A survey of land use and management, North-West Slopes of New South Wales

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Abstract
Repeated observations of 278 sites along a 645 km transect between Tamworth and Bingara were made between spring 2010 and winter 2011 to investigate major land use and management activities with a view to monitor long-term changes on the North-West Slopes of New South Wales (NSW). Observations were made on four occasions to record data that showed 74 and 26% of sites were under pasture and crop land use, respectively. Of the sites under pasture, 62% had native perennial grasses, 12% lucerne, 3% tropical perennial grasses and 2% temperate perennial grasses. Of the sites used for cropping, 33% had cereal crops grazed by livestock, indicating the importance of this forage source. The mean level of ground cover ranged from 78 to 87% for observations made in autumn and spring, respectively and relatively few sites (nine with pasture and three with crop) showed signs of soil erosion. In the longer term, these data may be valuable for multiple uses including ground truth remote sensing data, recording shifts in land use and management through time and to guide industry development.

Key Words
Rapid observational survey

Introduction

The North-West Slopes of NSW has a diverse agricultural landscape dominated by mixed-farming enterprises. Land use and land management activities within this region are not static, but change in response to a range of factors including climatic drivers (e.g. drought), market demand (e.g. beef cattle v. sheep meat), commodity prices (e.g. grain v. wool), catchment incentives (e.g. Catchment Management Authority [CMA] pasture improvement programs) and industry development (e.g. adoption of new crops or pastures). Such changes are variable in both time and space.

In the past 25 years, two mail surveys of producers on the North-West Slopes have been used to define both on-farm practices and the forage resource base (Lodge et al. 1991; Lodge 2011). Recent anecdotal evidence has also suggested a decline in the forage base as a result of dry years (Lodge 2011). Rapid observational survey is a technique suitable to assess land use, management activity, erosion risk and ground cover at local or regional scales (e.g. Leys et al. 2007). Repeated observation of on-ground practice at the same location through time provides detail about on-farm activity that can relate change (if any), with associated impact on resource condition through time and space.

Following a review of approaches undertaken around Australia, protocols to undertake rapid observational survey were documented by Forward (2009) and Murphy (2009). The objective of the current study was to record land use and management activity for the North-West Slopes region with a view to monitor long-term changes in the forage base, specifically, sown pastures, forage crops and other novel practices such as pasture cropping.

Methods

Rapid observational survey

A 645 km transect was designed to sample 278 paddocks in the mixed farming landscape of the North-West Slopes, while completing a circuitous route from south of Tamworth to north of Bingara over a three-day period. The route was chosen to sample paddocks having predominantly arable land capability on the red chromosol soil landscape, while maximising the distance travelled on roads having low traffic volume. The route was stratified into sub-sets representing specific localities being the Goonoo Goonoo Creek catchment (126 sites), Winton-Manilla (78 sites) and Barraba-Bingara (74 sites). Sites (25 x 25 m) were selected at regular intervals of 1, 2, or 4 km spacing along the transect. Density of sites was determined by paddock size (i.e. no more than one site per paddock) and primary land use (e.g. cropping v. grazing). Sites were paired on both left and right sides of the road where possible, but were otherwise selected where paddocks were clearly

visible from a stationary vehicle. Coordinates of each site were recorded by a global positioning system (GPS) and were used to relocate the site on each sample date.

Observations

Observations were made at each site of key fields to describe land use, land management action, ground cover level, and erosion status (Forward 2009, Table 1). For this base-line group of surveys, observations were made on four sample dates throughout a 12-month period, approximately coinciding with the start of each season (spring, 13-14 September 2010; summer, 6-8 December 2010; autumn, 27-29 April 2011; and winter, 4-7 July 2011). The LandMAPT Database (Murphy 2009) was used to capture data values while in the field and interrogate values to identify trends among specific localities and any changes among the four sampling dates. Mean ground cover value was calculated as the weighted mean of the frequency distribution of cover classes.

Table 1. Data fields for land use, land management action, ground cover and soil erosion (after Forward 2009).

Field	Description	Categories/Range	State
SampleDate	Survey date	dd/mm/yyyy	Dynamic
LandUse	ALUM version 6/7 land use categories with extended field for crop or pasture type	3.x.x.x	Dynamic
LandManagementAction	Key land management action categories	Tilled, sprayed, grazed, standing, baled, burnt, abandoned, none etc	Dynamic
GroundCoverLevel	Mean percentage ground cover class	0-12, 13-25, 26-50, 51-75, 76-88, 89-100	Dynamic
WaterErosionSheet Severity	Presence and severity of recent water erosion (sheet) of site	X, 0-3	Dynamic
WaterErosionRillSeverity	Presence and severity of recent water erosion (rill) of site	X, 0-3	Dynamic

Results

Land use

Pooled data showed that 74 and 26% of sites were in pasture and cropping land use, respectively (Table 2). However, the proportions varied among the survey localities with a high proportion of sites in Barraba-Bingara (85%) having pastures present, and nearly half of sites in Winton-Manilla (44%) having crops present (Table 2).

Table 2. Proportions (%) of all sites in crop or pasture phase for each locality.

Locality	Crop	Pasture
Goonoo Goonoo	21	79
Winton-Manilla	44	56
Barraba-Bingara	15	85
Mean	26	74

Pastures

Overall, native perennial grasses were the dominant pasture type, being present at 62% of sites that were in a pasture land use (Table 3). Lucerne (12% of pasture sites), tropical perennial grasses (3%) and temperate perennial grasses (2%) were the most frequently observed sown species, with annual grass, annual legume and broadleaf weed species forming the balance (21%, Table 3). Pasture cropping (i.e. sowing a cereal crop into native perennial grasses) was observed on <1% of sites. The Winton-Manilla locality had a low frequency of sites with native perennial grasses (50%) but a high frequency of sites with lucerne (18%) compared with either Goonoo Goonoo or Barraba-Bingara (Table 3). While sites dominated by sown tropical perennial grass had ~3% frequency overall, they occurred more often in the north of the survey area.

Crops

A forage crop (e.g. oat) grown for livestock grazing was the most commonly observed crop type, being present for 33% of all cropping sites (Table 4). Forage crops were more frequent in the Goonoo Goonoo and Barraba-Bingara localities with 41 and 67% of cropping land use sites, respectively, compared with 16% for Winton-Manilla (Table 4). Otherwise, cereal crops (e.g. wheat, barely or oat) grown for grain (26% of all cropping sites) were more frequent than those for oil seed (e.g. canola, 1%) or hay (2%), the remainder being

sites with crop residues or being prepared for sowing (38%, Table 4). Interestingly, paddocks were twice as likely to be prepared for sowing by using tillage in the Goonoo Goonoo and Winton-Manilla localities, compared with using no-till methods in the Barraba-Bingara locality (Table 4).

Table 3. Proportion (%) of pasture sites dominated by different pasture types for each locality.

Pasture type	Overall	Goonoo Goonoo	Winton-Manilla	Barraba-Bingara
Native perennial grasses	62	67	50	61
Lucerne	12	12	18	10
Tropical perennial grasses	3	1	4	5
Temperate perennial grasses	2	3	0	1
Annual broadleaf weeds	12	9	12	15
Annual grasses	7	6	13	5
Annual legumes	1	<1	2	3
Pasture cropping	<1	1	<1	0
Total sites	207	100	44	63

Table 4. Proportion (%) of cropping sites with different crop or cropping related activities for each locality.

Crop or crop activity	Overall	Goonoo Goonoo	Winton-Manilla	Barraba-Bingara
Forage for livestock	33	41	16	67
Cereal for grain	26	17	35	16
Hay or silage	2	0	4	2
Oil seed	1	0	2	0
Stubbles or residues	7	5	11	0
Tilled fallow	21	26	22	4
Herbicide fallow	10	11	10	11
Total sites	71	26	34	11

Ground cover and soil erosion

The mean value of ground cover ranged from 78 to 87% for observations made in autumn and spring, respectively (Table 5). For pasture sites, cover was relatively constant across sampling dates (88 to 90%, Table 5). However, ground cover always tended to be lower in crop compared with pasture sites (e.g. 74 v. 90% in summer, Table 5) and markedly declined in autumn (49%) and winter (55%) which is consistent with the preparation for planting of winter crops and their subsequent early establishment. The occurrence of sheet erosion of soil by water was relatively rare with a maximum of 12 sites (nine pasture and three crop) observed in spring 2010 (Table 5). Rill erosion was not observed.

Table 5. Mean ground cover (%) and proportion (%) of paddocks having sheet erosion in each season for all sites or for those with crop or pasture for each locality. Values in parentheses are the count of paddocks in each group.

	Ground cover			Sheet erosion		
Sampling time	Overall	Crop	Pasture	Overall	Crop	Pasture
Spring 2010	87 (278)	78 (77)	90 (201)	4 (12)	4 (3)	5 (9)
Summer 2010	86 (278)	74 (65)	90 (213)	3 (7)	4 (2)	2 (5)
Autumn 2011	78 (278)	49 (74)	88 (204)	1 (4)	1 (1)	2 (3)
Winter 2011	80 (278)	55 (69)	88 (209)	<1 (1)	0	<1 (1)

Discussion

These data indicated that native perennial grass (62% of pasture sites) was the dominant forage type in a landscape dominated by grazing land use. Earlier studies reported that native and natural pastures occupied 71% of the rural area of the North-West Slopes (Lodge et al. 1991) and more recently that 49% of farm area was occupied by unimproved native grass and timber country with or without over-sown subterranean clover (Lodge 2011). While the proportion of sites under native perennial grasses varied between the different localities surveyed (e.g. 50 and 68% for Winton-Manilla and Goonoo Goonoo, respectively), this forage type remains a key component of livestock production systems.

While this survey showed that lucerne (12%) was the dominant sown pasture type with lesser contributions from tropical perennial grasses, temperate grasses and annual legumes (7% collectively, Table 3), a recent mail survey of graziers (Lodge 2011) revealed that native pastures over-sown with subterranean clover and

superphosphate (15%), lucerne (5%), temperate grass (3%), tropical grasses (2%) and grazing cereals (5%) occupied relatively small, but important proportions of their properties in northern NSW. A key difference between findings from the mail survey and observation of roadside paddocks was that the latter approach identified a high occurrence of degraded pastures dominated by either annual broadleaf weeds (12%, e.g. saffron thistle) or annual grasses (7%, e.g. barley grass), which further supports anecdotal evidence of a marked decline in the regional forage base in recent years (Lodge 2011). Another key difference was that the mail survey indicated that grazing cereals occupied just 5% of producer's properties, yet in our survey livestock were observed grazing cereals at 33% of cropping sites (Table 4).

Repeated observation throughout the year also revealed management practices such as methods of pasture establishment. Closer examination of the data for Winton-Manilla from season to season revealed an increase of lucerne sites between spring and summer 2010-11 as new stands emerged from beneath harvested cereal crops, demonstrating the establishment of lucerne by using cover crops. Similarly, the method of preparing paddocks for sowing crops and pastures was observed to differ among localities, with cultivation more common in Winton-Manilla and herbicide use in Barraba-Bingara, indicating the widespread adoption of direct drilling in the latter area.

Ground cover levels were generally high and even the maximum occurrence of sheet erosion in spring 2010 was relatively minor (<5% of sites). However, ground cover was <75% in autumn and winter at sites used for cropping, thereby indicating an increased risk of erosion taking place.

These rapid observational survey data are the first of their type for the North-West Slopes of NSW and make it possible to provide a unique view of land use and producer practice. While the current route was sampled on four occasions that coincided with change of season over a 12-month period, fewer observations per year may provide similar insights. If observations were made at start of April, August and December, key management activities such as planting of forage crops and pastures, dominance of summer- or winter-growing species, and harvest of grain crops could still be captured. The true value of these data is probably in their accumulation over time to observe and record changes in land use, management and resource condition thereby identifying target areas for increased on-ground action or indeed to demonstrate successful adoption and implementation of new practices.

Conclusions

These data generated by rapid observational survey have created a baseline for future observations. At this time, these data showed that native perennial grasses, forage crops and lucerne form the foundation of forage systems in a landscape dominated by grazing land use, with relatively minor contributions by tropical and temperate perennial grasses. Through time this may change in response to drivers such as climate change adaptation and requirements for different livestock production systems.

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