



Department of  
Primary Industries



# final report

Project code: B.PBE.0035  
Prepared by: SP Boschma  
New South Wales Department of Primary Industries  
Date published: September 2014  
ISBN: 9781740362658

PUBLISHED BY  
Meat & Livestock Australia Limited  
Locked Bag 991  
NORTH SYDNEY NSW 2059

## **Climatic range and condition of pasture grasses and legumes world-wide – International Grasslands Congress 2013 survey**

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

This publication is published by Meat & Livestock Australia Limited ABN 39 081 678 364 (MLA). Care is taken to ensure the accuracy of the information contained in this publication. However MLA cannot accept responsibility for the accuracy or completeness of the information or opinions contained in the publication. You should make your own enquiries before making decisions concerning your interests. Reproduction in whole or in part of this publication is prohibited without prior written consent of MLA.

## **Abstract**

Grassland and agricultural ecosystems cover large areas of Australia and the globe, providing livelihoods and food for millions of people world-wide. It is anticipated that the world population will continue to increase. This increase and the shift in diet to more animal derived foods will increase the pressure on our pasture/grassland systems. The 22nd International Grasslands Congress was held in Sydney in 2013. This meeting of the world's grassland and pasture scientists provided an opportunity to survey delegates to determine the current productivity of the world's largest and most productive pastures/grasslands. The objective of this MLA funded project was to develop the survey. In September 2013 a link to the survey in SurveyMonkey®, consisting of five questions, was distributed to congress delegates by email. Two hundred and sixty responses were received, and data checking and validation have commenced. The information in this survey will be useful for scientists to identify species successes and failures, foreshadow adaptation issues and establish international partnerships, which in turn will benefit Australian red meat producers.

## **Executive summary**

Grassland and agricultural ecosystems cover large areas of Australia and the globe, providing livelihoods and food for millions of people. The demands on our pasture/grassland systems will increase with the anticipated increase in world population and increase dietary demand for animal derived products. Reports suggest that current production systems are impacting negatively on our pastures and grasslands.

In 1970 at the 11th International Grasslands Congress (IGC), held in Brisbane, delegates were surveyed to determine the distribution of pasture grasses and legumes used across the world. The 22nd IGC was held in Sydney in 2013. This was an opportune time to again survey delegates on the productivity of the world's largest and most productive pastures/grasslands. A project was conducted, funded by MLA to develop this survey.

The survey was created in SurveyMonkey® and consisted of questions regarding:

1. Name and details of the person entering the information and details of the region addressed in the survey;
2. Name, characteristics and condition of the three most productive (herbage quantity) pasture/grassland types used by producers;
3. Name, characteristics and condition of the three largest pasture/grassland types;
4. Germplasm resources; and
5. Urgent pasture/grassland research priorities for the region addressed in the survey.

The survey link was distributed to IGC delegates by email. Two hundred and sixty responses were received and data checking and validation have commenced.

The information in this survey will be useful for scientists to identify species successes and failures, foreshadow adaptation issues and establish international partnerships, which in turn will benefit Australian red meat producers.

## Table of contents

<b>1</b>	<b>Background .....</b>	<b>4</b>
<b>2</b>	<b>Project objectives .....</b>	<b>5</b>
<b>3</b>	<b>Methodology .....</b>	<b>5</b>
<b>4</b>	<b>Results .....</b>	<b>5</b>
4.1	Survey content.....	5
4.2	Data checking .....	5
4.3	Preliminary results.....	6
<b>5</b>	<b>Discussion.....</b>	<b>11</b>
<b>6</b>	<b>Conclusion .....</b>	<b>12</b>
<b>7</b>	<b>Acknowledgements .....</b>	<b>12</b>
<b>8</b>	<b>Appendix 1 – Questionnaire .....</b>	<b>13</b>
<b>9</b>	<b>Bibliography .....</b>	<b>19</b>

# 1 Background

Grasslands are one of the largest ecosystems in the world and are the dominant ecosystem in many countries (White *et al.* 2000; World Resources Institute 2000), including Australia (Bell *et al.* 2014). On a global basis, grasslands cover 52.5 million km<sup>2</sup> or 41% of the land surface excluding Greenland and Antarctica (World Resources Institute 2000). Grasslands across the globe are multifunctional, providing a wide range of goods and services including food, fibre, forage, fuel and energy, medicines, carbon and water storage, watershed protection for many major river systems, wildlife habitat and environmental and genetic resources conservation (e.g. World Resources Institute 2000; Akiyama and Kawamura 2007; Kemp and Michalk 2007; Soussana *et al.* 2013). About a third of the world's livestock rely on grasslands and a quarter of the world's population live on or around them (Kemp and Michalk 2013).

Agricultural ecosystems (agroecosystems) cover 28% of the land surface (excluding Antarctica and Greenland) and attribute \$1.3 trillion in food, feed and fibre products and 99% of calories consumed by humans (Wood *et al.* 2000; World Resources Institute 2000). Globally, about 70% of agroecosystems are pasture and the remaining 30% are croplands (World Resources Institute 2000).

In Australia, agricultural enterprises cover 52% of land area (includes grassland and agroecosystems) and almost 94% of this agricultural area is non-cropping (Australian Bureau of Statistics 2012), that is, consists primarily of sown or native pastures, which underpin the red meat, wool and dairy industries.

To date global food production has maintained pace with population growth (World Resources Institute 2000), however, it has been estimated that by 2050 the amount of food produced will need to increase 70–100% to feed the world's population which is increasing about 80 million annually (World Resources Institute 2000; Burney *et al.* 2010 cited in Smith *et al.* 2013). In addition, there has been a global shift in human diet to more animal derived products (Oenema *et al.* 2013). These increases will place increasing pressure on pastures and grasslands world-wide and needs to be considered in terms of environmental issues and long term sustainability. Our current food production systems are considered to be impacting negatively on the environment resulting in biodiversity loss, climate change, land degradation and water pollution (e.g. World Resources Institute 2000; Hopkins and Holz 2005; Steinfeld *et al.* 2006; 2010 cited in Oenema *et al.* 2013; Galloway *et al.* 2008 cited in Oenema *et al.* 2013). To ensure long-term global food security, productivity will need to increase using environmentally sound practices and improved resource use efficiency (Tilman *et al.* 2002; Godfray *et al.* 2010 cited in Oenema *et al.* 2013).

International Grassland Congresses (IGCs) have been the leading global event for pasture and grassland scientists to meet and exchange current research, new concepts and ideas for over 80 years. During the 11th IGC held in Australia in 1970, delegates were asked to complete a survey. The survey consisted of a number of questions relating to grass and legume species used in pastures and their use. This information was used to determine the distribution of pasture grasses and legumes used across the world (Russell and Webb 1976). In 2013, almost 45 years later, the world's pasture and grassland experts met in Sydney, Australia for the 22nd IGC. This was an opportune time to conduct another survey to capture information on important pastures and grasslands across the globe, assess their condition, and identify factors limiting their productivity. The 2013 IGC theme "revitalising grasslands to sustain our communities" fit the purpose of the survey and was supported by the President of the Organising Committee, Prof David Kemp.

## **2 Project objectives**

The objective of this project was to develop a survey for distribution to delegates attending the 2013 IGC in Sydney.

The purpose of the survey was to determine the global distribution of pasture/grassland species, and review their productivity, condition and issues affecting productivity.

## **3 Methodology**

There are many definitions of grassland and pasture. In this project the term 'pasture/grassland' was used and included all forage systems used by grazing livestock such as pastures, forages, rangelands and grasslands.

A survey was developed in conjunction with Prof David Kemp, international pasture and grassland scientist and President of the 2013 IGC Organising Committee. The challenge was to word the questions simply, yet as generic as possibly since terminology varies across the globe and English was not the first language of many of the delegates. The intention was also to provide a comprehensive list of possible answers to minimise use of the 'other' category. For example, livestock types consisted of 13 categories ranging from beef cattle to yak and camel.

The survey questions and format were developed in Microsoft Word then created as an online survey in SurveyMonkey®. The draft survey was tested internally then distributed to the IGC committee and a number of pasture scientists for feedback. The survey was modified in line with their feedback. Once finalised the survey link was distributed to delegates on the IGC mailing list in early September. The link remained active for about 8 weeks closing in early November 2013. The data were downloaded to Microsoft Excel.

## **4 Results**

### **4.1 Survey content**

The survey consisted of five questions most consisting of multiple components:

1. Name and details of the person entering the information and details of the region addressed in the survey;
2. Name, characteristics and condition of the three most productive (herbage quantity) pasture/grassland types used by producers;
3. Name, characteristics and condition of the three largest pasture/grassland types;
4. Germplasm resources; and
5. Urgent pasture/grassland research priorities for the region addressed in the survey.

The full survey in Microsoft Word format is presented in Appendix 1.

### **4.2 Data checking**

A total of 260 survey responses were received. Data checking and validation have commenced which include:

1. Correcting typographical errors

2. Adjusting data so that single names and terms are used (e.g. lucerne vs. alfalfa and Brazil vs. Brasil),
3. Addition of missing or supplementary data (e.g. latitudes, longitudes and altitudes), and
4. Deletion of incomplete or unusable data.

Once the data have been checked, analyses by a biometrician will commence.

### 4.3 Preliminary results

Summary of the invalidated data indicate that the respondents were from 44 countries with most from Australia (35), United States of America (20), New Zealand (16) and Brazil (10). Over 97% of survey respondents provided their details (name, institution, etc.), 94% provided annual average rainfall and the majority (76–88%) provided estimates of average maximum summer and minimum winter temperatures.

The name of the pasture types and the dominant species was highly variable and will require significant checking and summarising before analysis.

#### 4.3.1 Most productive pastures

The majority of the most productive pastures/grasslands were sown (76%) while the remainder were equally native or natural/naturalised. Interestingly only 40 and 37% of the second and third most productive pastures/grasslands respectively were sown and 28 and 37% respectively were native.

The three most productive pastures/grasslands commonly (54–57%) covered less than 25% of the landscape, while about a quarter (20–30%) covered 25–50% of the landscape. Only a minority (less than 10%) covered more than 75% of the landscape.

Beef and dairy cattle, and meat sheep were the most common livestock that grazed the three most productive pastures/grasslands (Table 4.1). Horses, wool sheep and other wild animals each grazed more than 20% of the most productive pastures. Wild animals included a range of ungulates (e.g. deer, bison, elk, buffalo, antelope, moose, alpaca, lama and hogs), also hares, kangaroos, wallabies and flightless birds.

**Table 4.1. Animals that graze the three most productive pastures/grasslands as a percentage (%) of responses. Respondents were able to select multiple responses and only those with more than >10% are listed.**

Grazing animal	Most productive	2nd most productive	3rd most productive	Average
Beef cattle	67	73	53	64
Dairy cattle	62	40	25	42
Meat sheep	44	44	37	42
Horses	25	27	25	26
Wool sheep	21	27	28	25
Other wild animals	22	20	22	21
Meat goats	14	18	14	15

In addition to grazing livestock, the most and second most productive pastures/grasslands were also commonly used for hay and silage production (Table 4.2). The third most productive pasture was also commonly used for amenity,

conservation, recreational purposes, landscape restoration or conserved as hay (Table 4.2).

**Table 4.2. The most common alternative uses for the three most productive pastures/grasslands as a percentage (%) of responses. Respondents were able to select multiple responses.**

	Most productive	2nd most productive	3rd most productive
Hay	61	43	25
Silage	49	24	19
Dual purpose	23	18	14
Amenity/Conservation/Recreation	17	21	28
Landscape restoration	14	16	25

Respondents considered their most productive pastures/grasslands to be in average (49%) to good condition (34%), based predominantly on pasture production (76%) (Table 4.3). The second most productive pastures/grasslands were considered to be in average condition (58%) with less than 20% considered to be in good condition based mostly on pasture production. Condition of the third most productive pasture was more variable with 24% of respondents considering them to be in good condition and 40 and 36% to be of average and poor condition respectively (Table 4.3).

Overgrazing and declining fertility were the main issues affecting productivity of the two most productive pasture/grasslands world-wide (more than 46% of respondents for each issue). These issues, also weeds and poor income from livestock were the main issues (>39%) affecting productivity of the third most productive pastures/grasslands (Table 4.4). Over one third of respondents said that poor income from livestock, loss of valuable species, climate variability and cost of resowing were production issues. Interestingly soil acidity was an issue for 15–20% of respondents with climate change believed to be a productivity issue by 16–18% of respondents. ‘Other’ issues not included in the list included grazing management (lack of knowledge, incorrect timing, under grazing and poor utilisation), legumes (lack of legume, poor regeneration, residual herbicides), input costs coupled with low costs of return, incursion of introduced species, disease and insect pests.

**Table 4.3. Productive pasture/grassland condition and basis for rating as a proportion (%) of the total number of respondents. Respondents were able to select multiple responses for basis of rating.**

	Most productive	2nd most productive	3rd most productive	Average
<i>Pasture grassland condition</i>				
Poor	17	23	36	25
Average	49	58	40	49
Good	34	19	24	26
<i>Basis for condition rating</i>				
Ground cover	44	40	38	41
Botanical composition or change	46	46	47	46
Pasture production	76	63	54	64



**Table 4.4. Main issues affecting productivity of the most productive pastures/grasslands. Respondents were able to select multiple responses.**

	Most productive	2nd most productive	3rd most productive	Average
Over grazing	49	47	46	47
Declining fertility	51	46	37	45
Weeds	48	43	37	43
Poor income from livestock	34	39	39	37
Loss of valuable species	38	38	28	35
Climate variability	39	36	28	34
Cost of resowing	39	31	32	34
Soil acidity	20	20	15	18
Climate change	18	16	16	17
Urbanisation	22	12	10	15
Water erosion	12	12	13	12
No suitable replacement species	9	12	11	11
Not possible to replant species	4	8	14	9
Soil salinity	8	7	7	7
Wind erosion	5	5	8	6
Others	13	10	10	11

#### 4.3.2 Pastures that cover the largest area

The three pasture/grasslands that covered the largest area were predominantly sown [39 (largest) – 55% (third largest)] and about a quarter were natural/naturalised. The largest pastures/grasslands typically covered 25–75% of the landscape (61% of respondents) while the majority of the second and third largest pastures/grasslands covered less than 25% of the landscape (55 and 80% of respondents respectively). The relationship between the most productive and largest pastures/grasslands have not been identified at this stage.

These dominant pastures/grasslands are most commonly grazed by beef cattle (25–28% of respondents). Meat sheep and dairy cattle (14–17%), and wool sheep and horses (9–11%) also graze these areas (Table 4.5). In conjunction with grazing, about a third of the largest pastures/grasslands are also used for hay production and a fifth for silage production (Table 4.6).

**Table 4.5. Animals that graze the three largest pastures/grasslands as a percentage (%) of responses. Respondents were able to select multiple responses and only those with more than 10% are listed.**

	Largest area	2nd largest area	3rd largest area	Average
Beef cattle	25	28	28	27
Meat sheep	15	16	17	16
Dairy cattle	16	17	14	15
Wool sheep	9	10	11	10
Horses	10	10	9	10

**Table 4.6. Uses other than grazing that occur on the three largest pastures/grasslands. Respondents were able to select multiple responses.**

	Largest area	2nd largest area	3rd largest area	Average
Hay	30	30	33	31
Silage	21	21	21	21
Amenity, conservation area, recreation	20	14	16	17
Dual purpose	15	20	13	16
Landscape restoration	12	12	13	12
Other	3	4	4	3

Respondents indicated that 38–40% of their largest pasture/grasslands are in either poor or average condition. This was based almost equally on ground cover, botanical composition and productively (Table 4.7). The second and third largest pastures/grasslands were considered to be in average condition (59 and 50% of respondents respectively), based predominantly on pasture condition (Table 4.7).

The main issues affecting productivity of the three largest pastures/grasslands were the same as those affecting the most productive pastures/grasslands (i.e. over grazing and declining fertility; about 50% of respondents) (Table 4.8). Other significant issues identified included weeds (42%), loss of valuable species (35%), cost of resowing (34%), climate variability (33%) and poor income from livestock (32%) (Table 4.8).

**Table 4.7. Largest pasture/grassland condition and basis for rating as a proportion (%) of the total number of respondents. Respondents were able to select multiple responses for basis of condition rating.**

	Largest area	2nd largest area	3rd largest area	Average
<i>Pasture grassland condition</i>				
Poor	38	24	24	29
Average	40	59	50	50
Good	22	18	26	22
<i>Basis for condition rating</i>				
Ground cover	30	60	46	45
Botanical composition or change	31	81	60	57
Pasture production	37	96	81	71

**Table 4.8. The main issues affecting the productivity of the largest pastures/grasslands as a proportion (%) of respondent responses. Respondents were able to select multiple responses.**

	Largest area	2nd largest area	3rd largest area	Average
Over grazing	62	45	43	50
Declining fertility	48	46	47	47
Weeds	51	43	33	42
Loss of valuable species	41	39	24	35
Cost of resowing	37	34	31	34
Climate variability	42	31	26	33

B.PBE.0035 - Climatic range and condition of pasture grasses and legumes world-wide – IGC 2013 survey

Poor income from livestock	39	32	26	32
Soil acidity	23	18	20	20
Climate change	21	14	11	15
No suitable replacement species	17	11	13	13
Water erosion	14	13	13	13
Urbanisation	19	8	9	12
Not possible to replant species	15	8	9	11
Others	11	6	4	7
Soil salinity	8	6	6	7
Wind erosion	9	5	5	6

### 4.3.3 Germplasm sources

Of the 137 responses received for this question, the majority of pasture/grassland germplasm that has been tested was sourced from other countries (70% of respondents) and about half of the respondents indicated that ecotypes/cultivars have been selected or bred from material collected in their country, with about 40% collected from the region. Respondents indicated that the most common providers of new germplasm are commercial companies (79% of respondents) and their own organisation (42%). A small proportion of material is provided by United States Department of Agriculture (14%) and by Germplasm Resources Information Network (10%). Other sources include Government research institutes, international research partners, and organisations such as the International Center for Tropical Agriculture and National Institute of Agricultural Technology.

### 4.3.4 Research priorities

The most urgent research priorities were considered to be management of livestock production systems (66% of respondents) and soil-plant-animal inter-relationships (63%). More than 40% of the respondents felt that species development, weed management, management of integrated crop/livestock systems and climate change adaptation were priority areas for research (Table 4.9).

**Table 4.9. Priority areas for pasture/grassland research presented as a proportion (%) of responses. Respondents were able to select multiple responses.**

Priority area for research	%
Management of livestock production systems	66
Soil-plant-animal inter-relationships, including nutrient and fertiliser management	63
Pasture, forage and grassland species development	46
Management of weeds	46
Managing integrated crop / livestock systems	43
Climate change adaptation	42
Forage quality	38
Environmental services from grasslands	38
Reclamation of degraded grasslands	35
Water use efficiency of pastures	34
Conservation of grasslands	29
Management of pasture plant pests and diseases	25
Forage conservation	24
Pasture seed production	23
Applications of information technology and remote sensing (precision pastures)	22
Understanding wider social and political drivers	19

Integrating livestock production with mining, forestry, urbanisation and alternative land uses	17
Meeting market and community needs	15
Harmful products in pastures	12
Turf and amenity grasslands	4

---

## 5 Discussion

An online survey such as SurveyMonkey® was effective for creating and distributing the survey to an international audience. It allowed easy access for respondents to complete the survey at a time and location of their choosing.

It can be difficult to achieve a good balance between simplicity and collecting data with sufficient detail to make conclusions. People are commonly time-poor so a simple task may be completed but a difficult or long one is less likely, unless the objective is important to them personally. Despite efforts to keep the survey simple it was possibly still somewhat difficult to interpret and the detail requested may have deterred some people from completing it, or resulted in incomplete answers. This could possibly be overcome by further ‘testing’ before distributing to the wider audience, or lower expectations for data collected.

Providing all possible answers as options assists data compilation and reduces the amount of manual adjustment required. There are three areas that would have benefitted from more options:

1. The grazing livestock section in two of the questions contained 13 options. The option ‘other domestic livestock’ was selected by up to 7% of respondents and included multiple entries of deer, alpaca and llama. Buffalo, pig and donkey were also listed.
2. Four germplasm sources were provided and almost 20% of respondents used the ‘other’ option. More specificity for commercial companies, or inclusion of ‘e.g. seed companies’ may have assisted respondents and the addition of options that covered international research partners and agencies such as Government research institutes, international research partners, and organisations such as the International Center for Tropical Agriculture and National Institute of Agricultural Technology would also have been beneficial.
3. Addition of species lists would have been of great benefit. A list which consisted of 300 species was constructed to use in the survey but it would not have been comprehensive or representative of dominant species from all countries, especially those with native or naturalised pastures/grasslands. When the survey was being created in SurveyMonkey®, discussions also highlighted that the program was not able to autocomplete from lists (i.e., shorten lists as letters were entered reducing the number of possible entries). If this had been possible respondents could have quickly identified whether their species was or was not listed. However, inability to do this would have slowed and possibly irritated respondents when an error showed indicating that their species was not listed. For this reason manual entry of all species was used.

Data checking and validation has commenced. Once it has been completed analyses will be conducted and the results published in a scientific journal.

Preliminary inspection of the data indicate that scientists world-wide think that the most productive pasture/grasslands are currently in average condition, with over

grazing and declining fertility being the main issues affecting their productivity. The forecast increase in population (World Resources Institute 2000) and increase in animal derived foods in the human diet (Oenema *et al.* 2013) will apply additional pressure to pastures/grasslands. Over 60% of respondents felt that management of livestock systems was a priority area of research and was supported by grazing management as a common issue affecting productivity of the largest and most productive pastures/grasslands world-wide. The other commonly identified priority was for research into the inter-relationships between the soil, plants and grazing animals. A holistic system approach is required. The future depends on understanding, managing and sustaining our pastures and grasslands.

Once analysed these findings will be of use to scientists to identify species successes and failures, foreshadow adaptation issues and establish international partnerships, which in turn will benefit Australian red meat producers.

## **6 Conclusion**

The 2013 IGC provided a unique opportunity to survey scientists with knowledge of pastures/grasslands from across the world on the productivity and condition of grasslands they are most familiar with. A survey using SurveyMonkey® consisting of five questions was developed and distributed online to IGC delegates and 260 responses were received. Data checking and validation has commenced.

## **7 Acknowledgements**

The support and assistance provided by Prof David Kemp and Suzanne Priest developing the survey is greatly appreciated.

## 8 Appendix 1 – Questionnaire

### Condition of Grassland Species used in the Worlds Pasture and Grassland Systems

A survey for the 22nd International Grassland Congress

At the 11th IGC held in 1970, delegates were surveyed to determine which pasture species were commonly used across the globe. 40 years later there have been significant species developments and new issues affecting pasture and grassland condition and productivity, such as climate variability, climate change, declining research and declining terms-of-trade. This survey will update information on the important pasture species that are used in sown and permanent pastures and rate the condition of pastures and grasslands across the globe. This information will be compared with that collected 40 years ago and used to identify areas for future research and resource needs.

This survey has been developed by New South Wales Department of Primary Industries (Australia) with support from the 22nd International Grassland Congress Organising Committee and funding from Meat and Livestock Australia (MLA). Information collected will be collated and published in a scientific journal. The survey data will be stored by MLA. Personal details will not be distributed or published. If you wish to complete the survey for a second or more sites then please logon and do separate surveys.

Please enter your details (optional) in case we need to check any points you made and details of the region you are describing (essential, \*) in this survey so that we can identify it. Your personal details will not be distributed or published.

Name	
Institution	*
Address (include state / province / country)	
Email	
Region you are representing in this survey	*
Name of nearest large town or city	*

If you can, please complete any of the following additional details for the region you are describing in this survey to assist its identification.

Latitude	
Longitude	
Altitude (m)	
Average annual precipitation / rainfall (mm)	
Average number of frost-free days per year (days)	
Average typical minimum winter temperature (°C)	
Average typical maximum summer temperature (°C)	

Following are a series of questions for the three most productive pastures used by farmers and the three pasture types covering the largest area in your region. The pastures can be sown, native, natural or naturalised grassland and can include forages and shrubs, and any ecosystem used by grazing livestock. The words 'pasture' and 'grassland' are inter-changeable.

The first question asks you to rate the three most productive pastures / grassland types used in the region. In this survey we mean productive in terms of plant production useful for livestock production (more than for livestock survival). The second question asks you to rate the three pastures / grasslands that are the largest in area in the region. Some general questions then follow.

Please answer as much as you can for up to three pasture / grassland types.

**1. What three pasture / grassland types used by farmers produce the greatest quantity of herbage in the region?**

<i>Most productive</i>	<i>2nd most productive</i>	<i>3rd most productive</i>

a. What are the key species in this pasture / grassland?  
e.g. *Phalaris aquatica*, *Brachiaria* spp., *Leymus chinensis*


b. Is this pasture / grassland?

Sown	<input type="checkbox"/>	<input type="checkbox"/>
Native	<input type="checkbox"/>	<input type="checkbox"/>
Natural / naturalised	<input type="checkbox"/>	<input type="checkbox"/>

c. What area of the landscape in your region do you estimate this grassland covers?

<25%	<input type="checkbox"/>	<input type="checkbox"/>
25–50%	<input type="checkbox"/>	<input type="checkbox"/>
50–75%	<input type="checkbox"/>	<input type="checkbox"/>
>75%	<input type="checkbox"/>	<input type="checkbox"/>

d. What animals graze this pasture / grassland? (*tick all boxes that apply*)

Beef cattle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dairy cattle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Yaks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Meat sheep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wool sheep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dairy sheep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Meat goats	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cashmere / Angora goats	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dairy goats	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Camels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Horses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other domestic animals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Please specify	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wild animals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Please specify	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

e. What are the other uses for this pasture / grassland? (*tick all boxes that apply*)

Hay	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Silage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dual purpose e.g. seed / grain and grazing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B.PBE.0035 - Climatic range and condition of pasture grasses and legumes world-wide – IGC 2013 survey

Amenity, conservation area, recreation (e.g. horse riding)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Landscape restoration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other. Please specify	<input type="checkbox"/> _____	<input type="checkbox"/> _____	<input type="checkbox"/> _____

f. In your opinion, what is the general condition of this pasture / grassland relative to the potential production of palatable forage that could be achieved?

Poor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Average	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

g. Is your condition rating based on (tick all boxes that apply):

Ground cover	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Botanical composition or change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pasture production	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other. Please specify	<input type="checkbox"/> _____	<input type="checkbox"/> _____	<input type="checkbox"/> _____

h. What are the main issues affecting productivity of this pasture / grassland? (tick all boxes that apply)

Over grazing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Too many animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Declining fertility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Loss of valuable species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No suitable replacement species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Not possible to replant species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cost of resowing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Climate change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Climate variability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soil salinity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soil acidity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wind erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poor income from livestock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Urbanisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Others. Please specify	<input type="checkbox"/> _____	<input type="checkbox"/> _____	<input type="checkbox"/> _____

(opportunity to enter multiple)

(opportunity to enter multiple)

(opportunity to enter multiple)

You can answer for up to 3 pasture types

**2. What pasture / grassland types cover the largest area in your designated region?**

***Largest area***

***2nd largest***

***3rd largest***

Is this the same pasture as rated in a question above?

Most productive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
-----------------	--------------------------	--------------------------	--------------------------



B.PBE.0035 - Climatic range and condition of pasture grasses and legumes world-wide – IGC 2013 survey

- |                     |                          |                          |                          |
|---------------------|--------------------------|--------------------------|--------------------------|
| 2nd most productive | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3rd most productive | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

If the 3 most productive pasture / grassland types also cover the largest area, please go to Q3.

If any of 3 are not the most productive, please continue with Q2.

2a. What are the key species in this pasture / grassland? e.g. *Phalaris aquatica*, *Brachiaria* spp., *Leymus chinensis*

_____	_____	_____
_____	_____	_____
_____	_____	_____

b. Is this pasture / grassland?

- |                       |                          |                          |                          |
|-----------------------|--------------------------|--------------------------|--------------------------|
| Sown                  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Native                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Natural / naturalised | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

c. What area of the landscape in your region do you estimate this grassland covers?

- |        |                          |                          |                          |
|--------|--------------------------|--------------------------|--------------------------|
| <25%   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 25–50% | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 50–75% | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| >75%   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

d. What animals graze this pasture / grassland? (tick all boxes that apply)

- |                              |                                |                                |                                |
|------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Beef cattle                  | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Dairy cattle                 | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Yaks                         | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Meat sheep                   | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Wool sheep                   | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Dairy sheep                  | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Meat goats                   | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Cashmere / Angora goats      | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Dairy goats                  | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Camels                       | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Horses                       | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Other domestic animals.      | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Please specify               | <input type="checkbox"/> _____ | <input type="checkbox"/> _____ | <input type="checkbox"/> _____ |
| Wild animals. Please specify | <input type="checkbox"/> _____ | <input type="checkbox"/> _____ | <input type="checkbox"/> _____ |

e. What are the other uses for this pasture / grassland? (tick all boxes that apply)

- |  |                                |                                |                                |
|--|--------------------------------|--------------------------------|--------------------------------|
| Hay  | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Silage   | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Dual purpose e.g. seed / grain and grazing                 | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Amenity, conservation area, recreation (e.g. horse riding) | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Landscape restoration                                      | <input type="checkbox"/>       | <input type="checkbox"/>       | <input type="checkbox"/>       |
| Other. Please specify                                      | <input type="checkbox"/> _____ | <input type="checkbox"/> _____ | <input type="checkbox"/> _____ |

f. In your opinion, what is the general condition of this pasture / grassland relative to the potential production of palatable forage that could be achieved?

B.PBE.0035 - Climatic range and condition of pasture grasses and legumes world-wide – IGC 2013 survey

Poor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Average	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

g. Is your condition rating based on *(tick all boxes that apply)*:

Ground cover	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Botanical composition or change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pasture production	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other. Please specify	<input type="checkbox"/> _____	<input type="checkbox"/> _____	<input type="checkbox"/> _____

h. What are the main issues affecting productivity of this pasture / grassland? *(tick all boxes that apply)*

Over grazing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Too many animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Declining fertility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Loss of valuable species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No suitable replacement species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Not possible to replant species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cost of resowing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Climate change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Climate variability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soil salinity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soil acidity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wind erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water erosion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poor income from livestock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Urbanisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Others. Please specify	<input type="checkbox"/> _____	<input type="checkbox"/> _____	<input type="checkbox"/> _____
	<i>(opportunity to enter multiple)</i>	<i>(opportunity to enter multiple)</i>	<i>(opportunity to enter multiple)</i>

**3. Germplasm resources**

**a. What source are you getting new pasture / grassland material from?**

- Ecotypes / cultivars that have been selected / bred from material collected in the region
- Ecotypes / cultivars that have been selected / bred from material collected in the country
- Ecotypes / cultivars that have been selected / bred from material collected from other countries

**b. Who are the main organisations providing new material for your regional pastures / grasslands?**

- Your own organisation
- Material supplied by United States Department of Agriculture (USDA)
- Material supplied by Germplasm Resources Information Network (GRIN)
- New cultivars from commercial companies. Please specify \_\_\_\_\_ *(opportunity to enter multiple)*
- Other. Please specify \_\_\_\_\_ *(opportunity to enter multiple)*

**c. What new pasture / grassland species / cultivars have been tested and are either about to be or are now being used (last ten years) commercially in your region?**

*(List up to five new species)*

---

---

---

---

---

**4. What do you consider the most urgent pasture/grassland research priorities for your region?**

*(Tick as many as you wish)*

- Management of livestock production systems
- Managing integrated crop / livestock systems
- Applications of information technology and remote sensing (precision pastures)
- Forage quality
- Forage conservation
- Soil-plant-animal inter-relationships, including nutrient and fertiliser management
- Reclamation of degraded grasslands
- Environmental services from grasslands
- Climate change adaptation
- Water use efficiency of pastures
- Conservation of grasslands
- Pasture seed production
- Turf and amenity grasslands
- Meeting market and community needs
- Understanding wider social and political drivers
- Integrating livestock production with mining, forestry, urbanisation and alternative land uses
- Pasture, forage and grassland species development
- Management of pasture plant pests and diseases
- Management of weeds
- Harmful products in pastures

Thank you for completing this survey. We look forward to seeing you in Sydney, 15–19 September.

For further information contact:

Dr Suzanne Boschma  
NSW Department of Primary Industries  
Tamworth Agricultural Institute, 4 Marsden Park Road, Calala NSW 2340  
T : +61 2 6763 1202 | F : +61 2 6763 1222 | E : [suzanne.boschma@dpi.nsw.gov.au](mailto:suzanne.boschma@dpi.nsw.gov.au)

[Privacy statement...](#)

[Disclaimer...](#)

## 9 Bibliography

- Akiyama T, Kawamura K (2007) Grassland degradation in China: Methods of monitoring, management and restoration. *Grassland Science* **53**, 1–17.
- Australian Bureau of Statistics (2012) 'Year Book Australia – 2012.' (Australian Bureau of Statistics: Canberra)
- Bell LW, Hayes RC, Pembleton KG, Waters CM (2014) Opportunities and challenges in Australian grasslands: Pathways to achieve future sustainability and productivity imperatives. *Crop and Pasture Science* **65**, 489–507.
- Burney JA, Davis SJ, Lobell DB (2010) Greenhouse gas mitigation by agricultural intensification. *Proceedings of the National Academy of Sciences* **107**, 12052–12057.
- Hopkins A, Holz B (2006) Grassland for agriculture and nature conservation: production quality and multifunctionality. *Agronomy Research* **4**, 3–20.
- Kemp DR, Michalk DL (2007) Towards sustainable grassland and livestock management. *Journal of Agricultural Science* **145**, 543–564.
- Kemp DR, Michalk DL (2013) Revitalising Grasslands to Sustain our Communities. In 'Proceedings of the 22nd International Grassland Congress' (Eds DL Michalk, GD Millar, WB Badgery, KM Broadfoot) Preface. (NSW Department of Primary Industry: Orange)
- Oenema O, de Klein C, Alfaro M (2013) Does intensification of grassland and forage use lead to efficient, profitable and sustainable ecosystems? In 'Proceedings of the 22nd International Grassland Congress' (Eds DL Michalk, GD Millar, WB Badgery, KM Broadfoot) p56–66. (NSW Department of Primary Industry: Orange)
- Russell JS, Webb HR (1976) Climatic range of grasses and legumes used in pastures: Results of a survey conducted at the 11th International Grassland Congress. *Journal of the Australian Institute of Agricultural Science* **42**, 156–166.
- Smith J, Tarawali S, Grace D, Sones K (2013) Feeding the World in 2050: trade-offs, synergies and tough choices for the livestock sector. In 'Proceedings of the 22nd International Grassland Congress' (Eds DL Michalk, GD Millar, WB Badgery, KM Broadfoot) p1–9. (NSW Department of Primary Industry: Orange)
- Soussana JF, Barioni LG, Ari TB, Conant R, Gerber P, Havlik P, Ickowicz A, Howden M (2013) Managing grassland systems in a changing climate: the search for practical solutions. In 'Proceedings of the 22nd International Grassland Congress' (Eds DL Michalk, GD Millar, WB Badgery, KM Broadfoot) p10–27. (NSW Department of Primary Industry: Orange)
- Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M, de Haan C (2006) Livestock's long shadow: environmental issues and options. (Food and Agriculture Organization: Rome)
- Steinfeld H, Mooney H, Schneider F, Neville LE (Eds) (2010) Livestock in a changing landscape: Drivers, Consequences and Responses. (Island Press: Washington, DC)

Galloway JN, Townsend AR, Erisman JW, Bekunda M, Cai Z, Freney JR, Martinelli LA, Seitzinger SP, Sutton MA (2008) Transformation of the nitrogen cycle: Recent trends, questions, and potential solutions. *Science* **320**, 889–892.

Tilman D, Cassman KG, Matson PA, Naylor R, Polasky S (2002) Agricultural sustainability and intensive production practices. *Nature* **418**, 671–677.

Godfray HCJ, Beddington JR, Crute IR, Haddad L, Lawrence D, Muir JF, Pretty J, Robinson S, Thomas SM, Toulmin C (2010) Food Security: The Challenge of feeding 9 billion people. *Science* **327**, 812–818.

White R, Murray S, Rohweder M (2000) *Pilot Analysis of Global Ecosystems: Grassland Ecosystems*. (World Resources Institute: Washington, DC)

Wood S, Sebastian K, Scherr S (2000) *Pilot Analysis of Global Ecosystems: Agroecosystems*. (World Resources Institute: Washington, DC)

World Resources Institute (2000) *World Resources 2000–2001: People and Ecosystems: The Fraying Web of Life*. (World Resources Institute: Washington, DC)