MIXED FARMING

FACT SHEET

GRDC Grains Research & Development Corporation

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Mixing livestock with no-till farming

Intensifying cropping and reducing livestock has been a trend as the adoption of conservation agriculture has spread. There is a renewed interest in the value of livestock as a risk management tool in the wake of escalating crop input costs, climate variability and fluctuating commodity prices. Resolving the conflicts between livestock production and no-till/conservation agriculture is a challenge.

KEY POINTS

- Livestock is an important source of farm diversification and risk management.
- Negative impacts of livestock on soil structure and surface cover must be balanced against consumer demands and constraints of no-till cropping, including weed control issues, lack of soil cover and disease.
- Livestock use can be adapted to improve integration with cropping through rotational grazing or livestock removal/ agistment.

PHOTO: EMMA LEONARD

Grazing management that prevents over-grazing of crop residues is important if the integration of livestock and no-till cropping systems is to be successful.

The mixed farming paradox

No-till cropping systems – possible pros and cons

Advantages:

- improved soil physical structure;
- more timely sowing;
- improved soil water storage, especially at seeding; and
- full stubble retention enabled by narrow points and disc openers, precision cropping and controlled traffic.

Disadvantages:

- weed control issues;
- lack of soil cover;
- inadequate crop diversity in rotations;
- run-down of soil carbon;
- build-up of plant and soil-borne disease; and
- machinery costs.

Integration of livestock in no-till systems – possible pros and cons

Advantages:

- non-chemical control of pests including herbicide-resistant weeds;
- increased biodiversity in plant and soil communities;
- higher soil organic carbon levels;
- more available nutrients (nitrogen); and
- use of excess crop residues and failed crops.

Disadvantages:

- more labour required for stock management and welfare;
- removal of ground cover during grazing, leading to increased erosion;
- patchiness of livestock impact on soil, plants and soil biota;
- redistribution of nutrients to stock camp areas;
- volatilisation losses associated with urine patches;
- soil compaction from livestock movement; and
- weed redistribution.

Managing 'the mix'

- rotational grazing with strict minimum ground cover (50 per cent to 70 per cent) and/or soil condition (especially wetness) levels, together with individual paddock monitoring;
- removal of livestock to sacrificial paddocks or confinement feeding areas;
- livestock agistment; and
- livestock sale.

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Table 1 Summary of the impacts of the livestock-pasture system on six environmental and one production aspect of no-till cropping systems and estimated changes with management options

Aspect	Impact	Type	Stock type			Stocking rate		Grazing management			Pasture type	
			Cattle	Sheep	Goats	Low	High	Set-stock	Rotational	Confinement or removal*	Annual	Perennial
Ground cover	Removal of ground cover, trampling, erosion risk	Negative	↓	-	↓ (?)	↓↓	↓↓↓	↓↓↓	↓↓ or ↓(?)	↓↓↓	↓↓	↓ (?)
	Utilisation/ management of stubble	Positive	↑ (?)	-	↓ (?)	↑↑	↓↓↓	↓↓↓	↑↑	↓	-	↑ (?)
Soil compaction	Decreased pore space, increased bulk density, decreased infiltration, remoulding	Negative	↓	↑↑	?	-	-	↑↑↑	?	↓↓↓	↑↑	↓ (?)
Soil water	Drying of soil profile, decrease in crop yield	Negative	?	?	?	?	?	-	?	-	↓↓	↑↑
	Decreased recharge, lowering of water tables	Positive	?	?	?	↑	↑↑	↓ (?)	?	-	↓↓	↑↑↑
Nutrient cycling	Redistribution of nutrients to stock camps	Negative	↓ (?)	↑↑	↑↑	↑↑	↓	↑↑	?	↑↑↑	-	↓ (?)
	Supply of nitrogen, increased soil organic matter, increased biological activity	Positive	-	↑↑	↑↑	↓↓	↑	↓	↑↑	↓↓	↑↑	↓ (?)
Pest management	Redistribution or burial of weed seeds, reduction in beneficial species	Negative	-	↑↑	↓ (?)	↓↓	↑↑	↑↑	?	↓↓	↓↓	↓↓
	Control of weeds, reduction of stubble and soil-borne diseases	Positive	↓	-	↑↑	↑ or ↓↓	↑↑	↓	↑↑	↓↓↓	↑↑	↓↓
Biodiversity	Decreased species abundance and diversity	Negative	↓ (?)	↑	↑↑	↓↓	↑↑	↑↑	↑↑	↓	↑↑ (?)	↓↓
	Build-up of organic carbon, greater diversity compared with crop	Positive	-	-	↓	↓	↓↓	↓↓	↓	↓↓	↑	↑↑
Integrating crops and livestock	Decreased timeliness, increased management complexity and labour	Negative	↓	↑↑	↓	↓↓	↑↑	↓↓	↑↑	↑↑↑	↓ (?)	↑↑
	Increased crop yield, increased soil nitrogen, pest management	Positive	↓	↑↑	↑↑↑	↓↓	↑↑	↑	↑↑ (?)	↓↓↓	↑↑	↓↓

Symbols indicate the impacts of management in a semi-quantitative manner. Upward arrows indicate an increase in the impact, either negative or positive as greatly increasing (↑↑↑), increasing (↑↑) or slightly increasing (↑). Downward arrows indicate a decrease in the impact, either negative or positive as greatly decreasing (↓↓↓), decreasing (↓↓) or slightly decreasing (↓). A hyphen (-) indicates no effect. (?) indicates uncertain effect or no data. * The impacts of confinement or removal have been assessed assuming that the livestock are not run on cropping paddocks at all.

Ground cover and animal production – the trade-offs

There are advantages and disadvantages associated with the integration of livestock into no-till cropping systems (Table 1).

A review of livestock impacts on no-till systems was conducted by Curtin University of Technology (Muresk) and the Department of Agriculture and Food, Western Australia, on behalf of the GRDC. This examined the effects of grazing livestock on ground cover, soil compaction, soil water, nutrient cycling, pest management, biodiversity and crop production. It also discussed options for managing these impacts.

Ground cover

Grazing of stubbles by livestock in mixed farming enterprises is in direct conflict with stubble retention – an important component of conservation farming. Cropping systems that combine reduced tillage and stubble retention aim to provide soil cover, aid moisture retention and contribute to organic matter recycling.

Positive	Negative
Use/management of stubble	Removal of ground cover Increased erosion risk caused by tracking and trampling
Management	
Use perennial pastures, summer fodder crops and grazing-failed or dual-purpose crops to address feed gaps and maintain annual ground cover. Monitor grazing during summer/autumn to ensure cover levels remain above 50 per cent (1000 kilograms per hectare of dry matter for cereal stubbles, 750 kg/ha for dry pastures) to provide surface stability against water erosion. Use rotational grazing, temporarily remove livestock from areas with insufficient ground cover (to confinement feeding, neighbouring paddocks or other farms) or sell livestock to maintain ground cover.	

Soil compaction

Compaction caused by livestock movement is generally restricted to the top five to 15 centimetres of soil and is concentrated in gateways, camps and around troughs. Soil compaction by livestock is less widespread and shallower than that caused by machinery. Most compaction occurs when livestock trample soils that are wet, lacking in ground cover and/or poorly structured.

Positive	Negative
	Decreased pore space Increased bulk density Decreased infiltration Remoulding, pugging
Management	
Prioritise maintenance of pasture cover in grazing management decisions since soil physical properties are insensitive to stocking rate in the long-term.	

Soil water

Annual crops and pastures in southern Australia do not use out-of-season summer/autumn rainfall. This can lead to episodic recharge contributing to secondary dryland salinity. Perennial crops can improve water use and assist salinity management. Most commercial perennials for dryland broadacre cropping are pastures.

Positive	Negative
Decreased recharge Lowering of water tables	Drying of soil profile Decrease in crop yield
Management	
Integration of perennial crops and pastures can potentially improve water use and assist salinity management in mixed farming systems, however current options are largely restricted to high rainfall areas.	

Nutrient cycling

Nitrogenous fertiliser use has increased dramatically since the early 1990s, mainly due to the intensification of cropping in rotations. Escalating nitrogen fertiliser prices are expected to continue and have prompted renewed interest in sourcing nitrogen from legumes planted during the pasture-livestock phase of mixed farming.

Positive	Negative
Increased supply of nitrogen More soil organic matter Greater biological activity	Redistribution of nutrients to stock camps
Management	
Employ more intensive grazing management, for example rotational grazing, or use portable electric fencing or virtual fencing to create smaller paddocks to control livestock nutrient deposits. Include a wider range of pasture plants in the diet or use feed supplements. Pastures containing varying levels of secondary plant compounds (tannins, terpenes and alkaloids) such as medics and clovers can vary in palatability during their lifespan; this causes grazing patterns to be modified. These methods can alter grazing behaviour and the way nutrients are returned to the soil in animal urine and faeces.	

Pest management

An integrated pest management approach considers chemical, biological, cultural and mechanical control options, including grazing, to tackle weeds, invertebrates and diseases in a way that is specific to the climate, environment, pest(s) and farm/farmer.

Anecdotal evidence suggests control of herbicide-resistant weeds is a major driver for farmers to incorporate livestock in no-till cropping systems.

Positive	Negative
Control of weeds by reducing biomass and controlling seed set Reduction of stubble and crop residues Decrease in soil borne diseases	Redistribution or burial of weed seeds Reduction in beneficial invertebrate species
Management	
Carefully monitor timing and intensity of grazing; manipulate the range of plant species and develop knowledge to distinguish the impacts of grazing on pests and beneficial species. To prevent the introduction of weed seeds by livestock: uphold crop hygiene including withholding periods of up to 10 days; use grazing management to control seed-set or in combination with burning of chaff dumps; and employ good husbandry practices such as shearing sheep prior to seed-set.	

Biodiversity

Livestock's impact on biodiversity in rural Australia is a combination of the direct effects of grazing animals and the impact of changing to a livestock-pasture system.

The key challenge is to encourage contributions that benefit the ecosystem, such as predatory species of crop and pasture pests, without compromising farming profitability.

Positive	Negative
Build-up of organic carbon Greater biodiversity compared with cropping	Decreased species abundance and diversity compared with undisturbed soil
Management	
Maintain native perennial grasses in pastures for associated productivity water use and biodiversity benefits. Employ more targeted use of phosphorus fertiliser when soil tests indicate it is needed to increase productivity. Reduce inputs and grazing intensity in areas inhabited by high-value native grassland. Maintain connected habitats such as linked shelterbelts to encourage beneficial predatory species.	

Converting water into money – the pros and cons

There is a trade-off between income and income variability in mixed farming systems.

Crops convert more water into money than livestock

Systems with a higher proportion of cropping and a lower percentage of livestock generate a higher income, but also face higher income variability. Return on assets is more sensitive to the proportion of livestock than variability in net farm income (Figure 1 a & b).

Higher percentage of cropping = higher income

Generally net farm income (NFI) and return on assets (ROA) increase as the proportion of cropping in a mixed farming enterprise increases.

Higher percentage of livestock = reduced income variability

Conversely, as the percentage of livestock increases in the farming system the ROA declines, however livestock activities reduce the variability of NFI – a phenomenon that is most evident where livestock contributes more than 15 per cent of the income.

Do livestock have a long-term role in no-till cropping systems?

The continuation of livestock in most mixed farms is likely to be influenced by:

- higher prices for livestock, particularly meat;
- declining sheep numbers – a challenge to growers who wish to use livestock opportunistically. There are genuine concerns for the size and genetic diversity of the national flock – a situation that is expected to reach a critical level within the next five to 10 years; and
- if growers are prepared to apply the same level of attention to detail required for rotational grazing or confinement feeding that they currently apply to cropping.

Integrating crops and livestock

Increased frequency of rotational cropping has seen long pasture leys replaced by break crops such as crop legumes and oilseeds, increasing the need for inputs such as nitrogen fertiliser. Threats to continuous cropping from herbicide resistance, disease build-up and poor break crop productivity have subsequently shifted the focus back to pastures, grazed or ungrazed.

Impacts of livestock in the system

Positive	Negative
Increased crop yield Use of pasture legumes to increase soil nitrogen Pest management	Decreased timeliness; conflicts with cropping operations Increased management complexity and labour
Management	
Select appropriate pastures that will fit into this system and conduct a side-by-side assessment of the gains/losses compared with grazed pastures. Use dual-purpose crops that can be grazed in the early stages of grain production in high-rainfall zones. Further research is required to develop varieties for medium and low-rainfall areas. Segregate livestock and cropping into separate land management units. Research is required to examine respective impacts on soil fertility, production and fertility.	

FIGURE 1 a) The effect of percentage of livestock in the total gross margin (TGM) on return on asset (ROA)

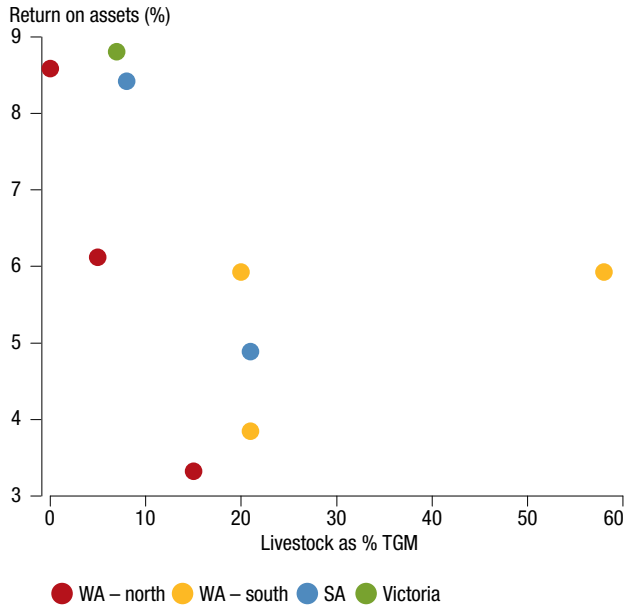
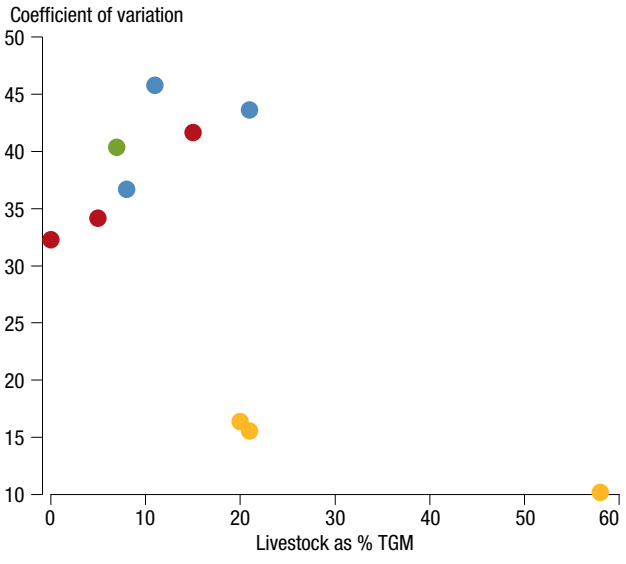


FIGURE 1 b) The impact of percentage of livestock in the total gross margin (TGM) on the coefficient of variation of net farm income (NFI) for case study mixed-farming businesses from Western Australia, South Australia and Victoria



One business in South Australia (SA2) had a calculated ROA of 16% as land is leased, so it is not shown on the graph.

Dual-purpose crops, for grazing and grain production, can be a useful and profitable means of integrating cropping and livestock.

Intercropping, overcropping or companion cropping refers to the combination of crops and pastures, particularly perennial on the same piece of ground, each occurring concurrently for at least part of its life cycle.

Cropping – not an 'all-or-nothing' decision

Research findings and anecdotal evidence suggest that the complete removal of livestock from no-till cropping systems is often not the best approach; that cropping should not be an 'all-or-nothing' decision for most growers.

Long-term economic, environmental and social benefits can be achieved by exploring ways to minimise negative, and accentuate positive, aspects of integrating livestock in the system.

Triple-bottom-line gains can be realised through:

- improved management of grazing practices and livestock production;
- attention to pasture management;
- a move away from the 'stock and forget' approach to sheep management; and
- implementation of precision livestock technologies.

Including livestock in the mix – what are the key determinants?

Determining the 'fit' of livestock in a no-till cropping system is guided by:

- the underlying capacity of the land and environment combined with the relative profitability of cropping and livestock;
- the relative weed burden and the need to manage herbicide-resistant weeds;
- soil sensitivity to damage from grazing and trampling;
- infrastructure; and
- the farmer's passion, preference and career stage.

To establish the best mix for an individual situation, farmers should conduct a balanced evaluation of the benefits and limitations of each, and how various combinations will contribute to overall business goals and profitability.

MANAGEMENT CHECKLIST

It is important for growers to understand the key profit drivers and agronomic management of a cropping system before establishing whether a current system is working.

- Establish the proportion of your farm that is profitably arable.
- Establish the areas of good, average and poor cropping land and the likely production range of each over a range of seasons, for example, wet, dry, average (based on actual historical data to provide worst to best-case scenarios).
- Critique your current weed control program. List all management options available to control weeds in the absence of pasture (including integration of livestock) then ascertain which you would, and would not, use.
- Develop a picture as to what a crop program looks like without a pasture phase in the medium to long-term, that is year-in, year-out.
- When evaluating the options, look at the level of impact on weed control, the cost (capital and operating), ease of use and understanding, reliability and repeatability, effect on capacity (including header capacity, time of sowing, total area of crop spraying), and farmer experience.

SOURCE: ASHLEY HERBERT, FARM CONSULTANT, WESTERN AUSTRALIA

Useful resources:

Grain and Graze	**www.grainandgraze.com.au**
Dr James Fisher, Désirée Futures	**08 9641 1651, Email james@desireefutures.net.au**
Dr Peter Tozer, PRT Consulting	**0418 163 102, Email prt_consulting@live.com.au**
Dr Doug Abrecht, Department of Agriculture and Food Western Australia	**08 9690 2102, Email doug.abrecht@agric.wa.gov.au**
GRDC *Review of Livestock Impacts on No-Till Systems* (2010), Dr James Fisher, Dr Peter Tozer, Dr Doug Abrecht	**www.grdc.com.au/uploads/documents**
Dual-purpose crops fact sheet (July 2009)	**Ground Cover Direct 1800 11 00 44, www.grdc.com.au/bookshop**
Pastures from space	**www.pasturesfromspace.csiro.au**

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