Agricultural Land Classification Study - Walgett Shire

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NSW Agriculture

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Notes to Accompany Agricultural Land Classification Map

Contents

PREFACE **2**

1. INTRODUCTION **3**

2. AN OVERVIEW OF CLASSIFYING AGRICULTURAL LAND **4**

2.1 BACKGROUND 4
2.2 DESCRIPTION OF CLASSES 4
2.3 LAND THAT NEED NOT BE EVALUATED FOR AGRICULTURE 6
2.4 ASSUMPTIONS FOR CLASSIFICATION PROCESS 6
2.5 THE ROLE OF CURRENT LAND USE IN AGRICULTURAL LAND CLASSIFICATION 7

3 AGRICULTURAL LAND CLASSIFICATION METHODOLOGY **7**

3.1 LIMITATIONS OF WALGETT MAP SCALE 7
3.2 COLLECTION OF BACKGROUND DATA AND INFORMATION 7
3.3 AGRICULTURAL PRODUCTION IN WALGETT SHIRE RELATIVE TO SURROUNDING SHIRES 9
3.4 THE LAND SUITABILITY ASSESSMENT PROCESS 12
3.5 CREATING THE MAP 14

4. AGRICULTURAL LAND CLASSIFICATION **16**

4.1 THE EVALUATION OF RURAL LANDS IN WALGETT SHIRE 16
4.2 DESCRIPTION OF THE AGRICULTURAL LAND CLASSIFICATION CLASSES 19

REFERENCES **24**

APPENDICES **25**

APPENDIX 1 - YIELD DATA FOR SELECTED CROPS 25

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NOTE TO MAP USERS

The Walgett Shire Agricultural Land Classification map was produced for use at a scale of 1:100 000 it must not be used at a more detailed scale (for example 1:50 000).

The map should be interpreted in conjunction with the information contained within this report and Chapter 9 of the Rural Lands Evaluation Manual (Department of Planning, 1988)

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AGRICULTURAL LAND CLASSIFICATION STUDY

WALGETT SHIRE

TECHNICAL REPORT

PREFACE

The Walgett Agricultural Land Classification (ALC) Project was carried out with the assistance of the National Land and Water Audit (NLWA), a program of the Natural Heritage Trust. The Audit, initiated in 1998, had as one of its main themes, Australia's 'Vegetation Cover, Condition and Use'. New South Wales managed the implementation project for this theme; 'Native Vegetation mapping to support vegetation management in the low-rainfall cropping areas of Walgett Shire, NSW'.

NSW Agriculture's contribution to the implementation project was the preparation of an Agricultural Land Classification map for Walgett Shire. The Department's state-wide program of ALC mapping was considered by the NLWA project management team as an expedient method of building socio-economic parameters into native vegetation management. Other elements of the implementation project included protocols for upgrading the Murray Darling Basin woody-non woody vegetation mapping, improved vegetation mapping for Walgett and work on 1750 native vegetation data base modelling.

The NSW Agriculture component of the implementation project was managed by an internal team that involved input from agronomy, land classification, spatial information and policy specialists. The Walgett project has enabled the Department to further develop its agricultural land classification system through the use of more refined data sets. This outcome will have application to ALC mapping elsewhere in NSW. The assistance of the National Land and Water Audit in pursing this project is acknowledged.

1. INTRODUCTION

The Walgett Agricultural Land Classification Report applies to the Walgett Local Government Area. This report is produced to allow interpretation of the Walgett Agricultural Land Classification Map produced by Mr John Hindle, Scientific Officer (Land Use) NSW Agriculture in October 1999.

The map was compiled by NSW Agriculture to assist with the preparation of strategic land use plans. **It is inappropriate to use this map for property development at the farm level.** The map was produced at a scale of 1: 100 000 and must not be used at a more detailed scale (for example 1:50 000). The map provides a generalised interpretation of agricultural land suitability based on the landform, soil, vegetation, climatic, economic and social characteristics of the area. These characteristics were compared to the agronomic needs of agricultural enterprises typical for the area and lands ranked in accordance to their suitability for sustained agricultural production. In general terms, the greater the range of crops able to be produced economically, the higher the yields and the more reliable the production of a locality the higher the land class (class 1 being the best land class).

The agricultural land classification scheme used in this report is based on the system described in Chapter 9 of the *Rural Land Evaluation Manual* (Department of Planning 1988). However the land class definitions used in the manual are not entirely applicable to land uses in Walgett Shire, or for many western areas of the NSW wheat belt. Consequently the standard definitions have been modified in this report to reflect land use in these areas. The intent and much of the wording of the standard definitions is still reflected in the modified ones used for Walgett Shire and they serve the same purpose of prioritising land on the basis of its suitability for agriculture.

Because the land class definitions are not the same as those appearing in the *Rural Land Evaluation Manual* (RLEM) (Department of Planning, 1988), drawing direct parallels between this Walgett mapping study and those areas mapped under the standard system, should only be done with care.Despite the modifications to the land class definitions the agricultural land classification scheme is still based on a state-wide system, therefore it is possible for an area to be without some classes of agricultural lands. In the case of Walgett Shire there are no class 1 lands and class 2 lands are restricted to areas where irrigation is present and rainfall reliability is greatest. The delineation between class 3 and class 4 agricultural lands are subtle and rely as much on climatic variables as edaphic and landscape characteristics. Areas of class 5 lands have extreme limitations to agricultural production and are limited in extent.

The agricultural land classification classes have been delineated using field observations, topographic maps, an analysis of the relative yield and reliability of production for crops common to the north west of NSW, satellite imagery, soils data and vegetation information.

As detailed in Table 1, the study shows class 2 making up approximately 8 % of the study area. Class 3 lands are the dominant class in the Central Division, incorporating the majority of the dryland cropping areas, and making up some 33 % of Walgett Shire. The Western Division is characterised by a predominance of class 4 lands, which comprise in total some 56 % of the Shire. Class 5 lands are generally restricted to areas of very dense vegetation or

areas of particularly poor soils, they comprise only 1.2 % of the area.

Table 1: **Walgett Shire agricultural land classification classes: area and percentage of the Shire**

Agricultural Land Class	Area (ha)	% Shire
Class 2	176,000	7.9
Class 3	747,000	33.5
Class 4	1,260,000	56.4
Class 5	27,600	1.2
Other	22,722	1.0
Total	**2,233,322**	**100**

2. AN OVERVIEW OF CLASSIFYING AGRICULTURAL LAND

2.1 Background

Agricultural land classification is based on evaluating a limited set of biophysical, social and economic constraints that influence the use of land for agriculture. In general terms the fewer the constraints that are placed on the land, the greater its value for agriculture. The evaluation process enables the preparation of agricultural land classification maps that can be used for strategic planning including regional and local environmental planning instruments, regional economic development and natural resource management.

It is important to note that land in any given class will have a similar degree of limitation but not necessarily the same type of limitation. For example, an area may be placed into class 4 because of one significant limitation, such as high soil erosion hazard, or several minor limitations such as slope, stoniness, soil depth and distance to markets / handling facilities.

The evaluation of physical, social and economic constraints for agricultural production requires expertise in natural resource survey techniques as well as knowledge of sustainable agricultural systems. Officers from NSW Agriculture who undertake agricultural land classification have these skills. It must be recognised that the process of agricultural land classification relies upon interpretation of information by an expert and that the map marks a point in time reflecting current understanding of agricultural systems, infrastructure, and market and resource conditions.

The classification of land as suitable for a particular agricultural activity, for example cultivation, does not mean that NSW Agriculture recommends that these lands should be developed for this use, only that they are suitable for a particular use or enterprise. Other considerations (for example, nature conservation) may prevail making the land unsuitable for agricultural development.

2.2 Description of classes

Agricultural land classification maps place land into one of five classes according to its suitability for a wide range of agricultural activities. As mentioned in the introduction, Walgett Shire has been mapped using a system closely based on the Agricultural Land

Classification system as described in the RLEM. However, the standard definitions for Classes 2, 3 and 4 have been modified for use in Walgett Shire. The modifications differ from the standard definitions by removing references to crop-pasture rotations, and to the suitability of land for pasture improvement. In Walgett Shire, and in much of the western wheat belt, cropping sustainability is based much less on crop-pasture rotations and more on cropping frequency, fallow management, reduced tillage, stubble retention and crop rotation. The revised definitions refer to this and the distinction between Classes 2, 3 and 4 reflect the degree to which these management approaches are necessary to achieve sustainable cropping.

As much of the shire is, as far as slope and soil type is concerned, arable, the reliance on this criteria to distinguish between classes is reduced in the revised definitions. More emphasis is placed, particularly with regard to Class 4 land, on the influences of climate variability (and reduced effective rainfall) and distance to services and infrastructure.

The definitions for land classes used for the Walgett Shire study are listed below.

Class 1: Arable land suitable for intensive cropping where constraints to sustained high levels of agricultural production are minor or absent.

Class 2: Land suited for regular cultivation and suitable for a range of crops for incorporation into rotations. Land is also highly suited to grazing. It has a moderate to high overall suitability for agriculture with some environmental constraints which reduce overall level of production.

Class 3: Land suited to cropping but with increased reliance on conservation tillage and fallowing to reduce production risk. Good grazing land. Soil and/or climatic factors limit long term production to moderate levels.

Class 4: Land best suited to grazing. Cultivation of crops possible on capable soils, but associated with high production risk requiring fallow management and 'opportunity cropping'[1]. Production may be seasonally high however overall production level is low as a result of major environmental constraints.

Class 5: Land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which preclude land improvement.

For the purposes of comparison the standard RLEM definitions are listed below.

Class 1: Arable land suitable for intensive cropping where constraints to sustained high levels of agricultural production are minor or absent.

Class 2: Arable land suitable for regular cultivation for crops, but not suited to continuous cultivation. . It has a moderate to high suitability for agriculture but

1 Cropping requiring careful management and particularly flexible fallow length to ensure adequate soil moisture for crop success. Crop frequency often less than 1 crop per year.

edaphic or environmental constraints reduce the overall level of production and may limit cropping to a rotation with sown pastures.

Class 3: Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of soil or environmental constraints.

Class 4: Land suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high but overall production level is low as a result of major environmental constraints.

Class 5: Land unsuitable for agriculture or at best suited only to light grazing Agricultural production is very low or zero as a result of severe constraints, including economic factors that preclude land improvement.

2.3 Land that need not be evaluated for agriculture

Certain lands can be clearly excluded from agricultural land classification assessment due to their tenure or land use. These types of lands include national parks, state forests, mines, coastal dunes and areas zoned urban or village. In Walgett the areas that have been excluded from the mapping are: state forests, urban areas and nature reserves.

A distinctive feature of the agricultural land classification map is the identification of Travelling Stock Routes (TSRs) as class 4 lands. It is a requirement of the RLEM mapping method that these areas of Crown Land are mapped. TSRs are a valuable agricultural resource, particularly when their grasslands are utilised by travelling livestock or grazed by livestock to supplement feed shortages during dry periods or droughts. These lands are not available for the production of crops and are best classified as class 4.

2.4 Assumptions for classification process

In classifying agricultural land assumptions are made about agricultural land use. These assumptions, which are specified in the RLEM, are:

- appropriately high management level and technology is used;
- land with constraints that have been modified or removed should be assessed on its present status (eg irrigation areas, flood mitigation areas, cleared land);
- land with constraints that could be economically removed should be assessed as if they have been removed eg low chemical fertility, presence of stones;
- legislative constraints which limit areas or restrict production may be ignored if change is likely (or vice versa);
- economic inputs based on realistic farm management should be assumed;
- land suitable for intensive uses such as cropping is also suitable for less intensive uses such as grazing forestry, recreation etc;
- assessment reflects long-term capacity for sustained agricultural productivity;
- assessment may need to be reviewed if technological developments permanently change the productivity of the land.

2.5 The role of current land use in agricultural land classification

Given the above assumptions, existing land use may not always be a good indicator of appropriate land use and hence land class. The system of land classification is aimed at assessing physical, social and economic attributes of land rather than its current use. Never the less it must be noted that current land use often reflects land suitability. Where land is used beyond its physical capability land degradation is often evident.

3 AGRICULTURAL LAND CLASSIFICATION METHODOLOGY

3.1 Limitations of Walgett Map Scale

When using agricultural land classification maps it is important to understand the limitations of the scale at which the maps were produced. In addition it is essential that the map only be used within the limitations of the scale of mapping reliability.

Map scale is the relationship between a unit of length on a map and the actual length it represents on the ground. This scale is usually expressed as a ratio. A scale of 1:100 000 means that one unit on a map corresponds to 100 000 units on the ground. For example, 1 cm on the map corresponds to 100 000 cm or 1 km on the ground. One square centimetre corresponds to one square kilometre; one square millimetre represents one hectare. The minimum area that can be legibly delineated on a map is usually about 40 square millimetres (a circle of about 7 mm in diameter). At a scale of 1:100,000 this represents an area on the ground of approximately 40 hectares. **The logical conclusion is that features of an area of less than 40 hectares will not be represented on this map**.

Biophysical features usually have transitional zones between unique groups or classes. In the field, there are few instances where a sharp boundary line divides classes. In these circumstances, the boundary line represents the best fit position or a half way point between the two classes. The accuracy for locating the class boundary lines is expressed as a confidence limit. For a 1:100 000 map this limit is ± 1.5 mm representing a confidence limit of ± 150 m in the field (Riddler 1987). **As the boundary precision is a function of the level of detail recorded and observed in the field, the scale of agricultural land classification maps should not be enlarged**.

In addition, while the final maps show areas as being divided into discrete classes, in practice nature usually presents a mix of geology, terrain and soils, and sudden changes are unusual. Any map unit will include areas whose characteristics differ from those of the dominant class. For an area less than 40 mm^2 (7 mm diameter) on the map, these inclusion are too small to be legibly shown at the scale of mapping but they may occupy up to 40% of the unit. This is important to note, as errors in interpretation will occur if the map is enlarged beyond its original scale because these inclusions will not be shown. It is particularly easy and therefore tempting to enlarge maps when they are in digital form, however this should not be done.

3.2 Collection of background data and information

Four key sources of spatial background data were used for this survey—topographic maps, vegetation surveys, soil surveys, and satellite imagery. Additional information was also obtained by interviewing professional officers. These are discussed in the following subsections.

3.2.1 Topographic Maps

The topographic maps covering Walgett Shire were obtained from the Land Information Centre. The Eastern Division is covered mostly by 1:50 000 maps and Western Division, by 1:100 000 maps. These maps gave base-line information in relation to landscape features and watercourses as well as cultural features such as roads, towns and railways.

3.2.2 Vegetation Surveys

The distribution of vegetation across the Shire was mapped as part of the Murray Darling Basin M305 Basincare Project in the period 1992–1995 and was based on satellite imagery from 1991 and earlier. That project generated two products: a map differentiating woody from non-woody vegetation, and a map showing structural floristics (Ritman, 1995). The M305 structural floristics maps are presented at 1:100,000 scale, and the smallest area they map is 50 hectares. This project used only the structural floristics maps.

3.2.3 Soil Survey

Information about soils in the Shire was obtained from several sources. Data on soils in the Western Division were obtained from "Soils of the Northern Floodplains Regional Planning Area" (D.P. King, 1998). Data on the soils of lake beds in the Western Division from the "Land Systems Map - Angledool - Moree" (Walker and Boyd, 1972). For the Eastern Division the report "Field guide to soils of the Western Barwon Region Floodplains" (L. Keady and R. Banks, 1998) was used

3.2.4 Satellite Imagery

For this project, a Landsat Thematic Mapper (TM) multispectral satellite image, recorded in December 1997, was used. The digital data was radiometrically and geometrically corrected to level 4 and, subsequently, georeferenced to 30 m accuracy.

A number of benefits accrue from the use of satellite imagery in natural resource surveys such as agricultural land classification. These benefits include:

- satellite imagery provides access to data from the electromagnetic spectrum outside the visible range (which helps to characterise vegetation);
- imagery can be selected from a range of sources to ensure that spectral and spatial resolution and band selection are appropriate for the project;
- ability to access repeat satellite coverage to accommodate land cover changes over time; and,
- ability to classify areas that are inaccessible from the ground.

3.2.5 Information from Professional Officers

In addition to these published resources, interviews were held with professional officers (both from NSW Agriculture and other agencies) with experience in soil surveying, agricultural land use assessment, agronomy, horticulture and farm management practices. Information on current agricultural practices was also sought from a number of landholders in the Shire. The key themes covered in these discussions included:

- existing and potential agricultural and livestock practices, their role and limitations in view of the present state of technology for each enterprise;
- inter-relationships, opportunities and limitations for relevant physical, social and economic attributes used by particular, pasture, grain cropping and livestock enterprises;

- characterisation of agricultural land suitability classes for the Walgett area in terms of resource condition and agricultural system needs. Particular attention was paid to soil erosion hazards, climatic factors (rainfall) and current land use practices.

3.2.6 Climate data

Climatic data for Walgett Shire can be organised in a number of different ways. For this study the annual average rainfall data for the thirty year period 1961 to 1990 has been used. Average annual rainfall has been employed, as it is a figure commonly used by farmers in the locality. A thirty year period has been chosen as it is considered long enough to remove the influence of extreme events (wet or dry) in single years.

It is important to note that had a different range of years been used the values for average annual rainfall would be different. By way of illustration average annual rainfall in Walgett can be described in a number of ways each with a different average rainfall value, see table 2. What becomes apparent from this analysis is that it is not the actual rainfall values that are important but the relative values and the reliability of the rainfall.

Table 2

Walgett Post Office Average Annual Rainfall			
Since 1879	Last 50 years	1931 – 1960	1961 – 1990
455 mm	497 mm	482 mm	487 mm

Source: CSIRO & Bureau of Meteorology, 1998

3.3 Agricultural production in Walgett Shire relative to surrounding shires

3.3.1 Agricultural production in Walgett Shire

Dryland farming and livestock production, primarily beef, wool and sheep meat, dominates agriculture in Walgett Shire. In terms of dryland farming, wheat predominates the area of production. An average area of about 130,000 hectares of wheat was grown each year between 1983 and 1997 (ABS 1999). Wheat areas in 1998 and 1999 are estimated at over 200,000 ha, reflecting the advances in crop production technology for western cropping areas. Grain legume crops such as chickpeas are increasingly being incorporated into rotations. 1999 area estimates for chickpeas are in excess of 20,000 ha. Total summer crop areas are considerably smaller than winter crop areas. Grain sorghum is the main dryland summer crop grown. (ABS 1999).

Some irrigated agriculture is present in Walgett Shire. While suitable for a range of commodities irrigated agriculture focuses on cotton production. The areas dedicated to irrigated cotton has been growing steadily and in 1997 occupied some 14,300 hectares (ABS 1999).

3.3.2 The relative value of agricultural production

The agricultural land classification system applied by NSW Agriculture is a state-wide system. Therefore, before land classes can be applied to specific areas a sense of the relative

agricultural merit of the study area is required. In order to assess the relative merits two production indices are employed: relative yield and production variability (Singh, Dhingra and Dhillon, unpublished).

Relative yield is a measure of the productive potential of an area when compared to the average level of production for a region or state. In order to assess the relative yield for Walgett Shire the production figures for the Shires which fall within a 200 km radius of the town of Walgett were compared, see map 3 for location of shires. The figures were compared to give a relative yield figure, calculated in the following manner:

- relative yield = average yield for the shire / average yield for the region x 100

Using this formula production values were broken into three classes: high, medium and low. More than 95% of the relative yield values for all the crops considered, range between 50 and 150% and their major concentration is between 75 and 125%. The values in this range have been defined as 'Medium Relative Yield'. Values above 125% are defined as 'High Relative Yield' and values below 75 defined as 'Low Relative Yield.

Production Variability, or the coefficient of variation in production, is a measure of the reliability of production. Coefficients of variation, up to 30% are considered to represent a comparatively stable or reliable level of production between years. High coefficients of variation, those greater than 30%, are considered unstable. Stability in production is important as it reflects the level of risk associated with production in an area. The greater the coefficient of variation the less reliable crop production the greater the risk of economic crop failure.

The coefficient of variation is calculated in the following way:

- Coefficient of variation = standard deviation of region yield / shire yield x 100

The results of the analysis of shires included within a 200km radius of Walgett are summarised in Table 3, details for each crop and each local government area are given in Appendix 1. From the information provided in Table 3 it is apparent that with the exception of irrigated cotton agricultural production in Walgett is low for all major commodities and where production levels are medium, barley, oats and chickpeas, production is unstable. Based on this analysis it is apparent that as a general guide, crop production in Walgett Shire is less reliable and more variable than the average of it and its surrounding shires. The notable exception to this rule is where irrigation is available. The high productivity, high stability result for irrigated cotton demonstrates the productive potential of the area but also highlights the dramatic impact of climatic variation on agricultural systems in the area.

As a result of this analysis class 1 agricultural lands have been excluded from Walgett, class 2 lands are limited to areas under irrigation or lands in the east of the Shire where rainfall is highest and reliability is greatest. Class 3 lands are the dominant land class representing much of the dryland farming areas. There is no doubt that these areas are highly capable, in terms of landscape and soil conditions, of crop production but the harsh and uncertain climatic conditions that prevail in this area exclude these lands from class 2.

Table 3 **Crop Productivity of Shires Relative to the Regional Average**

	Stable high production	Unstable high production	Stable medium production	Unstable medium production	Low production
Shire	**Relative yield >125 % CV up to 30%**	**Relative yield > 125 % CV > 30%**	**Relative yield 75 - 125 % CV up to 30 %**	**Relative yield 75 - 125 % CV > 30%**	**Relative yield < 75 %**
Barraba			Irrigated Cotton	Wheat Barley Sorghum	
Bingara			Wheat Barley Irrigated Cotton	Sorghum	
Bogan				Barley	Wheat Chickpeas Sorghum
Brewarrina	Irrigated Cotton				Wheat Barley Sorghum
Coonamble			Irrigated Cotton	Wheat Barley Chickpeas Sorghum	
Coonabarabran	Sorghum		Dryland Cotton	Wheat Barley	Chickpeas
Gilgandra		Barley		Wheat Chickpeas	Sorghum
Gunnedah	Wheat Sorghum		Irrigated Cotton	Chickpeas	
Moree		Chickpeas	Sorghum Irrigated Cotton	Wheat Barley	Dryland Cotton
Narrabri		Chickpeas	Sorghum Irrigated Cotton	Wheat Barley Dryland Cotton	
Walgett	Irrigated Cotton			Chickpeas	Wheat Triticale Sorghum Dryland Cotton, Barley
Warren		Sorghum	Irrigated Cotton	Wheat Barley Chickpeas Dryland Cotton	

3.4 The land suitability assessment process

Following the establishment of the relative value of agriculture in Walgett Shire, classification of the lands within the Shire was undertaken. This evaluation of the physical, social and economic resources of the Shire was carried out using established principles as set out for land evaluation/suitability surveys (Dent and Young, 1981). The land suitability assessment process involves three successive stages.

1. identification of the land's characteristics,
2. assessment of natural resource qualities for sustainable agricultural production, and,
3. the evaluation of rural lands in terms of suitability for agricultural enterprises.

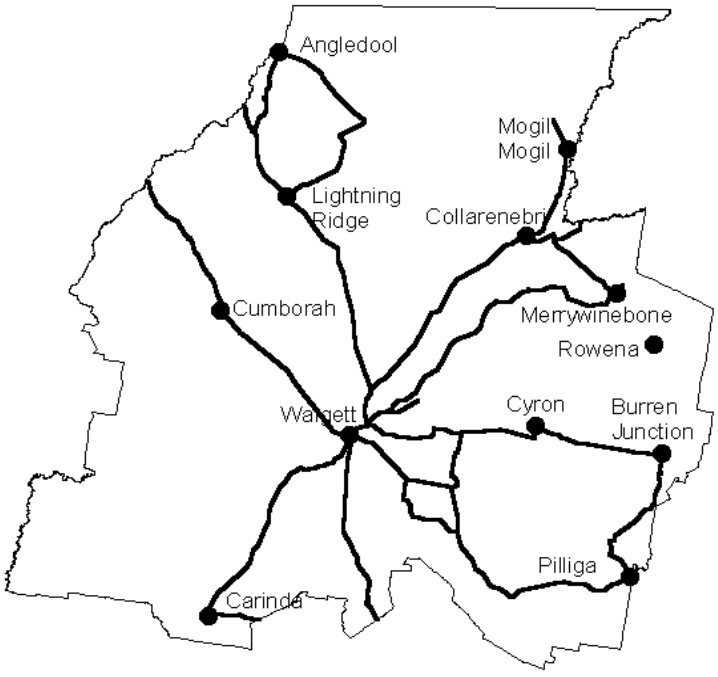
These processes are based on interpretation strategies such as location and association, temporal change and convergence of evidence (Hindle,1986).

Stage 1

The first stage involved identification, analysis and interpretation of land characteristics. A field reconnaissance survey was undertaken during February 1999 to examine the following natural resource characteristics: landform, drainage patterns and soils as well as the presence of grasslands and timber cover. These characteristics were recorded on topographic maps.

Existing roads and tracks were used to systematically traverse the Shire, particularly agricultural lands adjacent major rivers and creeks. The following areas were visited during the field trip, Walgett, Cumborah, Narran River, Angledool, Lightning Ridge, Cryon, Burren Junction, Pilliga, Come-by-Chance, Collarenebri, Mogil Mogil, Merrywinebone, and Carinda. See Map 1 for location of these areas and roads travelled in the Walgett Shire.

Map 1 Location of areas and roads travelled in the Walgett Shire.



The primary factors used to assess soil quality were slope, soil type, soil fertility, vegetation cover and current land use practices. The assessment was based, in the main, on the information sources identified in section 3.2

The distribution of vegetation in the Eastern and Western Divisions was obtained from the M305 structural floristics map mentioned in section 3.2.2.

The spatial distribution of landform features (topography, drainage patterns and erosion) was obtained by observing pattern and texture on the Landsat image, supplemented by the information on the topographic maps.

Stage 2
The second stage assessed the capability of the natural resources to sustain agricultural production.

In this process, consideration was given to the productive potential of the land resource, as well as limitations to use. Deliberately conservative estimates of resource capability were employed to avoid land degradation through soil structural decline, dryland salinity and wind and water erosion as well as to ensure the protection of water quality.

Stage 3
The final stage in the land suitability assessment process was the evaluation of the rural landscape for its suitability to support sustainable agricultural systems. The basis of this evaluation process is the matching of the natural resource qualities to the needs of a range of sustainable agricultural systems. During the evaluation process the RLEM guidelines were used to establish relationships between physical, social and economic attributes observed in the field, natural resource qualities and suitability for agricultural enterprises.

In undertaking the evaluation for Walgett Shire it became apparent that the attributes listed in Table 4 were critical in determining agricultural land suitability classes

Table 4 Key attributes in determining agricultural land suitability classes

Physical attributes	Social and economic attributes
Landform	Skilled labour
Vegetation	Road infrastructure and condition
Soils	Distance to markets, handling facilities
Potential for land degradation	Access to capital
Climate (effective rainfall)	
Current land use	

In August 1999 further field work was undertaken to check the validity and accuracy of the map in terms of its evaluation of the rural landscape for sustainable agricultural production. The field work concentrated on areas immediately to the south and west of Walgett, the Cryon Plain, Lightning Ridge and Angledool. The field work confirmed the importance of climate as a limiting factor for agricultural production and the quality of soil resources.

3.5 Creating the map

Spatial representation of the land suitability assessment process was undertaken using topographic maps and satellite images.

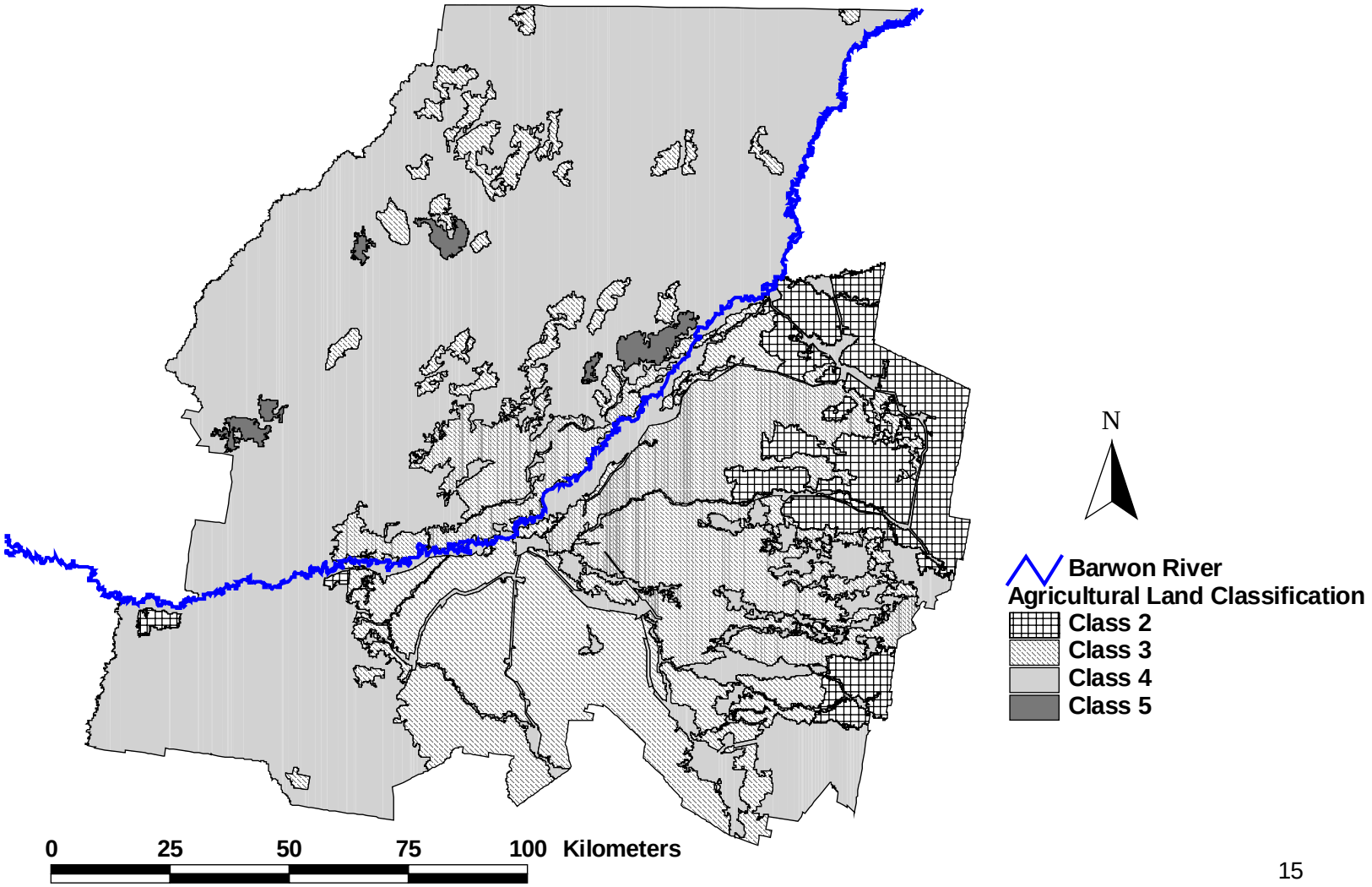
The agricultural land classification classes observed in the field were drawn onto topographic sheets. Where the agricultural land classification classes for rural lands could not be observed from roads, they were extrapolated from the ancillary data such as soil and vegetation surveys plus the visual interpretation of Landsat imagery. This information was then drawn on colour, hard copy Landsat imagery. The satellite images were plotted at scale of 1:50 000 and 1:100 000. The images used were Landsat 5 Thematic Mapper (TM) imagery December 1997. It was radiometrically and geometrically corrected to level 4 and then georeferenced to 30m. The data contained the visible green, visible red, near infra-red and mid (short wave) infra-red bands.

This process was assisted by the production of maps in ArcView® showing the distribution of selected vegetation species (M305) across the satellite imagery.

The agricultural land classification class boundaries were digitised from the colour, hard copy images using a stream digitising technique and PC Arc Info software. Editing and labelling of polygons was undertaken using Unix Arc Info while the final hard copy output was generated using PC and Unix ArcView®.

Map 2 shows a generalised outline of the agricultural land classification classes for Walgett Shire. The purpose of this map is to provide a general picture of the suitability of localities for particular agricultural systems. It is apparent that there is a general trend from intensive cropping systems in the east to extensive grazing systems in the west. See the main agricultural land classification map for details.

Map 2 Walgett Shire - Agricultural Land Classification (Simplified)



15

4. AGRICULTURAL LAND CLASSIFICATION

4.1 The evaluation of rural lands in Walgett Shire

The evaluation of rural lands is essentially a matching of the inherent physical, social and economic attributes of the rural landscape against the needs of sustainable agricultural systems. These relationships have been summarised in the following tables. Table 5 illustrates the relationship between the agricultural land classification classes and potential agricultural systems, while Table 6 shows the relationship between agricultural land classification classes and land form, soils, vegetation, climate, land use as well as social and economic attributes.

Table 5: ***Guide to agricultural land based on land uses for Walgett Shire -***

SUITABILITY CLASSES		LAND USES			
Class	**2. DESCRIPTION**	**Field Crops**		**Grazing / Pasture**	
		Summer crops[1]	Winter crops[1]	Improved	Unimproved
		Irrigated Rainfed	Non-continous	Irrigated Rainfed	
2	Land suited for regular cultivation and suitable for a range of crops for incorporation into rotations. Land is also highly suited to grazing. It has a moderate to high overall suitability for agriculture with some environmental constraints which reduce overall level of production	☆ ★	★	☆ ★	★
3	Land suited to cropping but with increased reliance on conservation tillage and fallowing to reduce production risk. Good grazing land. Soil and/or climatic factors limit long term production to moderate levels.	● ☆	☆	● ☆	★
4	Land best suited to grazing. Cultivation of crops possible on capable soils, but associated with high production risk requiring fallow management and 'opportunity cropping. Production may be seasonally high however overall production level is low as a result of major environmental constraints.	❍ ❍	❍	❍ ●	☆
5	Land unsuitable for agriculture or suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which preclude land improvement.	❍ ❍	❍	❍ ❍	●

★ Class having requirements in excess of those needed for sustained production from the land use

☆ Class having the minimum requirements for sustained production from the land use

● Class may be suited to the land use depending on the nature of the limiting factors to crop production

❍ Class not suited to land use because of limiting factors to cultivation and/or production

Notes:

1. The ability to cultivate is a pre-requisite for cropping in this table. In Walgett Shire the establishment of opportunity crops on class 4 lands using minimum tillage techniques is not represented.

TABLE 6: ***Relationships between agricultural land classes and key resource attributes in Walgett Shire***

CLASS	LANDFORM	SOILS	VEGETATION	CLIMATE	SOCIAL & ECONOMIC	RECOMMENDED LAND USE	
						Dryland	Irrigation
2	Alluvial plains, with local drainage lines and rarely inundated by flood water from major rivers	Dark grey Clays (Cracking)	Coolabah	Greater than 525mm rainfall*. Evaporation rates and maximum temperatures relatively lower	Close to supplies, skilled labour and receival centres with good quality roads. Relative risk of economic crop failure: low to moderate	Cereal, oilseed, fibre and pulse crops Grazing lands improved & native pastures	Cereal, oilseed, fibre and pulse crops
3	Alluvial plains with local drainage lines, rarely inundated by flood water and slightly elevated rises. Scattered drainage depressions adjacent or near most of the major drainage lines with occasional or regular inundations in the lakebeds and on the floodplains.	Grey, Brown and Red Clays Alluvial soils Red Brown Earths Lake Beds and Grey Clays	Coolabah, Myall, Black Box, Grasslands	Greater than 450mm rainfall*.	Most areas close to supplies, skilled labour and receival centres. Crop choice options moderately limited by climate. Relative risk of economic crop failure: moderate. Western Division areas have legislative constraints.	Cereal, oilseed, and pulse crops Grazing lands improved and native pastures	Cereal, oilseed, fibre and pulse crops
4	Prior stream formation on slightly elevated rises and undulating lands. Active stream and river channels and low terraces.	Alluvial Prairie Grey Clay Drainage Line Clays Red Brown Earth Hard Setting Red Earth Solodized Solonetz Sodic Soils Earthy Sands Siliceous Sands Gilgai Soils	Coolabah, River Red gum, Bimble box, Wilga, Western Rosewood, White Cypress Pine, Leopard Wood	Less than 450mm rainfall*, or greater than 450 mm on land type with major production constraints.	More capable soil types in this class have reduced access to skilled labour and supplies. Economic viability of cropping programs significantly reduced by poorer quality of roads and transportation costs of input/output products. Crop choice options severely limited by climate. Relative risk of economic crop failure: moderate to high. Western Division areas have legislative constraints.	Grazing lands, Opportunity cropping	Nil
5	Pilliga Scrub Undulating ridges, heavy timbered areas, permanent swamps and sand basin river beds	Red Earths Siliceous Sands	White Cypress Pine, Bull Oak, Pilliga Box, Western Grey Box, Acacia spp, Wilga, Carbeen, Western Rosewood, Whitewood, Budda, Belah, Leopard Wood	Climatic constraints secondary to other factors	Severe constraints to agricultural production.	Light grazing or supporting activities related to agricultural production	Nil

- = Mean rainfall for past 30 years**.**

REFERENCE: Keady, L., Banks, R (1998) *Field guide to Soils of the Western Barwon Region Floodplains* Department of Land & Water

4.2 Description of the agricultural land classification classes

Following is a brief description of the physical (landform, soil and climatic) social and economic attributes for agricultural enterprises within each agricultural land class as mapped for the Walgett Shire. For detailed descriptions of the soils in the Walgett Shire, refer to D.P. King, 1998, Keady and Banks, 1998 and Walker and Boyd, 1972.

Class 1

There are no class 1 agricultural lands found in Walgett Shire.

Class 2

This class includes rural lands suitable for the production of a wide range of broadacre (cereal, oilseed, fibres and pulse) crops, under irrigated or dryland conditions. Class 2 lands are found in the areas of greatest rainfall (greater than 525* mm/annum) and rainfall reliability, that is lands in the east of the Shire. Irrigation areas suitable for the production of summer and winter crops are also class 2 regardless of rainfall.

The land form element within this class has only local drainage lines and are only inundated for long periods in major flood events.

In dryland areas soils in this class include only dark grey Clays (Vertosols). These soils have a uniform colour and texture (clay profile) with self-mulching characteristics at the surface and represent the most productive soil type found in the shire. Seasonal cracking features allow the summer rainfall to enter the subsoil. These soils have few limitations for the cultivation of dryland, irrigated, summer and winter crops. The influence of these limitations can be reduced when sound agricultural management practices are used in sustainable farming systems. However, in intensive cropping rotations, over cultivation of potentially sodic and dispersive topsoils can break down the soil structure and create self-sealing characteristics. These features mainly apply to irrigation areas with reductions in soil permeability, impaired germination and plant growth.

Class 2 land includes Coolabah (*Eucalyptus coolabah*) vegetation communities which are associated with the dark grey Clays.

Minimum tillage combined with stubble retention will assist in maintaining soil moisture, soil fertility, soil structure and adequate grain yields. These techniques can be used in conjunction with long fallows where summer and/or winter rainfall is stored in the soil profile. Sustainable farming programs should be flexible and based on a range of crops. Oilseed, fibre and pulse crops (grain legumes) should be included in rotations to reduce the instances of diseases, and add nitrogen to the soil for use by following crops.

Class 2 includes irrigated areas suitable for production of summer crops, particularly on the Dark Grey, Cracking Clays. In the western section of the Central Division portion of the Shire, the light Brown Alluvial Soils used for the production of irrigated cotton have been down graded to class 3 lands, due to the lower soil fertility and lower water holding capacities.

Heavy pesticide use has the potential to limit the suitability of land for agriculture through accumulation of residues. If soil pesticide residues become too high, it will restrict use of the land and may result in down-grading of the land class.

The social and economic limitations do not represent a limiting factor to the adoption of agricultural systems.

The presence of few biophysical limitations for the cultivation of broadacre crops provides a moderate to high suitability for sustained agricultural enterprises within this class. Productivity potential is high to very high for a wide range of irrigated and dryland crops.

Class 3

Class 3 is the broadest class in the system, with the land being suitable for a wide range of agricultural enterprises and management practices. These include the potential cultivation of dryland and irrigated broadacre crops. The overall level of productivity is moderate. Class 3 land has lower agricultural suitability rating due to the presence of physical social and economic limitations on moderate agricultural enterprises. This may be expressed as limiting the range of suitable broadacre crops as well as crop yields compared to class 2 land.

Class 3 land occurs on the Cryon Plain, in the Collarenebri, Rowena Burren, Junction and Walgett areas, west of the Barwon River on clay soils, and some lake beds in the Western Division. There are various methods for determining the western boundary for the economic production of winter grain crops. For this study the 450mm isohyet (mean 30 year rainfall) provided the most practical, easily understood and widely accepted method for determining the western boundary for class 3 land. West of this isohyet distance from services and grain handling infrastructure also becomes more of a limiting factor.

Class 3 land is associated with a wide range of landform elements and soil types:

- Grey, Brown and Red Clays (Vertosols)

These soils are associated with scattered drainage depressions on the flood plains adjacent, or near, most of the major drainage lines. In some cases, the drainage depressions may be broad flat areas, known as warrambools. These areas having a low flooding frequency are often suitable for dryland cropping enterprises. The soils are deep, sometimes self-mulching, with a clay texture and moderate to high soil fertility. Sometimes the soils have slight sodic limitations and may be infrequently flooded.

These soils have low to moderate limitations for cultivation and are suitable for arable cropping programs in rotation with pastures.

- Alluvial Soils (Grey Clays/Grey Vertosols)

The alluvial soils occur adjacent the main rivers, with stream migration producing meander scrolls, cutoffs and ox-bow lakes. The soil texture ranges from sands to clays, depending on flood history.

The Grey Vertosols again occur adjacent the main rivers and have a medium clay texture. Both soils have moderate soil fertility with the major limitation being flood hazard and water-logging.

- Red Brown Earths (Red and Brown Chromosols)

These soils are found on the upper or elevated flood plains, down slope from the Red Earths.

The texture ranges from clay loam or sandy clay loam overlaying a reddish brown medium clay subsoil. The limitations are low soil fertility, hard setting and sodic characteristics. When cultivated these soils are prone to wind and water erosion with production of minor

scalded surfaces.

- Lake Beds and Grey Clays (Grey Vertosols)

These soils occur in the lake beds. They have a heavy texture, seasonal cracking characteristics, and are often sodic at depth and have a moderate soil fertility. These soils are associated with the Narran and Rotten Plain land system units. The limitations are flood hazard, shallow water tables, and surface crusting.

Class 3 land includes Coolabah (*Eucalyptus coolabah*) / Black Box (*Eucalyptus largiflorens*), Coolabah/Myall (*Acacia pendula*) and Myall vegetation communities. These timber species are associated with the above soil types.

On class 3 land, minimum tillage and stubble retention becomes an essential part of dryland cropping management programs. This is particularly applicable where the soils have moderate water holding capacities, low to moderate soil fertility and moderate soil structure. In these cases, long fallows and crop rotation, will assist in maintaining grain yields and soil fertility, particularly where suitable broadleaf (pulse, oilseed and fibre) crops and pastures are used in the crop rotations. On class 3 land a reduced range of crops can be economically grown compared with class 2 land.

In the Western Division portion of the Shire, and where mean annual rainfall is greater than 450 mm, only heavy textured soils with high moisture holding capability (ie. generally with plant available water capacities of > 200mm/m of soil) have been included into class 3.

In the more isolated areas of the Shire transportation costs associated with crop inputs ,when combined with the adverse influence of lower rainfall on crop yield, the reduced range of crops that can be economically grown and limited management options results in the downgrading of the agricultural land classification to classes 3 or 4.

The combination of the above limitations for class 3 land produces a moderate suitability for cultivation, with cropping only sustainable in rotations including strategic fallowing, and using conservation farming techniques such as stubble retention and reduced tillage. Incorporation of pasture phases into the rotation may also improve sustainability. Class 3 land has high levels of productivity for suitable improved pastures and moderate levels of productivity for crops well suited to the area.

Class 4

This class includes a major part of the grazing lands within the Shire. The grasslands can provide good grazing for livestock, while scattered timber (both individual trees and pockets of remnant vegetation) can provide shade and shelter for livestock. The overall level of production is low to moderate from locally adapted pastures. Adverse soil characteristics, variability in climatic conditions, particularly rainfall, and moderate to severe social and economic constraints, restrict production of grain crops.

Although Travelling Stock Routes (TSRs) are Crown Lands, they are included in class 4. TSRs are a valuable agricultural resource, particularly when their grasslands are utilised by travelling livestock or grazed by livestock to supplement feed shortages during dry periods or droughts.

In some years, it may be possible to produce ‘opportunity’ crops on some class 4 land which have soils with a high capacity to store water. Opportunity cropping involves a flexible

approach to fallow length whereby a crop is sown whenever the soil water reaches a predetermined trigger. It contrasts to a fixed approach whereby the fallow length is set irrespective of the amount of stored soil water (Hayman, *et al*.1996). For many farmers in the eastern zone of the northern grains region the predetermined trigger on a vertosol is 100 mm available stored water for wheat and 150 mm for sorghum. These values correspond to 60 and 90 cm of wet soil as measured by a push probe

Production will need to be based on minimum tillage techniques. However, the potential for economic failure is very high, due to the unreliable annual rainfall, particularly west of the 450 mm isohyet. The presence of severe limitations for production of grain crops (both physical, social and economic) is the principal reason for downgrading these lands to class 4. The boundary of Class 3 and 4 land in some areas is based solely on mean annual rainfall and consequently appears quite arbitrary.

Appropriate fallow management is important for the success of all cropping programs in Walgett Shire. Through the use of correct fallow management techniques high yielding crops can be at times be obtained on some class 4 land. However as we move from class 4 to class 3 then to class 2 the frequency with which these crops can be obtained increases. Cropping frequency on class 4 land will generally be less than 1 crop per year.

Class 4 lands occur north and west of Burren Junction, particularly in the old Burren Junction area and along the Cubbaroo Warrambool, west of Pilliga, south of Pian Creek in the Wanourie area, south of the Castlereagh River, and in the Western Division on ridges and lower flood channels, particularly north of Collarenebri and west of the Barwon River to the Queensland border.

Class 4 land occurs on a wide range of landform elements and soil types such as:

- Alluvial Soils, Prairie Soils (Grey Dermosols) and Grey Clay Soils (Grey Vertosols)

These soils occur along active streams, river channels and low terraces. The topsoils range from a sandy clay loam, clay loam to a clay with moderate to high soil fertility.

These soils are associated with the River Red Gums communities adjacent the major channel lines. Limitations such as flood hazards, and high erodibility, particularly stream bank erosion, severely restrict the cultivation of these areas. Most of these areas are protected lands under the Soil Conservation Act and its various amendments and clearing for agricultural development is generally not permitted without special consent.

- Grey and Brown Clays plus Drainage Line Clays (Warrambools)

These soils are found along or adjacent small inactive and intermittently active drainage lines (warrambools). Soils are deep heavy-textured, seasonal cracking and of moderate fertility. Limitations are undulating surfaces, slow or impaired drainage, flooding and soil erosion hazards. Some soils are sodic and/or saline at depth and sometimes occur on protected lands.

- Red Brown Earth and Hard Setting Red Earths

These soils occur along former stream channels now mainly abandoned. They have a sandy clay loam topsoil with a medium clay subsoil. These “prior streams” are located on the higher sections of the flood plain and are usually associated with Bimble Box (Eucalyptus populnea).

Major limitations are hard setting, low infiltration and drainage, scalding and low fertility.

- Solodized Solonetz and Sodic Soils

The soils occur on the most elevated positions on the flood plains. Formation of scalds as evidence of land degradation. In most cases the shallow clay loam topsoil has been eroded to expose the medium clay subsoil. Major limitations are surface sealing, low infiltration rate, hard setting surfaces, absence of topsoil, surface crusting, sodic and dispersive subsoils.

- Earthy Sands and Siliceous Sands

The earthy sands are usually associated with a Pilliga Scrub and the siliceous sands, south-west of Mungindi. These soils carry timber vegetation and are only useful in providing seasonal grazing and shelter for livestock.

- Gilgai Soils

These soils have the characteristic features of undulating surfaces with rapid changes in soil types across the Gilgai depressions.

Grey Clay soils occur in the depressions with Red Clay and Red-Brown Earths on the shelves and crests. Limitations include the high shrink swell, water ponding characteristics and uneven growth of crops and pastures.

Class 4 land has moderate to high physical, social and economic limitations for agricultural productivity, particularly the difficulty in preparing cultivated seed beds due to adverse rainfall and soil characteristics, high input/output costs (particularly transport costs of products) and labour/capital limitations. These limitations were particularly applicable in the Western Division where their influence increases in a westerly direction.

Class 5

Land generally unsuitable for agriculture but may provide shelter for livestock. Agricultural production, if any, is very low due to severe constraints.

Severe or absolute constraints to agricultural production have resulted from adverse physical, climatic, environmental social and economic factors. Lands included in this class are densely timbered areas consisting of mature trees and/or regrowth areas, permanent swamps and sand bars in beds of major rivers.

- Red Earth (Red Kandosols) and Siliceous Sands (Tenosols) Ridges

These soils are associated with the undulating ridges as an elevated landform above the floodplains. Although their small size may preclude them from appearing on the map, opal fields fall into Class 5 lands.

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APPENDICES

Appendix 1 - Yield data for Selected Crops

WHEAT

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Quirindi (A)	3.48	2.51	2.06	2.67	2.64	2.67	2.37	2.31	2.52	2.49	3.48	2.83	1.07	2.82	3.62	2.63	0.63	160	24
Gunnedah (A)				1.87	2.23	2.12	1.77	1.87	2.23	1.98	2.56	2.94	0.72	2.04	3.07	2.12	0.60	128	29
Coonabarabran (A)												2.71	0.37	2.17	2.73	1.99	1.12	121	56
Parry (A)	1.82	2.40	1.36	2.27	1.96	2.27	1.91	1.57	2.21	1.56	1.82	2.75	0.48	1.94	2.84	1.94	0.58	118	30
Inverell (A) - Pt B										1.00	2.46	2.41	0.77	1.57	2.70	1.82	0.82	110	45
Moree Plains (A)				1.63	1.43	2.12	1.79	1.43	1.97	1.98	1.54	2.59	0.37	1.65	2.81	1.78	0.62	108	35
Narrabri (A)				1.31	1.49	1.58	1.5	1.51	2.26	1.4	1.69	2.75	0.77	1.94	2.88	1.76	0.61	106	35
Yallaroi (A)												2.37	0.35	1.37	2.80	1.72	1.09	104	64
Warren (A)	1.80	2.05	1.56	1.55	0.99	1.55	1.77	1.46	1.91	0.71	1.80	2.74	0.16	1.35	2.63	1.60	0.66	97	41
Barraba (A)	2.09	1.68	1.05	1.49	1.50	1.49	1.50	1.37	2.07	0.99	2.09	2.17	0.12	1.32	2.52	1.56	0.59	95	38
Inverell (A) - Pt A										0.99	1.52	2.31	0.38	1.55	2.54	1.55	0.81	94	52
Manilla (A)	1.29	2.03	1.31	1.57	1.65	1.57	1.48	1.29	1.98	1.22	1.29	2.30	0.17	1.16	2.35	1.51	0.54	92	36
Bingara (A)	1.23	1.62	1.04	1.61	1.57	1.61	1.72	1.30	1.87	1.31	1.23	2.07	0.67	1.41	2.23	1.50	0.40	91	27
Coonamble (A)				1.05	0.89	1.05	1.49	1.26	1.80	0.58	1.12	2.79	0.22	1.99	2.00	1.35	0.70	82	52
Walgett (A)	0.65	1.76	1.35	0.65	0.79	0.65	1.42	1.06	1.29	0.65	0.65	2.19	0.26	1.72	1.89	1.13	0.57	69	51
Bogan (A)	0.97	1.78	0.95	0.69	0.89	0.69	1.67	1.24	1.40	0.46	0.97	1.98	0.30	0.80	2.08	1.13	0.55	68	49
Brewarrina (A)	0.88	1.28	1.17	0.27	0.79	0.27	1.35	1.07	0.58	1.47	0.88	1.62	0.76	0.85	1.30	0.97	0.41	59	42
Regional Av.	1.58	1.90	1.32	1.43	1.45	1.51	1.67	1.44	1.85	1.25	1.67	2.44	0.47	1.63	2.53	1.65	0.49	100	29

OATS

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Inverell (A) - Pt B										0.82	2.00	1.54	0.72	1.27	1.41	1.29	0.47	125	37
Quirindi (A)	0.57	1.17	0.97	1.52	1.51	1.52	1.46	1.02	0.82	0.94	1.89	1.63	0.24	1.82	1.27	1.22	0.46	118	38
Brewarrina (A)	1.82	1.68	0.50	0.17	1.27	0.17	0.94	0.00	1.30	1.12	1.43	3.70	0.00	1.77	2.39	1.22	1.01	118	83
Moree Plains (A)				1.07	1.17	1.26	1.11	1.28	1.41	1.18	1.09	1.55	0.19	0.85	1.13	1.11	0.34	107	31
Gunnedah (A)				0.83	1.16	1.17	1.16	1.1	1.02	1	1.58	1.47	0.26	1.03	1.28	1.09	0.33	105	31
Parry (A)	0.29	1.08	1.10	1.39	1.31	1.39	1.26	1.38	1.24	0.95	1.01	1.10	0.43	1.12	1.23	1.08	0.33	105	30
Coonabarabran (A)												1.50	0.36	1.17	1.31	1.08	0.50	105	46
Barraba (A)	0.36	0.86	0.90	1.33	1.27	1.33	1.29	1.20	1.12	0.82	1.17	1.82	0.23	0.69	1.25	1.04	0.41	101	39
Narrabri (A)				0.81	1.01	1.21	0.97	0.94	1.3	0.8	0.79	1.7	0.38	1.07	1.40	1.03	0.34	100	33
Warren (A)	0.37	1.48	1.30	1.10	0.92	1.10	1.09	1.12	0.88	0.53	0.79	1.43	0.21	0.99	1.78	1.00	0.42	97	42
Yallaroi (A)												1.42	0.58	0.85	1.09	0.99	0.35	95	36
Inverell (A) - Pt A										0.53	1.30	1.26	0.41	1.15	1.22	0.98	0.40	95	41
Bingara (A)	0.52	0.76	1.21	1.16	1.08	1.16	1.15	1.02	1.18	0.61	0.79	1.27	0.48	1.02	1.22	0.98	0.27	94	28
Coonamble (A)				0.99	0.82	0.99	1.06	0.96	0.97	0.43	0.75	1.46	0.47	1.26	1.38	0.96	0.32	93	33
Walgett (A)	0.16	1.03	1.11	0.81	0.76	0.81	1.02	1.17	1.00	0.19	0.26	1.45	0.46	1.32	1.77	0.89	0.47	86	53
Manilla (A)	0.14	0.94	0.72	0.98	1.10	0.98	1.21	1.17	1.17	0.68	0.60	1.06	0.07	0.92	1.02	0.85	0.35	82	41
Bogan (A)	0.01	1.31	0.85	0.62	0.85	0.62	1.32	1.14	1.06	0.13	0.72	1.15	0.10	0.52	1.14	0.77	0.43	74	57
Regional Av.	0.47	1.15	0.96	0.98	1.09	1.05	1.16	1.04	1.11	0.72	1.08	1.56	0.33	1.11	1.37	1.03	0.31	100	30

BARLEY

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Quirindi (A)								2.12	1.53	1.95	2.63	2.31	1.07	2.35	2.94	2.11	0.60	135	28
Parry (A)								1.71	2.20	1.52	2.11	2.49	0.79	2.07	2.55	1.93	0.58	123	30
Inverell (A) - Pt B										1.01	1.93	2.74	1.28	1.94	2.66	1.93	0.70	123	36
Gunnedah (A)								1.68	2	1.49	2.17	2.46	0.56	1.76	2.60	1.84	0.64	118	35
Inverell (A) - Pt A										1.38	2.35	2.21	0.63	1.96	2.47	1.83	0.71	117	39
Yallaroi (A)												2.09	0.85	1.46	2.71	1.78	0.80	114	45
Coonabarabran (A)												1.82	0.89	2.00	2.32	1.76	0.62	113	35
Moree Plains (A)								1.59	2.16	1.17	1.43	2.34	0.70	1.50	2.63	1.69	0.64	108	38
Narrabri (A)								1.35	1.95	1.39	1.72	2.36	0.64	1.66	2.38	1.68	0.57	108	34
Bingara (A)								1.48	1.87	1.23	1.52	2.07	0.87	1.37	1.99	1.55	0.41	99	26
Barraba (A)								1.26	1.55	0.51	1.39	2.35	0.30	1.66	2.19	1.40	0.72	90	51
Warren (A)								1.05	1.62	0.95	1.57	1.66	0.42	0.97	2.57	1.35	0.65	86	48
Coonamble (A)								1.30	1.40	0.78	1.04	1.88	0.47	1.62	1.77	1.28	0.49	82	38
Manilla (A)								1.06	1.45	0.85	0.71	1.82	0.30	1.66	2.18	1.25	0.63	80	50
Bogan (A)								1.78	1.56	0.50	1.21	1.48	0.42	0.84	1.85	1.21	0.56	77	46
Walgett (A)								1.36	1.12	0.56	0.45	1.95	0.28	1.64	1.83	1.15	0.65	73	57
Brewarrina (A)								0.75	0.75		0.07	1.29	0.47	1.07	1.45	0.84	0.48	53	57
Regional Av.								1.42	1.63	1.09	1.49	2.08	0.64	1.62	2.30	1.56	0.52	100	33

SORGHUM

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Quirindi (A)	1.45	3.72	1.87	3.35	2.65	3.35	2.50	3.06	2.59	3.50	3.69	3.28	2.45	4.51	5.82	3.19	1.06	151	33
Coonabarabran (A)												2.38	2.13	3.43	3.75	2.92	0.79	138	27
Inverell (A) - Pt B										3.27	2.51	2.03	2.38	3.42	3.29	2.82	0.58	133	21
Gunnedah (A)				1.87	2.34	2.62	2.23	2.96	2.65	3.26	2.57	2.95	1.79	3.23	3.85	2.69	0.60	127	22
Warren (A)	1.45	2.13	3.01	2.44	1.41	2.44	3.83	1.02	3.19	4.97	2.94	2.08	2.97	2.41	3.72	2.67	1.03	126	39
Inverell (A) - Pt A										3.14	2.17	2.30	2.24	2.51	2.87	2.54	0.39	120	15
Parry (A)	0.81	3.60	1.28	3.08	2.26	3.08	2.43	2.71	1.97	3.12	1.51	1.95	1.66	4.01	3.79	2.48	0.96	117	39
Yallaroi (A)												1.37	2.13	2.44	2.76	2.18	0.60	103	27
Bingara (A)	0.93	2.54	1.17	1.60	2.25	1.60	1.65	1.92	2.07	2.68	1.76	2.11	1.62	3.99	2.47	2.02	0.73	96	36
Barraba (A)	0.67	2.79	0.79	2.55	1.30	2.55	0.40	3.00	2.00	1.40	2.37		1.28	1.94	3.22	1.88	0.91	89	49
Narrabri (A)				1.28	1.87	1.94	1.85	1.42	1.96	2.43	1.01	1.88	1.50	2.71	2.57	1.87	0.52	88	28
Moree Plains (A)				1.67	1.59	1.61	1.53	1.91	1.91	2.21	1.27	1.58	2.09	1.92	2.28	1.80	0.31	85	17
Manilla (A)	0.33	2.58	0.94	1.99	1.31	1.99	2.03	1.73	2.33	0.89	1.20	1.44	0.81	1.99	3.04	1.64	0.74	78	45
Coonamble (A)				1.32	0.42	1.32	0.37	2.10		1.60	0.53	2.45	1.44	1.51	4.52	1.60	1.17	76	73
Brewarrina (A)		2.69	0.76		2.30		0.00	0.86	1.97	1.73	1.79	0.00	1.98	0.00	3.10	1.43	1.08	68	76
Walgett (A)	0.63	0.78	0.25	0.78	0.12	0.78	2.94	1.67	1.42	1.13	0.63	1.05	1.40	2.34	1.90	1.19	0.77	56	65
Bogan (A)									0.17		1.01	5.00	0.07	0.00	0.00	1.04	1.98	49	190
Regional Av.	0.89	2.60	1.26	1.99	1.65	2.12	1.81	2.03	2.02	2.52	1.80	2.11	1.76	2.49	3.12	2.11	0.55	100	26

TRITICALE

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Narrabri (A)				1.25	2.25	1.51	0.81	1.64	1.03	2.61	4.78	3.77	2.40	2.55	5.68	2.52	1.52	187	60
Inverell (A) - Pt A											1.46		0.63	2.63	2.10	1.70	0.86	126	51
Moree Plains (A)				1.91	1.65	2.72	1.47	1.67	2.14	0.54	0.68	2.03	0.13	2.60	2.86	1.70	0.88	126	52
Quirindi (A)	1.31	1.46	1.50	2.86	1.92	2.86	1.82	1.28	0.96	1.07	2.00		0.18	1.20	2.50	1.64	0.75	121	46
Coonabarabran (A)													1.63	1.45	1.80	1.63	0.17	120	11
Manilla (A)	0.42	1.86	0.94	1.08	1.65	1.08	0.50	1.25	2.50	1.11	3.13			2.86	1.00	1.49	0.86	110	58
Coonamble (A)				1.20	0.80	1.20	1.08	0.94	0.79	2.35	1.91				2.97	1.47	0.77	109	52
Gunnedah (A)				1.15	2.09	1.71	1.43	0.92	1.98	0.59	1.39					1.41	0.52	104	37
Warren (A)	0.64	1.73	1.82	1.72	0.69	1.72										1.39	0.56	103	40
Barraba (A)	0.40	0.92	0.80					2.13								1.06	0.75	79	70
Bogan (A)	1.00	2.00	0.80	0.25	0.71	0.25	2.02							0.82	1.57	1.05	0.67	77	64
Parry (A)	0.46	1.64	0.76	1.15	1.00	1.15	0.63	0.38	1.63	0.60	1.50		0.50	0.50	1.60	0.97	0.48	72	50
Walgett (A)	0.98	0.73	0.75		2.08		0.06									0.92	0.74	68	80
Bingara (A)	0.98	1.31	0.99	1.26	1.10	1.26	0.25	0.07	0.30	0.64	0.33			0.00	0.77	0.71	0.48	53	67
Brewarrina (A)		1.00	0.20													0.60	0.57	44	94
Inverell (A) - Pt B																			
Yallaroi (A)																			
Regional Av.	0.77	1.41	0.95	1.38	1.45	1.55	1.01	1.14	1.42	1.19	1.91	2.90	0.91	1.62	2.28	1.35	0.56	100	42

IRRIGATED COTTON

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Walgett (A)													1.59	1.85	1.66	1.70	0.14	132	8
Brewarrina (A)													1.27	1.91	1.71	1.63	0.33	126	20
Warren (A)													1.69	1.25	1.82	1.59	0.30	123	19
Narrabri (A)													1.65	1.45	1.57	1.56	0.10	121	7
Barraba (A)														1.62	1.41	1.51	0.15	117	10
Coonamble (A)													1.40	1.24	1.89	1.51	0.34	117	22
Yallaroi (A)													1.32	1.45	1.65	1.47	0.17	114	11
Inverell (A) - Pt A														1.34	1.49	1.41	0.10	110	7
Moree Plains (A)													1.11	1.27	1.66	1.34	0.28	104	21
Parry (A)													1.70	1.62	0.58	1.30	0.62	101	48
Gunnedah (A)													1.51	1.09	1.24	1.28	0.21	99	17
Quirindi (A)													1.39	0.50	1.21	1.03	0.47	80	45
Bingara (A)													1.01	0.98		0.99	0.02	77	2
Bogan (A)													0.92			0.92		72	
Coonabarabran (A)															0.09	0.09		7	
Manilla (A)																			
Inverell (A) - Pt B																			
Regional Av.													1.38	1.35	1.38	1.29	0.02	100	1

DRYLAND COTTON

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Bogan (A)															1.74	1.74		220	0
Parry (A)														1.03		1.03		130	
Quirindi (A)														0.90	1.10	1.00	0.14	127	14
Warren (A)													1.62	0.10		0.86	1.08	109	126
Coonabarabran (A)													0.67	0.96	0.93	0.85	0.16	108	19
Gunnedah (A)													0.84	0.93	0.68	0.82	0.13	103	
Yallaroi (A)													0.58	0.77	1.06	0.81	0.24	102	
Narrabri (A)													0.48	0.68	1.09	0.75	0.31	95	41
Moree Plains (A)													0.28	0.61	0.68	0.52	0.22	66	41
Walgett (A)													0.21	0.42		0.31	0.15	40	48
Inverell (A) - Pt A													0.26			0.26		33	0
Brewarrina (A)																		0	
Barraba (A)																			
Bingara (A)																			
Manilla (A)																			
Inverell (A) - Pt B																			
Coonamble (A)																			
Regional Av.													0.62	0.71	1.04	0.79	0.22	100	28

CHICKPEAS

YIELDS

Year	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*Avrg.*	*Std D*	*R.Yield*	*C.Var*
Bingara (A)	1.43								1.45	0.72	1.43	2.00		1.39	1.57	1.43	0.37	181	26
Parry (A)				1.57	0.90	1.57	0.99	1.11	1.31	0.62						1.15	0.35	146	31
Quirindi (A)	0.94		0.00	1.55	1.67	1.55	1.68	1.65	1.49	1.09	0.94	0.70	0.59	1.28	0.86	1.14	0.50	145	44
Inverell (A) - Pt A	0.92									0.55	0.92	2.56	0.69	0.85	1.51	1.14	0.69	145	61
Yallaroi (A)												1.46	0.45	1.03	1.56	1.12	0.51	142	45
Moree Plains (A)				1.24	1.19	1.22	1.36	0.95	1.52	0.6	0.78	1.35	0.42	0.95	1.64	1.10	0.37	140	33
Narrabri (A)				0.29	1.06	1.04	0.96	0.98	1.67	0.71	0.93	1.11	0.68	1.00	2.02	1.04	0.45	132	43
Coonamble (A)	0.66			0.90	0.48	0.90	0.74	1.38	1.13	0.27	0.66	1.03	0.34	1.35	1.73	0.89	0.43	113	48
Gunnedah (A)				0.68	1.35	1.12	1.04	0.82	1.73	0.74	0.35	0.77	0.00	0.80	1.26	0.89	0.46	113	52
Walgett (A)	0.82	1.60					1.25	0.79	0.48	0.38	0.82	0.99	0.07	1.02	0.88	0.83	0.42	105	50
Warren (A)	0.81		0.45	1.09	0.78	1.09	1.11	0.28	1.16	0.35	0.81	0.66	0.32	0.72	1.33	0.78	0.34	99	44
Bogan (A)								0.40	0.63							0.51	0.16	65	31
Coonabarabran (A)												0.58			0.17	0.38	0.29	48	77
Inverell (A) - Pt B	0.71									0.00	0.71		0.00			0.35	0.41	45	115
Barraba (A)																			
Manilla (A)																			
Brewarrina (A)																			
Regional Av.	0.90	1.60	0.23	1.05	1.06	1.21	1.14	0.93	1.26	0.55	0.84	1.20	0.36	1.04	1.32	0.91	0.37	116	40