increased growth by the warming in winter and by the CO_2 especially in spring and early summer but not winter. With regard to the perplexing evidence of inhibition of plant growth by elevated CO_2, such reports still emerge from time to time. Recently it has been reported that the tropical tuber crop, cassava, has substantially reduced growth when the atmospheric CO_2 concentration is increased. It is difficult to conceive of a mechanism for this result except as an artefact of the experiment. It was shown in the 1980s that commercial bottled carbon dioxide supplies sometimes have trace amounts of the gas ethylene in them. Ethylene is a powerful naturally occurring plant growth substance that can inhibit plant growth especially of some species. Thus one possibility for such inhibitions of growth in CO_2 enrichment experiments is that the CO_2 supply was not routinely cleaned of trace ethylene. Authors do not always report what they did in that respect.

In summary, despite a further 20 years of experimentation, our ability to accurately predict the combined impact of increasing CO_2, temperature and change in rainfall on pasture production is still not good. The problems confronting progress include the need for long term experiments well beyond the time frame of research grants, the multiplicity of variables interacting with those three climate change variables to determine a response, and the high cost of controlling CO_2 and temperature in the field. A more recent emphasis is the potential reduction in mineral element concentrations in plant dry matter when grown in elevated CO_2 and any associated change in nutritive value to the grazing animal.

From the president

Dry weather, particularly in the northern part of the State, is causing concern, but hopes are still high for an improved cropping and pasture season just around the corner. Society members from various localities report that while some livestock prices are currently favorable, cereal products are way too low and costs of production are on the rise yet again. A continuing story for most primary producers, emphasizing the need to stay on top of developments, and not lose sight of maintaining sound, agricultural practice.

This newsletter contains more detail on the conference to be held at Dubbo from 28th. – 29th. July. The AGM will take place on the evening of the 27th and all are welcome to attend and ask questions of your committee. Cathy Waters and Kathi Hertel along with their committee are putting in a great effort to produce what is shaping up as a very stimulating program. Please put the date into the diary and support your Society and benefit from hearing and seeing the latest developments in pasture and animal technologies.

One of our long term committee members, Haydn Lloyd Davies has retired from the state committee, owing to what Haydn describes as his "lack of mobility". I can assure all members that there was no lack of mental agility, but we of course had to respect Haydn's wishes, with considerable regret and many thanks for his outstanding contribution to the Society. Haydn, a life member, served three terms as president, eight years as editor and was on the committee since 1993. This has been a unique contribution to the Society and in no small way the reason for the success of the Society, when other similar organizations have declined in recent years. On behalf of all members I wish Haydn and Helen, who supported Haydn so well over the years, all best wishes for the future.

I do hope to see many members in Dubbo in July, and in the meantime a wetter May and June.

Mick Duncan

THE GRASSLAND SOCIETY OF NSW INC.

A unique blend of people with a common interest in developing our most important resource – our Grasslands

The Grassland Society of NSW was formed in March 1985. The Society now has approx. 500 members and associates, 75% of whom are farmers and graziers. The balance are agricultural scientists, farm advisers, consultants, and executives or representatives of organisations concerned with fertilisers, seeds, chemicals and machinery.

The aims of the Society are to advance the investigation of problems affecting grassland husbandry and to encourage the adoption into practice of results of research and practical experience. The Society holds an annual conference, publishes a quarterly newsletter, holds field days, and is establishing regional branches throughout the State.

Membership is open to any person or company interested in grassland management and the aims of the Society.

OFFICE BEARERS OF THE GRASSLAND SOCIETY OF NSW – 2009-2010

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Subscription for 12 months (July to June) is $50. This entitles you to copies of the Newsletters and a copy of the Annual Conference Proceedings.

For more information, please contact the Society's Secretary, Janelle Witschi (telephone: 02 6369 0011).

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The Secretary
Grassland Society of NSW
PO Box 471
Orange NSW 2800

Email: secretary@grasslandnsw.com.au