What is hindering the adoption of new annual pasture legumes? Extension requirements to over come these barriers

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Abstract. Farmers and consultants were surveyed to identify current level of adoption and constraints to adoption of new annual pasture legumes in the mixed farming zone of Western Australia. Subterranean clover is the most widely grown annual pasture legume and promoted by all the consultants. French and yellow serradellas and biserrula are recommended by up to 40% of consultants and grown by 20 to 30% of growers: far less than sub clover. Adoption is considered to be constrained by the 'cost of establishment' along with unpredictable/unreliable seasonal rainfall. The consultants suggested there is potential for wider adoption of the new pasture legumes across the mixed farming zone of Western Australia. They regard the information produced from the Department of Agriculture and Food WA as reliable, but want more information. Extension resources need to enable farmers and their consultants to estimate benefits of legumes in systems in which livestock are absent or less important. Key learning's:

- In order to successfully integrate new annual pasture legumes into farming systems, growers and consultants need to be provided with information on economic benefits as well as technical detail relating to production and management.
- The main barriers to adoption of new annual pasture legumes are the perceived cost of establishment and unreliable production in variable environments.
- Subterranean clover is the most widely grown and recommended pasture species and a useful benchmark against which to compare the performance of the new species.

Keywords: annual pasture legumes, adoption, subterranean clover, extension

Introduction

Temperate legumes pastures have become an essential component of farming systems in Southern Australia, covering an estimated 23.5 million hectares by 1997 (Sandral et al. 1997 cited by Norman et al. 2000). However, changes to farming systems over the last 15 or so years have exposed shortfalls in the two species on which these farming systems have largely been dependent: subterranean clover (*Trifolium subterraneum*) and annual medics (*Medicago sp.)*(Nichols et al. 2006). In order to overcome their limitations, more than forty new annual pasture legumes have been developed (Nichols et al. 2006) with traits including: deeper root systems, increased hard-seededness for persistence, acid tolerance, greater insect and disease tolerance as well as being aerial seeded which gives the ability to harvest the seed with a conventional header (Loi et al. 2005). In spite of the broad suite of pasture legumes now available, Salam et al. (2008) consider the level of adoption of the new cultivars to be less than would be anticipated by their performance. The potential of the new annual pasture legumes is yet to be realised in the low to medium rainfall areas of Western Australia where intensity of cropping is increasing on good soils and livestock is pushed to poorer soils (Norman et al. 2000). This paper reports findings from surveys of farmers and commercial agricultural consultants examining what they considered to be the barriers to wider cultivation of some of the new pasture legumes.

Farmer adoption of particular cultivars or other technologies is not solely predicated on the relative advantages of the technology but also depends on social, cultural and personal factors of the target community and the 'trialability' of the technology (Pannell et al. 2006). The advantages of particular pasture legumes are relative to all other types of pasture, other legume and non-legume break-crops, and synthetic sources of nitrogen. Their comparative advantages are impacted by changing climate and wider changes in the agriculture sector, such as the relative profitability of grain and livestock production, reflected recently in the increased proportion of cropping in mixed farms in Southern Australia (Ewing and Flugge 2004; ABARE 2009). Social, cultural and personal factors impacting decisions taken by farmers are well described by Pannell et al. (2006) and range from capacity to process new information to social networks and a broad range of factors associated with values, goals and financial management styles of the farming unit.

The research described here assumes the participating farmers and advisors were aware of some new annual legumes. It surveyed farmers and agricultural consultants to determine if they saw greater potential for the pasture legumes and which factors may be limiting their adoption.

The findings reported here are part of a research project of the Department of Agriculture and Food Western Australia (the Department), funded through Pastures Australia, which aims to "overcome the constraints to adoption of new annual pasture legumes in the medium and low rainfall mixed farming zone of Southern Australia". The main constraints addressed by the project include weed management problems, high cost of establishment and grower concerns about photosensitisation of sheep grazing biserrula (*Biserrula pelecinus*) dominant stands. The project is developing three pasture management technologies to address these problems. 'Autumn-cleaning' is a weed management strategy in which a combination of non-selective herbicides and grazing remove weeds prior to the germination of new annual pasture legumes. Eastern star clover (*T. dasyurum*) and Santorini[A], a yellow serradella variety (*Ornithopus compressus*), are suited to this technology as they express a delayed germination of up to six weeks (Ferris 2008). Establishment costs of new hard seeded annual pasture legumes can be reduced by under sowing the seed with the preceding crop for germination the following year (Loi et al. 2008): a technology promoted under the name of 'twin-sowing'. A third component of the project is development of a grazing management package which will reduce the risk of photosensitisation from biserrula.

These initial surveys were conducted to provide benchmark information about: (1) the use of both the traditional (subterranean clover) and new annual pasture legumes (biserrula, yellow and French serradellas (*O. sativus*) and gland clover (*T. glanduliferum*); (2) the state of grower knowledge about 'twin-sowing', 'autumn cleaning' and management of photosensitivity in biserrula; (3) what are the main constraints to adoption of the new annual pasture legumes; and (4) where consultants get their information from and what extension tools they require to be able to advise clients on pastures with confidence. The results of these surveys are being used both to shape the development of the management packages (the technologies) to optimise the comparative advantage of the legumes in farming systems, and extension tools which will be made available to farmers and their advisors so they can make better decisions about adoption and/or adapt their management to meet emerging challenges.

Methodology

Surveys were conducted with farmers from the areas considered suitable for the technologies and with agricultural consultants, because of their potential role in assisting farmers to evaluate the technologies

Grower survey

A survey of farmers was conducted in March 2008. Targeted sampling from a database held by the pasture research group in the Department produced a sample size of 170. A structured questionnaire was administered by telephone to allow open-ended questions with interviewer probing (Neuman, 2000). Some questionnaires were distributed through grower groups. Farmers from 37 shires across the low (275-325mm) to medium (325-400mm) rainfall zones of the wheat belt of Western Australia completed 69 surveys: 32 from the central agricultural region, 21 from the northern agricultural region and 16 from the southern agricultural region. 60% of respondents were members of a grower group, the main ones being the Corrigin Farm Improvement Group, Ravensthorpe Agricultural Initiative Network, Liebe and Western Australia No-Tillage Farmers Association. The project is working with members of these grower groups.

The questionnaire used predominantly open-ended questions with some multiple-option and unstructured questions. It had three variations, the application of which depended on whether the respondent was growing new annual pasture legumes (biserrula, yellow serradella, French serradella and gland clover) at the time of survey. The survey asked how pastures are used in the respondents' farming system, their opinion about limitations/constraints to adoption of new annual pastures and awareness of three project technologies.

The data obtained was mainly qualitative and was grouped into themes. Descriptive statistics rather than statistical analysis were derived.

Consultant survey

A sample of 150 agricultural consultants active in the central, northern and southern agricultural zones (as determined by the department) of Western Australia were invited to participate in an online survey in the spring and summer of 2008. Non-probability sampling, with some targeted sampling for consultants with expertise was used. A total of 34 surveys were completed from respondents who consult in the low (275-325mm), medium (325-400mm) and high (>400mm) rainfall zones of Western Australia. Two respondents appeared to "drop out" part way through the survey so the responding sample size was corrected for the remaining questions.

The on-line survey form used a combination of open-ended, multi-option and unstructured response questions to ask about consultants about their clients' circumstances; legume pastures; annual pasture legumes; information and extension. Most of the data collected was qualitative so key themes were identified and descriptive statistical analysis performed. Seven (20%) respondents failed to answer one question the distribution of their clients across three rainfall zones. Due to problems with the programming of the survey tool, consultants were unable to answer one question asking why clients grew legume pastures and another asking their perception of barriers to adoption of the new annual legumes.

Results

Current use of annual pasture legumes

Subterranean clover is the most widely grown (83% of grower respondents) and recommended (100% of consultant respondents) annual pasture legume (Table 1).

Table 1. The main legumes consultants advise their clients to cultivate

Sub. Clover	Yellow Serradella	French Serradella	Biserrula	Gland Clover
100%	50%	50%	44%	3%

(Proportion of the 32 respondents who advise clients to cultivate nominated species)

Of the recently released annual pasture legumes, yellow and French serradella are the most widely grown (Table 2 and 3) and recommended (Table 1) followed closely by biserrula. In particular Cadiz[A] (French serradella) was the most widely grown of the new annual pasture legumes according to the grower (Table 2) and consultant surveys. Gland clover was the least recommended and grown of the new annual pasture legumes.

Table 2. Number and % of farmer respondents who currently grow the new annual pasture legumes

Species	Cultivar	# of respondents	% of total respondents
Biserrula	Casbah	14	20%
	Mauro[A]	1	1%
Yellow Serradella	Santorini[A]	3	4%
	Charano[A]	7	10%
French Serradella	Cadiz[A]	15	22%
	Erica[A]	3	4%
	Margurita[A]	4	6%
Gland Clover	Prima[A]	5	7%

Table 3. Consultants' estimates of the proportion of their clients growing nominated pasture legumes

Proportion of each consultants' clients who grow the legume	None	<5%	6-10%	11-15%	16-20%	>20%
Yellow Serradella	9%	28%	34%	16%	12%	0
French Serradella	9%	34%	22%	22%	6%	6%
Biserrula	9%	41%	22%	19%	9%	0
Gland Clover	44%	50%	3%	3%	0	0

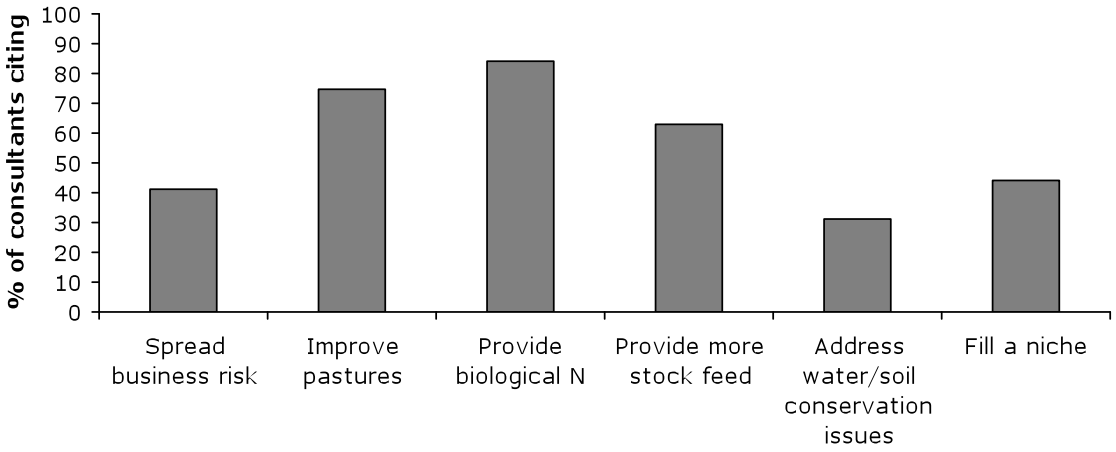
(shown as % of respondents nominating each level for each legume pasture)

Consultants were asked if the annual pasture legumes had been promoted in their area, with a binary choice answer of a little or extensively. Over two thirds of the consultants promote yellow and French serradella as well as biserrula. Gland clover was only promoted by 20% of the consultants and had received little promotion. Fewer consultants reported that biserrula had received extensive promotion but around half the respondents stated yellow serradella and French serradella had been extensively promoted in their "territory".

Both surveys asked why pastures were being grown on farms. Growers indicated the main purpose for retaining pastures in their farming systems was livestock feed (92% of respondents), nitrogen fixing abilities (51%), weed control (26%) and as part of a rotation (21%). However, as noted above, consultants were unable to respond to the question.

Consultant respondents promote the legume species mentioned in Table 1 for provision of biological nitrogen (84% of respondents), improving pasture (75%) and to provide more stock feed (63%) ahead of other functions (Figure 1), Respondents could, and many did, choose multiple reasons. Weed control was also advanced (further to the choices offered) by 5 consultants (15%) as a reason for their advocacy of these pastures.

Figure 1. Reasons consultants recommend the pasture legumes: Frequency of respondent choices from a menu.



Livestock and cropping trends

Since the primary role of pastures has been to feed livestock, growers were asked about their livestock numbers. All but one respondent had sheep, however they were reducing stock numbers and increasing the length of the cropping phase in response to high grain prices and low returns from livestock. The consultants also reported a clear trend of declining sheep numbers, with two consultants reporting that 100% of their clients were completely de-stocking. Most of the farms are reducing stock numbers while retaining some for pasture rotations (an average of 53% of clients by respondent). Only three consultants (working on the south coast) said that more than 50% of their clients were not changing the proportion of grazing and cropping areas. Only three of the consultants reported 70% or more of their clients were maintaining their current ratio of grazing to cropping.

Grower experience with new annual pasture legumes

25% of the grower respondents have not grown annual pasture legumes other than subterranean clover. Only half of growers were actively seeking information about annual pasture legumes, their main interest focussed on hard-seeded serradellas and aerial seeded clovers, in particular gland clover and the new bladder clover (*T. spumosum*).

20% of the grower respondents had grown the annual pasture legumes other than subterranean clover, however no longer do so. Species they had grown included French serradella (Cadiz[A]) (57% of former growers), biserrula (43% of former growers), yellow serradella varieties (21% of former growers) and 7% of former growers had dis-adopted both French serradella (Margurita[A]) and gland clover (Prima[A]).

Four main reasons for ceasing to grow these new annual pasture legumes emerged: technical problems relating to performance including unreliable establishment and persistence (50%), weed management problems (36%), financial considerations (36%) an inability of these species to cope with season variation (21%).

Consultants reported their clients have experienced several problems with the new annual pasture legumes. Weed control is considered a problem for the four species (Table 4). Regeneration and establishment issues were also cited fairly frequently, but more pronounced for the serradellas than biserrula or gland clover. Insects, grazing tolerance, harvesting and

seed production were also recorded as problems (Table 4). No one mentioned disease as a problem. The survey design included space to write in "other" problems.

Table 4. Problems with the [new annual pasture legume] species experienced by consultants' clients

Problem	Yellow Serradella		French Serradella		Biserrula		Gland Clover	
Weed control	18	(56%)	18	(56%)	17	(53%)	4	(12%)
Establishment	12	(37.5%)	11	(34%)	9	(28%)	4	(12%)
Regeneration	12	(33.5%)	15	(47%)	6	(19%)	4	(12%)
Insects	9	(28%)	7	(22%)	5	(16%)	2	(6%)
Harvesting	8	(25%)	7	(22%)	7	(22%)	3	(9%)
Seed production	6	(19%)	7	(22%)	5	(16%)	2	(6%)
Grazing tolerance	2	(6%)	2	(6%)	8	(25%)	1	(3%)
Disease	0		0		0		0	

(from 32 respondents, the table shows the number who checked each of the buttons represented by boxes in the table (% of total in brackets))

Adoption potential and constraints

Few of the consultant respondents considered the potential for adoption of the annual legumes to be high (Table 5). However consultants advising farmers in the medium and low rainfall zones tend to see greater potential for adoption of the new annual legumes than do their colleagues in the high rainfall zone. The serradellas were considered by more respondents to have medium or high potential for adoption than biserrula or gland clover (Table 5). It is striking that even without considering the area to be grown, 80-90% of responding consultants considered that less than 25% of their clients could potentially adopt these legumes.

Comparison of Tables 3 and 5 indicates that the level of adoption of the new annual legumes is less than consultants' estimation of their potential. Around 70% of all the respondents indicate that no more than 10% of their clients grow any one of the legumes (97% for gland clover). Half of the respondents indicated that biserrula is grown by less than 5% of their clients. 44% of respondents said their clients do not grow gland clover at all (Table 3) and 53% of respondents consider it to have a low potential for adoption among their clients (Table 5).

Table 5. Consultants' estimates of the potential for 'adoption' of annual pasture legumes in their client area

Pasture	Low (<5% of clients)	Medium (5-25% of clients)	High (>25% of clients)	Totals
Yellow Serradella	25%	56%	19%	100%
French Serradella	28%	59%	12%	100%
Biserrula	41%	47%	12%	100%
Gland Clover	53%	41%	6%	100%

(frequency for each ranking shown as proportion (%) of 32 respondents)

Farmers consider unreliable and/or unpredictable seasons to be one of the main barriers to adoption of the new annual pasture legumes in all 3 agricultural regions (Table 6). It must be noted that prior to the survey being conducted several years of drought have occurred in the northern agricultural region and unpredictable/unreliable seasons in the central and southern agricultural regions. The cost of establishment was raised as a barrier to adoption by almost half of the respondents from the southern (44%) and central (47%) agricultural regions (with 24% of respondents in the northern region). In the central region, 34% of respondents suggested that the increasing profitability of cropping enterprises against sheep production was a disincentive to adoption of the new annual pasture legumes. The inter-related problems of weed control and impact of herbicide, including residues, on the growth and seed-set were also listed as barriers to adoption.

Table 6. Growers' perception of barriers to adoption of the new annual pasture legumes

Constraint to adoption	Northern (% of 21 respondents)	Central (% of 32 respondents)	Southern (% of 16 respondents)
Unreliable/unpredictable seasons	38	38	44
Cost of Establishment	24	47	44
Weed Control	29	9	19
Problem soils & inability to match to right soil	5	6	38
Relative economics of sheep and crop	14	34	13
Herbicide residue problems	14	9	-
Pest Problems	10	3	31
Lack of persistence	10	19	6
Lost time & grazing during establishment	10	9	25
Lack of early dry matter production	10	-	6
Lack of education	5	6	6

Consultants were asked what is holding their clients back from adopting the new annual legumes; unfortunately the online survey form malfunctioned and any data from the checked buttons is invalid. However weed control and cost did feature and some respondents used the space provided to describe "other" problems to clarify their response. Some examples are: "The cost of establishment of any pasture in a pasture crop rotation is massive. I am advising a number of clients to re-sow this year. We are using sub clover. Cheap, reliable and performs in our environment. With phase cropping canola/barley/pasture there is no need to reseed the subs they come back marvellously and terrifically well". Another commented "sub clover is a more robust legume in our system". A more open sentiment is found in the need for "proof they work in a constantly changing system; proof that changing pasture species is important full stop".

Awareness of the technologies for increasing utility of new annual legumes

This survey assessed farmers' awareness of three technologies which have been developed to increase overcome some of the constraints on adoption:

1. 'Twin-sowing' hard seeded annual legumes with a grain crop to enable establishment of the pasture legume the following year
2. Control of weeds in hard seeded annual legumes by using knock-down herbicides prior to germination of the pasture ('autumn-cleaning')
3. An effective management system for biserrula to reduce the risk of photosensitivity.

Awareness of 'autumn-cleaning' is limited (30% of respondents). However 85% of respondents were already aware of the 'twin-sowing' technology. However they associated a variety of practices with that name. Some said they had under-sown crops with subterranean clover, others under sowed with lucerne.

More than 60% of respondents were aware of the potential for photosensitivity in biserrula dominant pastures. Many of these had not personally grown biserrula, as only 29% of respondents had ever grown biserrula. For the other 31%, knowledge of biserrula issues comes from agricultural magazines and newspapers.

Information on Pastures

Roughly half of the consultants responding to the survey obtain information about pastures from the internet and from published documents. However, when they specified which websites or the publishers of documents it became very clear that a large role is played by DAFWA staff and publications (Table 7). Of 32 consultants completing the survey, 26 (76%) obtain information about pastures from the DAFWA sources: 47% use the DAFWA website, 43% use the DAFWA publications and 59% cite experienced DAFWA personnel their source of information regarding pastures. Several consultants mentioned their use of publications from the Grains Research and Development Corporation and other research organisations.

Table 7. Where consultants obtain their pastures information

Source	Internet	Publications	DAFWA staff	other
No responses (% of sample)	17 (53%)	19 (59%)	19 (59%)	18 (56%)
DAFWA sources	15	14	19	0

Most consultants regard the information they have received as accurate, probably because they consider it to be based on relevant trials, rather than speculation or extrapolation (Table 8). However there is a clear need for more information (Table 8).

Table 8. Consultant evaluation of pasture information they have received

Inadequate	52% (13)	Complete	48% (12)
Inaccurate	11% (2)	Accurate	89% (16)
Speculative/extrapolation	18% (4)	Based on relevant trials	82% (18)

The consultants requested additional technical information including:

- how the legumes can be integrated into crop herbicide programs and options for weed control
- economic information comparing pasture rotations with and without stock
- economic comparisons of pasture versus fallows and other break crops
- specific agronomic requirements for management and performance of each cultivar
- information on new releases

Some consultants noted that all information should be simple, quick and easy and to access by growers and consultants.

With regard to form of technical information, from a non exclusive choice of three extension tools, 53% of respondents expressed a need for management packages, 41% need a reference file and 26% need a pasture course specifically for consultants to increase their confidence in providing advice. Other extension tools requested by the respondents include trials and updates on new releases via email.

Some of the consultants' general suggestions for extension of pastures included:

- Extension should focus on pastures to improve cropping through robust weed control and nitrogen fixation even without sheep since cropping pays the bills;
- Species aren't the limitation but poor adoption of better practices;
- PROMOTE pastures within the whole farming system through a holistic approach focusing on economics and sustainability rather then simply the species or cultivar;
- More trials for low rainfall areas
- Web based decision support tool

Discussion

Use of legume pastures

The legume component of pastures in the wheatbelt of Western Australia continues to be dominated by subterranean clover, grown and recommended by a majority of respondents. The large number of positive comments from respondents about sub-clover suggests that performance of subterranean clover should be considered as a benchmark against which new annual pasture legumes are compared in extension efforts. Comparison of consultants' estimation of the potential for yellow and French serradella (Table 5) with the current level of adoption (Tables 2 and 3) suggests there is an opportunity for increased adoption, but less for biserrula.

Holt and Russell (2005) point out that promotion ought to relate to the needs within the farming system. Given the changes occurring in farming systems, extension activities need to explain the role and benefits of the new annual pasture legumes within the emerging systems. Both surveys showed that farmers are reducing stock numbers and increasing the length of their cropping phase in response to high grain prices and low returns from livestock, as also reported by Loi et al. (2008). As a result, the area available for managing of rotating sheep has diminished. This is a particular constraint on managing photosensitivity in biserrula. Farmers need some biserrula-free pastures on which they can graze sheep when there is a risk of photosensitivity occurring. It also constrains farmers' capacity to remove grazing pressure from aerial seeded legumes during flowering and seed set. Pasture management systems need to be developed to enable farmers to work within these constraints.

Even in farming systems in which the role of livestock is reduced, legume pastures produce benefits other than livestock production. For extension purposes, those benefits need to be demonstrable and probably quantified. Extension statements of economic benefits of pastures to farming systems can no longer rely on quantification of only the contribution to livestock production with only qualitative observations about additional benefits to soil or agro-ecosystems such as in Bathgate et al. (2006). If the primary benefit of the pasture is going to be residual nitrogen, altered hydrology or longer term benefits to the cropping phase in the system, then agricultural consultants will need adequate information to enable them to introduce these factors into their economic modelling of the alternative scenarios. As one consultant wrote "I can promote them, but the economics of pastures without livestock in the system and the benefits to the rotation with good agronomic outcomes need to be addressed". Gibson et al. (2008) present results of modelling for eastern star clover which shows gains from control of herbicide resistant weeds, however such modelling needs to be repeated to include comparisons of a range of destocked or non-livestock rotations. Then this information needs to be available to consultants.

Potential and constraints to adoption of new pasture legumes

The factors contributing to limited adoption of the new annual pasture legumes indentified in this research are consistent with other studies. Hackney et al. (2008) suggested that it is likely that the recent droughts and unpredictable seasons had a significant impact on the performance and perceptions regarding new annual pasture legumes in New South Wales. In Western Australia, drought in the years preceding the survey eroded capacity of farmers in the worst affected region to invest in cultivating anything other than crop. Cost, particularly cost of establishment, is also cited as a major barrier to adoption of the new annual pasture legumes. Guerin & Guerin (1994) point out that "innovations will not be adopted if they are perceived to be unprofitable, risky, not easily integrated into existing farm practices, or too complex". Responses to the surveys show that the new annual pasture legumes are still under scrutiny. Farmers who have successfully integrated them into their systems have been able to counter the complexity with extensive personal consultation with pasture scientists. This high level of extension helped them adapt their farm practices to get the best out of the pasture. Wider adoption would require this management information to be more readily available to farmers and their advisers.

Eighty-four percent of the participating consultants promote pasture legumes for biological nitrogen fixation. All of them advise their clients to grow sub-clover and some are sceptical of alternatives. Perhaps such consultants need to be encouraged to take a more nuanced view of the annual pasture legumes rather than expecting single or few utility species to suffice in all situations. Describing an agenda for a "new annual pasture legume revolution" Nichols et al. (2006) indicated that the new legume cultivars were developed to fill a large number of potential ecological niches and the match between niche and cultivar needs to be described by a" multi-dimensional matrix" rather than a broad-scale swathe across a map. 88% of consultants surveyed consider less than 25% of their clients are potential adopters of both French and yellow serradellas and biserrula. Research and extension teams can work with those consultants who already see potential for adoption, to increase their working knowledge of the new annual pasture legumes.

New technologies

Since cropping is the economic driver of farming systems now and for the foreseeable future, pastures will only receive investment or management if they clearly enhance crop production and not jeopardise it's profitability through weed competition or seed contamination of the harvest. The 'autumn-cleaning' knock-down weed control technology is still under development (Ferris 2008) so only 30% of farmers surveyed had heard of it. However, many respondents suggested it could exacerbates the autumn feed gap, so this technology may only be viable for farming systems that have reduced stock numbers and where feed is not scarce at the break of the season. The existing level of awareness of 'twin-sowing' hard-seeded annual pasture legumes with the preceding crop for germination the following year (Loi et al. 2008) can be built on by ongoing research and extension. Biserrula is regarded as having low potential by 41% of consultants, yet only 9% of farmers surveyed had dis-adopted, or ceased growing it.

Information and extension

Findings from this survey align with those of Hackney et al. (2008), that more information on establishment and management of the new legumes is required and that research and extension in the different regions needs to address their specific needs. The existing information is credited as being based on evidence and accurate, a reputation that should be protected.

However since 52% of responding consultants consider the information now available is incomplete, there is a mandate to close this gap.

Missing in the gap is data showing how pastures contribute to cropping systems without livestock. Information based on trials of these systems needs to be available. Extension resources covering the values of annual legume pastures need to be available to growers and advisors or consultants. The challenge for extension of the growing suite of legumes suited to niche situations is to make available the full range of information which enables farmers and their advisors to relate the options to their own needs and derive specific recommendations which they can implement. Since such tools are more complex than simple brochures, the survey asked consultants what would help them.

Their responses suggest that few consultants would utilise a form of in-service training course in pastures, but that more would be interested in management packages and technical reference files. These need to be available in a format which is easy for consultants and growers to use. If the same kind of data about the whole range of options were to be available through the internet they are likely to be consulted, since the internet is used roughly as frequently as any of the sources listed in the survey.

Conclusion

The role of pastures within farming systems in Western Australia is changing as the importance of livestock in farming systems diminishes. Biological nitrogen fixation from legume pastures continues to be valued, particularly if they can also make cost effective contributions to disease break and control of herbicide resistant weeds. However, many farmers prefer low cost resilient legumes like sub clover to newer aerial seeded species which some growers perceive to have high cost and management issues, such as high cost of establishment, pest and weed control or susceptibility to herbicide damage. Innovative technologies such as ‘twin-sowing’ and ‘autumn-cleaning’ are being developed to increase the comparative advantage of the new annual pasture legumes. Twin-sowing is generally recognised by 85% of farmers surveyed so the extension challenge is to help farmers assess it and encourage decisions to trial it (Pannell et al. 2006). The role of ‘autumn cleaning’ in farming systems needs to be clearly identified and extension tools developed to target and inform potential growers of legume pasture for whom the autumn feed gap is not so critical.

To integrate the newer aerial seeded pasture legumes into farming systems requires changes to crop and pasture management systems. Hence they will not be adopted widely if they are simply promoted as an alternative to sub-clover or medics. Their promotion needs to be packaged with descriptions of the optimum niche for that legume or mixture (Albertson 2004) together with explanations of the best management options for them. An ongoing program of trials with grower groups is an effective way to build up the knowledge base of the legume systems (Gianatti and Carmody 2006). The recent drought years hindered trials in the northern agricultural region, but trials in such locations need to continue through the cycles of seasons to generate sufficient data which can be used in decision-support models.

Extension information provided through the Department is important and highly regarded by consultants in Western Australia. However, almost half of consultants surveyed consider existing information to be insufficient. Many consultants suggested that they would like more information on the new varieties so they can make recommendations appropriate to the farming system and rainfall area. As these new species offer specific advantages to niches that may differ in differing systems, they need to be promoted on the basis of those qualities applicable to particular farming systems. So if farmers and consultants are adequately informed of the new annual pasture legumes and associated technologies along with economic benefits to their or their clients rotation, then there is a greater chance that the technical and cost barriers to adoption will be overcome.

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