Time lags to adoption: Acquisition of variety information by West Australian wheat growers.

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Using the 'Time Lag to Adoption' approach the acquisition of varietal performance data by West Australian Wheat growers is examined.

Areas were there are anomalies in varietal deliveries pointed to areas where there may be significant differences in the adoptive behaviours of growers, or differences in the activities of public or private extension agencies. Significant differences are found.

Information network positions are used to supplement the 'Time lag' methodology, producing an eight fold increase in the predictive ability of the time lag model in this instance.

KEYWORDS: ADOPTION, TIME LAGS, WHEAT VARIETIES, INFORMATION ACQUISITION

Growing the variety best suited to an area is vital to the farm economy, and is one of the few management options which does not involve addition cost. Even a three per cent increase in yield may mean a twenty per cent gain in profit on many farms. A number of new varieties have been released over the past few years and these are now having an impact commercially. In the 1986/87 season over half the wheat area was sown to new varieties that yield better than the old varieties like Gamenya, Halberd and Madden.

It is even more critical nowadays to take advantage of the improved returns offered by higher-yielding varieties. Assessing the relative merits of different varieties quickly is a major problem for growers as new varieties with varying application to local conditions are emerging constantly. This is why scientific services are provided to make these assessments and recommend appropriate varieties.

(Fisher 1987)

You can toss wheat in and it will grow.

(A former chairman of the Wheat Board said).....'Any fool can grow wheat', and he meant it and he was right.

(Hurley, Fitzgerald, Harvey and Oppenheim 1987)

Introduction

Adoption levels of wheat varieties in Western Australia have been variable over the past 20 years. Those in control of extension services in Western Australia have long been concerned with the variability of the adoptive behaviour, with respect to wheat varieties, on a regional and local level throughout Western Australia (Parkin 1989).

The broad aims of the study which this paper has evolved from were to examine the rate and level of adoption of new wheat varieties by Western Australian wheat growers, and to characterise the grower attributes that are likely to be determinants of the rate and level of adoption.

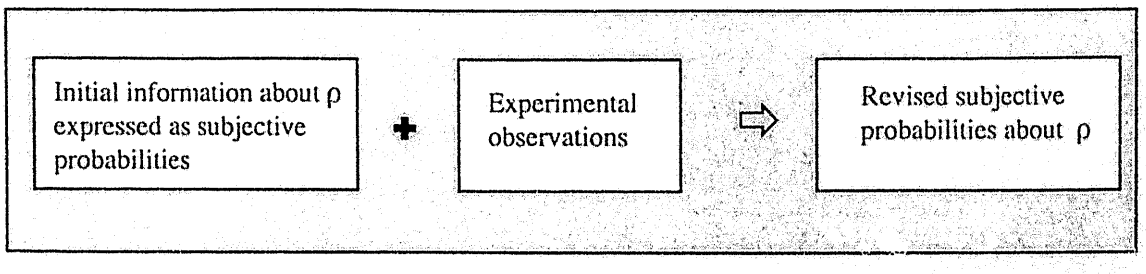
The provision of primary information about new wheat varieties in Western Australia is undertaken mainly by the Department of Agriculture, Western Australia, and a number of more prominent registered wheat seed growers and seed merchants. It may be suggested that the validity (repeatability) and the accuracy (reliability) of information about new wheat varieties disseminated by these sources are likely to be central to the acceptance of information about new wheat varieties.

Some of the questions that precipitated the study, which broadly falls into Lindner's classification as being a cross-sectional study of adoption (Lindner 1987), were

- Where do West Australian wheat farmers gather information about new wheat varieties?
- Is it possible that the grower will be wary of information from a source that has proved to be unreliable in the past?
- Do West Australian wheat farmers consider information from one source to be more valid or more reliable than from others?
- How much value would they place on information from one source as opposed to another?
- Does the 'early adaptor' seek information from sources with a local context, a regional one or from sources that may be distant in a spatial and or sociological sense?
- What validity is ascribed to the Department of Agriculture's Crop Variety Testing trials by the growers?
- Do growers look at and follow the progress of specific new varieties?
- Do growers look at the Crop Variety Testing trials at times other than field days?
- How do growers assess the performance of wheat varieties, both before and after trial on their own farm?
- To what level of sophistication do growers monitor the performance of new varieties on neighbouring properties?

By evolving from Lindner's (1987) work it is possible to speculate that in the potential for adoption of new wheat varieties, the grower is confronted with a 'risky choice' relative to the existing known varieties when deciding whether or not to use a specific new variety. Therefore the grower is in a state of uncertainty about the likely performance of the new variety and the impact of the variety's performance on their farm enterprise. Consequentially the grower will seek out information about the new variety's, therefore reducing the level of uncertainty. If a new variety proves to suitable for their enterprise as a consequence of the information search, the grower would then trial the new variety on their own farm. Such an approach follows the principles of Bayes' Theorem (Dale 1991).

Figure 1: Diagrammatic representation of Bayes' Theorem. (Griffiths 1987)



There is a time lag between the release of a new variety and time at which an individual grower chooses to grow the variety. The time lag is variable though its nature. For growers who have ready accesses to information about new varieties through their location or willingness to seek the information, the lag can be minimal. Those who do not have immediate access to information or are not actively seeking information about new varieties will have greater lags until awareness, information acquisition, trial and finally adoption or rejection of the new variety. These lags and a selection of the variables that may be influencing them were studied and correlated with a number of characteristics of growers, the information obtained is used in the construction of an empirical model.

The study examines the processes by which Western Australian wheat growers

- Discover new wheat varieties
- Seek more information about the variety
- Reach the point at which the grower moves from the information seeking phase to the actual process of trial of the variety on farm
- Reach the point at which a decision is made to bulk up the variety for inclusion in the inventory of varieties available for planting
- Reach the final stage of the adoption process where the disadoption of the variety begins.

Working definitions

There are a number of concepts or relationships within the body of this work that require definition, specifically with reference to the behaviour of wheat growers in the context of the research. The definitions that follow are intended to exemplify their meaning in the context of this work.

Reliability: In this paper reliability will be considered to be when a determination of an event is proven to be accurate through alternate techniques. Paten (1965) indicates that 'reliability', (precision of an estimate in unbiased random sampling) is the closeness with which that estimate approaches the true value for the universe. The statistical measure of reliability is its standard error.

Validity: In this study validity will be considered to be the ability of an event to be replicated and provide the same or similar outcome as in previous occurrences. That is, when questioned or interrogated in a manner that is designed to bring about a similar response. Paten (1965) provides more stringent definitions. Validity can be assessed through the use of test-retest and test-test techniques. Test - retest techniques involve the repetition of the same interrogations over a period of time, with test - test techniques requiring the use of different interrogations designed to elicit the same information asked at the same time. Rigorous statistical analysis of these concepts can be found in Minum (1978).

Quality: In the context of this work quality is functionally derived from reliability and validity. In short it refers to the appropriateness to the task - usually of information.

More specifically it refers to

- the credibility or reliability of the information source,
- the specificity of the information - is it region; shire; district; farm or perhaps paddock specific and
- growers evaluation of the degree of relevance of the information and does it contain mean and variable yield: disease resistance; grain characteristic and milling property information.

Wheat variety information: A Western Australian context

An increase in the breeding and development of wheat varieties for Western Australian growing conditions has resulted in the availability to growers of eleven new varieties since the late 1970's. This is in stark contrast to the previous 20 years when only three new varieties were released (Lewis 1989).

The resultant uptake of the new varieties has been marked by areas of rapid adoption. This is contrasted by slower adoption areas. This variation may be attributed to a number of factors, with a resultant disparity in returns that growers could expect to achieve as a consequence of adopting the new varieties. Fisher (1985) suggested that lost returns to West Australian growers through non adoption of the new dwarf wheat's to replace Gamenya, Halberd and Madden in 1984 were in the order of $60 million.

Fisher (1985) had reported that the adoption of wheat varieties has been variable throughout the state, with isolated pockets of growers or individual growers continuing to grow non recommended varieties. The problem has been highlighted by Department of Agriculture, Western Australia staff on a number of occasions (Parkin 1989 and Brown G 1990).

In the context of information provision about new wheat varieties, anecdotal evidence both collected by the author and alluded to by Lewis (1989) would suggest that there is a deal of scepticism amongst West Australian growers as to the reliability of information about wheat variety performance and the sources of that information. This issue was partially explored by Lewis (1989), through the examination of the application of available information on new wheat cultivars by a sample of West Australian wheat growers. Sixty eight per cent of 1100 growers in the Department of Agriculture's M2, M3, M4, L2, L3 and L4 recommendation areas (Figure 2) responded to a questionnaire on a number of matters pertaining to information generated from the Department of Agriculture's Crop Variety Testing program. Amongst an number of other findings, Lewis (1989) found that there is little variation between the agronomic practices associated with the Crop Variety Testing sites and those of the grower who farmed the property on which the test site was located. Further to that he suggested that

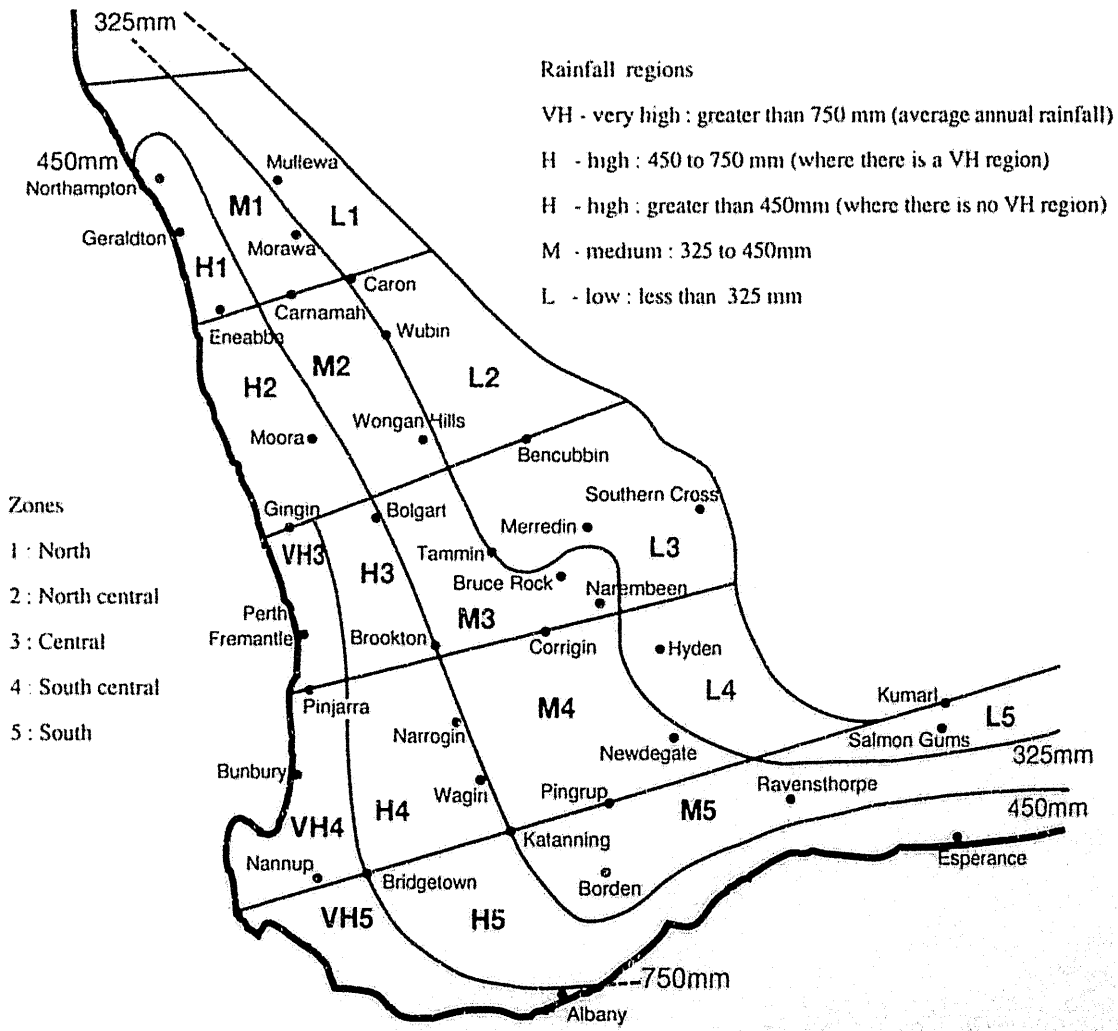
growers' attitude toward new wheat cultivars are largely determined by the source of their information about wheat cultivars rather than by their own experience with these cultivars.

Which is consistent with conventional group and network theory and that

It is likely that the rate of adoption of wheat cultivars could be increased by encouraging growers to make better use of the Wheat Variety Bulletin and advisers."

This statement was founded in a correlation between those growers who found new cultivars to be better and those who rated Department of Agriculture publications and advisory staff as 'important'. While this may be plausible there are other considerations that would suggest that 'better use' is largely a function of quantity and quality - reliability and validity. These matters will be considered later in this paper.

Figure 2: Department of Agriculture, Western Australia Crop Variety Testing and Recommendation areas.



Crop variety testing and registered seed growers

The Department of Agriculture, Western Australia has for some 25 years been conducting the current crop variety testing program or its predecessor. The role of the program is to test both new and recommended varieties of crops - sourced from both the Departmental breeding programs and other breeders in Western Australian and elsewhere - and to provide the 'seed' stocks from which to provide seed for growers throughout Western Australia. The program involves the extensive testing of recommended and non-recommended varieties currently in use, in addition to varieties being developed locally and the varieties imported into Western Australia

All promising lines from the Department's breeding program and other states (with an application in Western Australia), are tested in the crop variety testing program. Initially these lines are tested at 18 sites throughout the state. Depending on their performance, the testing of these lines may increase to 50 sites (advanced testing) in the following year. Results from at least two years of advanced testing are required before lines can be included in the crop variety recommendations. (Crook, Garlinge and Hoyle 1994)

Consequently an inventory of some thousands of varieties are constantly being assessed for their suitability for the growing conditions that prevail across Western Australia. The sites used in the assessment program are located at either Department of Agriculture facilities or on private farms.

Over the four year period between 1984 to 1988 the registered seed grower program was initiated through the auspices of the Registered Cereal Seed Scheme (Fisher 1987) and the Registered Field Crops Scheme (Brown G 1988) by the Department of Agriculture. The major function of these schemes was to facilitate the distribution of seed grain in bulk. Prior to the Department of Agriculture's handing the task of bulking-up and distribution of seed grain for commercial purposes to registered seedgrowers across the state, the distribution of new varieties was undertaken by the Department and involved the allocation of small quantities of seed to growers. The Department of Agriculture introduced these schemes so as to limit the continued draining of its resources that would be required to deliver the new and recommended varieties to all grain growers (Portmann 1994).

At the time of the field study there were some 80 registered growers across the state who facilitate the bulking and distribution of certified seed for field crops (Nicholas 1990).

Investigation One Variety Receivals

The first investigation of the study was to collect data from Cooperative Bulk Handling's varietal receival information for the 1986-87 to 1990-91 growing seasons and examine the data to find any apparent trends in varietal deliveries. The data used in the investigation is the aggregated variety deliveries for each receival point.

Analysis of Variety Delivery Data

An indicator of the adoption dynamic - 'adoption differential' - for aggregate siding deliveries was computed based on the recommended varieties for the growing seasons 1987-88 to 1990-91 Table presents the data analysis of the varietal delivery data and the result adoption differential for selected receival points. Recommended varieties were identified for each of the Department of Agriculture, Western Australia's crop variety recommendation areas (Figure 2), using the Department's Crop Variety Sowing Guide for each of the growing seasons (Brown G. 1989, 1990, 1991 and 1992).

To obtain the adoption differential for each delivery point the tonnages of the recommended varieties delivered were accumulated for each season and converted to percentages. Differentials were then calculated from the first of the seasons to the last. The differential is the slope of a line from the level of deliveries in the 1987/88 season, to the level in the 1990/91 season. The resultant values give a crude rate of adoption for the recommended varieties for all growers; the value is hereafter referred to as the adoption index (AI).

The derivation of a more precise index of adoption is possible through the accurate collection and calculation of the area's sown to individual varieties. However, consideration at the outset of the study of the accuracy of such statistics and their availability rendered them unsuitable.

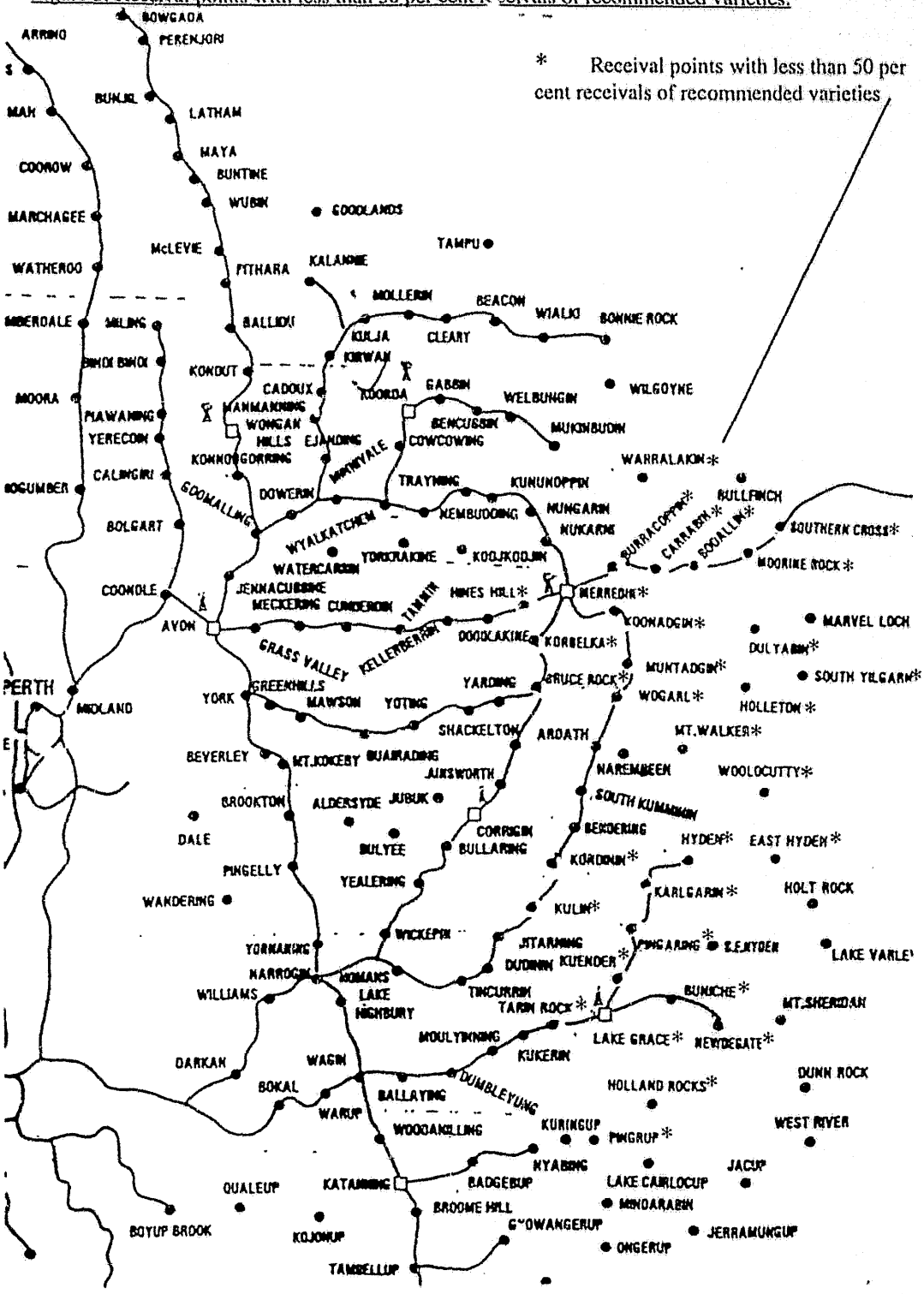
Adoption index analysis

The resultant AI values from the analysis of the data were plotted using coloured pins onto a map of the agricultural areas and visual interpretation of the patterns of adoption undertaken.

Receival points with less than fifty percent of deliveries from the recommended varieties list are indicated in figure 3. It is noticable that the majority of these points are in the North-Eastern and Eastern districts, Lakes and Kent Districts of the wheatbelt.

Areas spatially exhibiting trends of earlier adoption - greater diffusion in one sector of the area and other sectors exhibiting contrasting characteristics of later ado - less diffusion are found in the areas identified above. Such trends are manifest along the line from

Figure 3: Receival points with less than 50 per cent receivals of recommended varieties.



Quairading in the west (where there is earlier adoption - greater diffusion) to Bruce Rock in the east (where there is later adoption - less diffusion) and the continuum through the three receival points between these two centres was the major factor influencing its selection for further examination. The highlighted sections of Table 1 are indicative of the trends in the Quairading and Bruce Rock areas. A similar pattern, although not a linear one in spatial terms, is exhibited by the receival points selected to the west and north-west of Lake Grace, Tincurrin and Jitarning in the north -West (earlier adoption - greater diffusion) to Tarrin Rock and Lake Grace in the south - east (later adoption - less diffusion).

Table 1: Example of adoption index table for recommended and noodle wheats.

Delivery Point	Delivery Season					Adoption Index	
	1987/88	1988/89	1989/90	1990/91	1990/91 + noodles	AI	AI + noodles
PINGELLY	49.38	60.48	61.92	59.39	59.39	1.20	1.20
BROOKTON	40.71	62.90	76.55	80.02	93.77	1.92	2.30
MT KOKEBY	71.09	85.76	93.23	92.02	92.02	1.29	1.29
BEVERLEY	87.30	96.85	99.92	99.48	100.00	1.14	1.15
YORK	69.34	85.43	94.91	97.14	98.99	1.43	1.43
YARDING	11.31	30.22	39.49	61.77	63.97	5.46	5.66
SHACKLETON	7.18	22.37	29.95	44.04	76.57	5.97	10.34
YOTING	19.86	42.53	61.16	83.32	96.58	4.20	4.86
QUAIRADING	52.98	64.99	76.19	86.08	98.99	1.62	1.87
GREENHILLS	12.98	49.28	71.53	79.25	92.59	2.40	2.81
MAWSON	44.69	67.13	82.86	83.19	93.47	1.91	2.09
ARDATH	19.74	26.40	37.14	49.20	50.08	2.50	2.54
BRUCE ROCK	0.18	3.36	7.53	20.70	24.70	115.00	135.00
KORRELKA	3.19	8.48	12.01	22.29	23.25	6.99	7.29
SOUTH KUMMINS	53.60	59.82	66.26	64.90	64.90	1.14	1.13
NAREMBEEN	36.39	51.15	55.48	65.17	65.17	1.79	1.79
WOGARE	15.30	24.16	31.37	49.37	49.37	2.56	2.56
MUNTADGIN	16.09	19.10	29.48	39.57	39.57	2.46	2.46
KONDININ	23.66	29.01	19.64	28.68	28.68	1.21	1.21
HOLLETON	17.47	25.30	24.40	30.03	30.03	1.72	1.72
SOUTH VIDGARN	11.40	23.57	18.61	24.63	24.63	2.16	2.16
MT WALKER	12.83	18.20	15.12	34.26	34.26	2.98	2.98

Delivery season data is expressed as per cent of total delivery as recommended varieties

Responses seen in these two areas are not isolated occurrences; similar trends are found in other regions and districts. Figure 4 indicates the delivery levels of recommended varieties within the total delivery of wheat to each of the receival points. Figure 4 exemplifies the wheat variety adoption - diffusion trend in the Quairading and Bruce Rock area.

Somewhat similar patterns are evident in the Northern wheatbelt from Buntine, Maya, Latham to Bunjil; Kalanie, Goodlands, Kulja, Mollerin, Cleary to Beacon; In the central wheatbelt from Tammin, Kellerberrin, Doodlakine to Hines Hill; Wyalkatchem, Nembudding to Trayning; In the Great Southern from Badgebup, Nyabing, Kuringup, Pingrup to Hollands Rock.

These areas predominantly lie in the Eastern areas of the Wheatbelt, where with increasing distance from the coast there generally is diminishing annual average rainfall.

The areas fall into the advisory areas of four Department of Agriculture, Western Australia district offices, namely Merredin, Northam, Lake Grace and Narrogin.

A number of sharply contrasting areas were isolated, and two areas were selected for further, more detailed study.

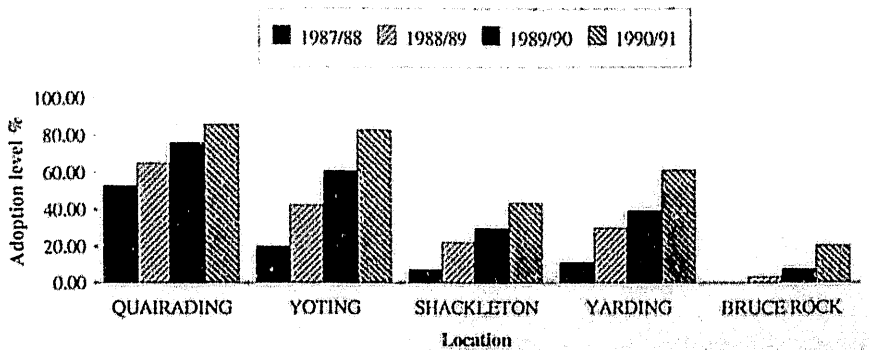
Criteria for selection of the two areas were

1. Each area has a transition from a high level of recommended varieties being delivered with apparent early adoption, through high levels of recommended varieties being delivered with apparent later adoption, to areas of low levels of recommended varieties being delivered and little or no apparent adoption of the recommended varieties.

2. Each of the areas were defined according to a consistency of rainfall patterns, soil type and geomorphology. Consequentially the agricultural practices employed by land users within each of the two are relatively homogeneous and are centred on a mixed wheat sheep farming model.

3. Two district offices of the WA Department of Agriculture service a portion of each area. That is, district office boundaries pass through the study area in both cases.

Figure 4.: Percentage of adoption of recommended varieties - Quairading and Bruce Rock shires.



Investigation Two: Grower Survey

Selected wheat growers in the two areas (n = 131) - established from investigation one - were surveyed. The two areas, the first between Quairading and Bruce Rock (n = 82) and the second between Jitarning and Tarin Rock (n = 49) are displayed in figure 5.

The areas planted to individual varieties or combinations of varieties are the simplest method of determining the actual level of adoption of varieties. The sowings of selected varieties are presented graphically in figure 6.

As can be seen in figure 6 the dominant variety in the early eighties, with 54% of the area sown to wheat by the respondents, was Gamenya. The level of plantings of Gamenya had continued to drop until the 1990 and 1991 seasons where the plantings levelled off. This reduced decline in the area planted is primarily due to Gamenya and Gutha obtaining a payment premium as they were accepted into the Australian Wheat Board's 'noodle wheat' (Brown G 1991) segregation.

The areas formerly planted to Gamenya were in turn 'predominantly' planted to firstly Aroona, Spear and then Reeves.

Overall the area planted to Halberd decreased marginally over the period of time that respondents were asked about. The area of plantings remaining in the high twenty to high thirty per cent range.

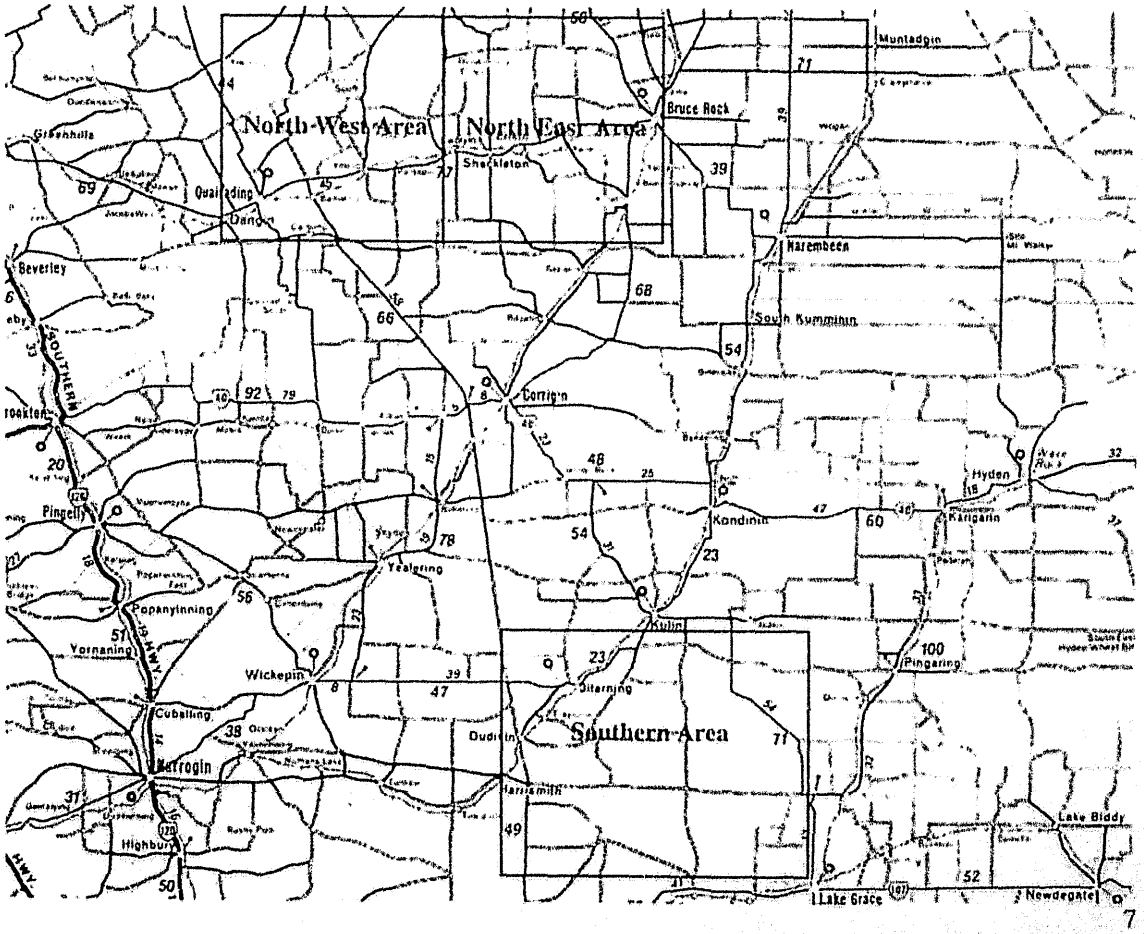
Plantings in the three areas of the study show remarkably different trends.

In the North-West area, the most notable trend is the replacement of Gamenya which dominated the area sown to wheat in the early eighties (93% in 1983) with four other varieties, Aroona, Kulin, Spear, and Reeves each being sown at approximately 20 % of the area sown in the early nineties.

In the North-East area, the replacement of Gamenya is again evident, initially it was replace by Halberd, levels of which have remained at approximately 30% of the total area planted. Plantings of Eradu, Kulin and Spear increased in the late eighties and early nineties. The continued planting of extensive areas of Halberd, which has been shown to out yielded by and of inferior milling quality to a number of other varieties (Brown G 1991), are of concern. The principle reason for growers continuing to grow this variety are its hectolitre weight and its perceived ability to 'do well' in a range of seasonal conditions.

These between area differences were further exemplified in other characteristics, some of which follow.

Figure 5: Location of study areas.



Methods for assessment of varietal performance varied considerably from grower to grower. However the dominant methods employed by growers were categorised as being less accurate between paddock comparisons. This category principally contained those growers who would harvest whole paddocks and compare gross tonnage (yield), hectolitre weights in addition to protein levels and screenings as determined by receiving organizations. Growers in the North-West area (68%) predominantly used this technique. There is no statistically significant difference between the areas.

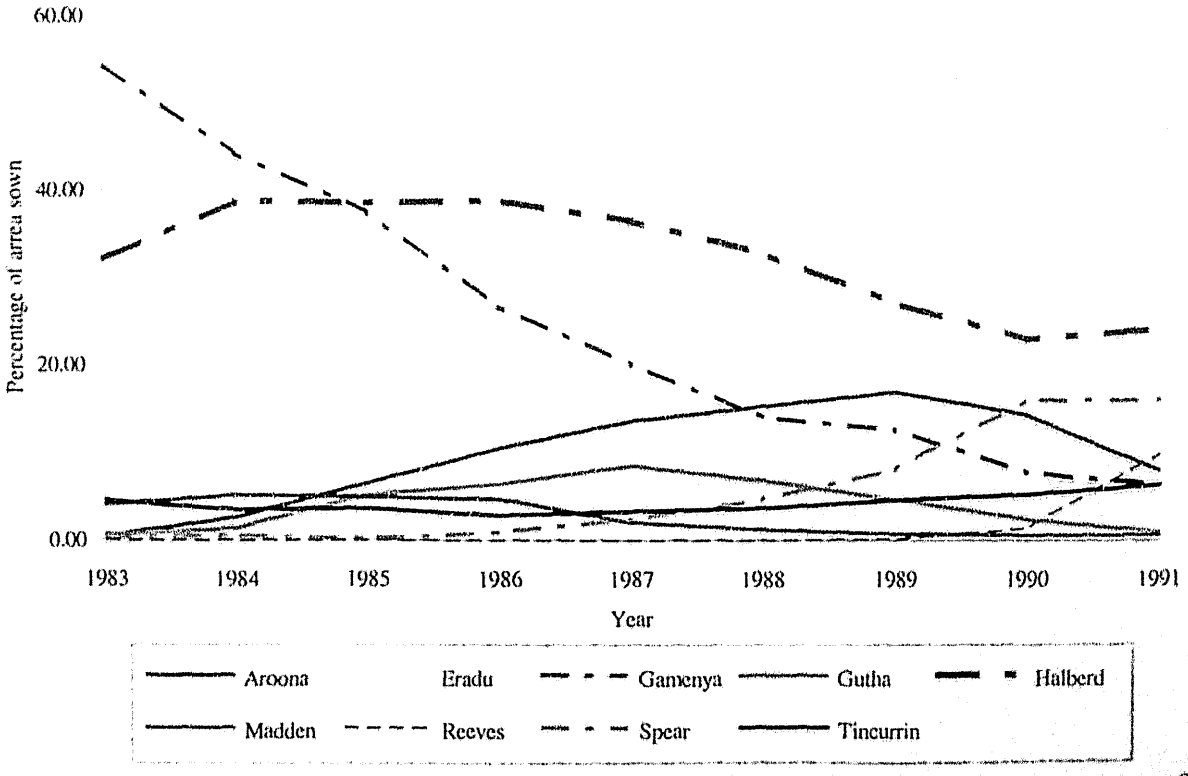
Growers in the South-East area (33%) would assess the performance of the new variety based on 'less accurate intra-paddock' comparisons. The main less accurate intra-paddock method of measurement is done by inaccurately measuring the amount of grain harvested in specified distance or elapsed time. The second method in this category would be to harvest a prescribed amount, i.e. a harvester box full, and measure the distance travelled to obtain the grain or travel at a set speed and record the time taken. In the North-East area two growers would use accurate derivatives of such techniques and one grower in the South-East area would use such a technique. The accuracy of the method was determined through the ability to either weigh the grain harvested or measure the distance travelled using accurate measuring devices such as scales or hodometers.

The time to rejection or acceptance data indicates that growers will be quicker to reject a new variety than to accept.

If the grower is going to reject a new variety that they have on trial they will have made that decision within three years of first trial and 74% of the growers would have made the decision to reject within two years. The only difference between areas is that North-West area growers would not reject as early as growers in the other two areas, with some 12% more rejecting in the third year. This apparent propensity to trial new varieties for a longer period is consistent with the risk profiles that will be discussed in the following section. The data obtained from these questions could be used as proxy for the independent variable for 'risk' in the development of the empirical model.

In a period of three years of trial of a new variety 91% of growers would have chosen to accept the new variety if they are going to accept the variety. There is little differentiation between the areas except that 55% of North-West and South-East growers would have accepted within two years and only 40% of North-East growers who would accept would have done so in two years. Again the north west growers show a greater propensity to keep a new variety. Growers from the North-East and South-East areas were likely to keep trialing a variety for five years before they would choose to keep the variety in their inventory.

Figure 6 : Percentage of area sown to selected varieties .



Risky choice between varieties

The respondents were asked about their preference for planting four hypothetical wheat varieties, producing variable yields, under variable seasonal conditions on two land types. Each variety had a different mean and variance in its yield. The lower mean yielding variety (Variety One) had lower variability, with the higher mean yielding variety (Variety Two) having higher variability. A light land scenario with the probability of a poor season of three in ten, an average season five in ten and good season two in ten was presented to the grower. The grower was asked to select which varieties they would grow in order of preference from one to four. A heavier land scenario with the probability of a poor season of three in ten, an average season reduced to four in ten and good season increased to three in ten were then presented to the grower. Again a selection of the growers preferred choice was requested. In each instance the chances of an average or better year is seven in ten.

If the grower choose to grow variety one in both instances - the variety that produced the most stable performance with the least variable yield - they were classified as being the most risk averse. If the grower choose to grow variety two in both instances - the variety that produced the highest yield performance with the most variable yield - they were classified as being the least risk averse. Those growers who selected variety three and four together or combinations of any of the varieties were classified on the basis of those selection into the intermediate categories between the risk averse and the risk taker.

A graphical representation is presented in figure 7.

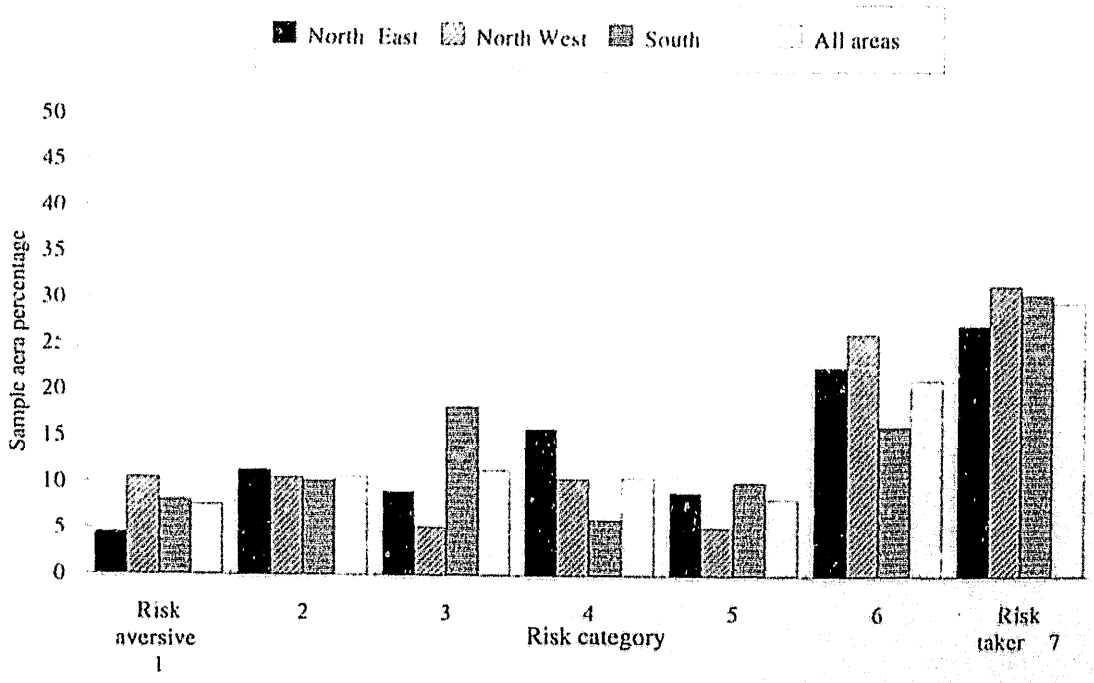
If the grower choose to grow variety one in both instances - the variety that produced the most stable performance with the least variable yield - they were classified as being the most risk averse. If the grower choose to grow variety two in both instances - the variety that produced the highest yield performance with the most variable yield - they were classified as being the least risk averse. Those growers who selected variety three and four together or combinations of any of the varieties were classified on the basis of those selection into the intermediate categories between the risk averse and the risk taker.

The profiles are broadly indicative of a high risk tolerance by most growers. Some 30% of the growers indicated that they were at the most risky end of the profile. The distribution of growers in the North-West area is the most heavily skewed toward the risk taker.

The risk distribution for the South-East growers shows a slightly more bimodal form, with a hump occurring around category 3. The general pattern in the North-East and South-East areas are indicative of a shift in this area to being more risk neutral. This is despite the South-East group having the second highest proportion of ' risk takers'.

Of interest is the level of North-East growers (11%) who fall into the group of 8% of all the growers who are the most risk averse. While not being truly bimodal the distribution for the North-West area has bimodal tendencies.

Figure 7: Grower 'risk profile'.



The role of the registered grower

While there is still resistance from some growers to the role of the registered seed growers, the majority of growers accepted them as reliable sources of variety information. It however needs to be noted that a number of the growers interviewed passed comments about the performance information that some registered growers had related to them. Instances where 'inflated ' performance had been quoted were reported to the interviewers. Those purportedly giving information inflating the performance of varieties were outside the sample frame of this study.

The registered grower system has the capacity to become an even more beneficial de facto extension provider with respect to new varieties of field crops. It is therefore of importance that the information given to the registered growers is in a readily conveyed form.

The introduction of quality assurance mechanisms into the grain growing industries can further enhance the role of the registered growers. It is therefore pertinent to suggest that all registered growers be made aware of their potential influence and the need for both accurate and timely dissemination of information.

Growers contact with CVT's and demonstration plots

The respondents were asked if they knew of the location of the nearest Department of Agriculture Crop Variety Testing site or demonstration plot in both 1991 and 1990. Additionally the respondents were asked if they had visited the sites in 1991 or 1990. The grower was then asked to identify their nearest registered seed grower. The grower responses were contrasted against the actual locations (Crook 1991) of the crop variety testing trials and other demonstration sites both within the study areas and nearby.

There is no statistically significant difference between the areas using the χ^2 statistic for the growers ability to correctly identify crop variety testing sites or demonstration plots. Nor was there any difference in the level of grower visits to the sites of test sites or demonstration plots in both the previous and current growing seasons. The level of visitation in 1991 is likely to be an artefact of the time at which the growers were interviewed - mid growing season - and the time at which they would have visited trials if they were likely to visit trials. That is they may have visited trials later in the growing season.

There was however a significantly different identification of the nearest plots in the current season. The southern group of growers were able to identify the site nearest to them more often than the northern groups.

There is no significant statistical difference between the three areas for grower visitation of the trial sites. While the number of respondents who had knowledge about the crop variety testing sites or who had visited them was low, the percentage of the grower population who had visited the sites from each of the subgroups would on face value appear to be correlated to the low number of individual who are cognisant of the crop variety testing system. The implications of a poor relationship between the growers and contact with the crop variety trials may be a correlate of their adoptive behaviour with respect to wheat varieties.

The levels of recognition of registered growers again follow the patterns established in previous data. There is a statistically significant difference ($\rho = 0.001$) between the three areas. Growers in the North-West area had a good understanding of the registered grower system. Of those growers 95% were able to recognise their closest registered grower, 5% recognised a more distant registered grower.

Some 53% of the South-East growers were unable to identify a registered grower and only 33% were able to identify their nearest registered grower.

While 66% of North-East growers identified their nearest registered grower, 32% of growers were unable to identify any registered grower.

Extension publications and their impact

The respondents were asked if they received the Department of Agriculture's Direct Mail Service and how they valued a number of publications that had been produced by the Department, the results indicate that in the northern study area there is a higher proportion of growers receiving the Department of Agriculture's publications except for the Crop Variety Sowing Guide.

There is a statistically significant difference ($\rho = 0.001$) between the areas using the χ^2 statistic for growers who subscribed to the Department of Agriculture's Direct Mail Service. In the North-West area 71% of growers subscribed, 64% of growers subscribed in the North-East area and 43% in the South-East area. These levels of subscription are likely to reflect the level of contact with the Department of Agriculture.

Additionally the respondents were asked if they had read or received a copy of a number of Departmental publications that had been produced with either partial or full support from the State Wheat Research Committee, and how they valued the publications.

There is no statistically significant difference between the areas using the χ^2 statistic for growers who received the current Crop Variety Sowing Guide. In this instance a greater proportion of the growers in the South-East area (18%) received or obtained a copy of the guide who do not subscribe to the Direct Mail Service, they had obviously either passively or actively acquired the guide. The was only small differences in the level of receival of the guide by North-East and North-West growers in comparison to Direct Mail Service subscription, however the apparent decrease amongst the North - East growers is unexplained.

There is a statistically significant difference (ρ = 0.002) between the areas using the χ^2 statistic for growers who had a received a copy of the 'Wheat Book' (Perry and Hillman 1991), a technical manual for wheat growers. Additionally of those who had received the 'Wheat Book' there was a significant (ρ = 0.002) difference in usage of the book. Not unexpectedly a low proportion (39%) of South-East growers had received a copy of the book despite is availability for some four months, some 62% of the growers had heard of the book. This contrasts sharply with the North-West growers were 90% had herd of the 'Wheat Book' and 87% had received a copy.

The trends evident through these statistics are that there is a correlation between consumption of Department of Agriculture publications and utilization of the 'new' recommended varieties.

Therefore it is important for those implementing the dissemination of information pertinent to wheat cropping and more specifically wheat variety publications of the Department of Agriculture, to consider the effectiveness of the distribution network for all of the information forms.

Grower perception of reliability of information sources

To elicit their feelings towards a number of information sources respondents were asked to rate those sources with respect to their reliability.

The responses to the question provide a number of interesting results.

The 'Ag Memo' distributed by Department of Agriculture's district offices received the highest approval rating as a reliable source of information to the growers. The role of the 'Ag Memo' in providing feedback on trials conducted within the region is seen as a primary source of information. The timeliness of this information appears to be of importance in the development of both the tactical and strategic planning of the grower. The information conveyed by the 'Ag Memo' is able to fit the windows of opportunity when the growers are deliberating on varietal issues.

The Department of Agriculture's 'Crop Variety Sowing Guide' and 'Farm Notes' rated next in terms of reliability of information. Grower consideration of these sources of information is often couched in terms of overall varietal performance. The information derived is considered in terms of applicability to the growers cropping operations and their benchmarking procedures.

The misconceptions about the agronomic practices associated with the Crop Variety Trials raised by Lewis (1989) are still prevalent amongst a number of the wheat growers interviewed in this study. This situation reduces the ability of those growers, who are falsely informed about the agronomic practices, to make valid decisions based on the information that the Crop Variety Sowing Guide conveys. This statement is predicated on the understanding that the growers would in fact consult the Sowing Guide. I would speculate that those who still have an incomplete understanding of the agronomic practices associated with the crop variety testing program do not consult the Sowing Guide. Unfortunately, data to support this notion was not formally collected.

In contrast to the findings of Brennan and Cullis (1987) with respect to the validity of local trials, growers were more receptive of the information provided by field days in the district to those away form the district. While it is not possible in this instance to distinguish the effects of outside trial results on information provided by other sources, only 25% of respondents suggested that field days away from the district were reliable sources of information. Some 47% of growers did not respondent to the question. This would suggest a low level of contact and or awareness of the such field days away from the district. In context, there are two field days in close proximity to either end of the northern study area. Similar events are held in close proximity to the southern study area. This lack of awareness should be of concern to those involved in the operation of the field days. However, consideration should be made of the influence of the 'Ag Memo' in the effect that it has in providing information that may be derived from field day attendance, albeit that the interaction that takes place at such days is missing.

The Quairading Grains Expo could be influencing the knowledge base of those in the North-West and North-East areas. However, I would suggest that the growers in those areas, specifically those in the North-West area, seem to be predisposed to 'searching' for information. It is however difficult to quantify such a statement, intangibles such as community involvement, activity and commitment, have long been associated with the area, these could be of central importance. The work of O'Brien *et al.* (1991) and O'Brien and Hassinger (1992) in the United States could be used in future examinations of this issue.

The 'Country Hour', the Australian Broadcasting Corporation's major rural radio production is considered by 77% of growers, in terms of reliability, to be good or better. This avenue is likely to be the most effective system of delivery for those growers who passively receive information about wheat varieties, especially in the discovery stage.

Of the three major rural publications the 'Countryman' had the greatest acceptance by growers - very good 10%, good 44%. The 'Elders Weekly' and 'Western Farmer' were marginally less reliable.

Pattern Analysis

The data from the northern area was subjected to cluster analysis on a normalized Euclidean distance basis to produce a dendragram. The dendragram was then used to obtain indicative of groupings within the data set. The variables utilised in analysis were the network

position of the respondent, the scale of wheat cropping operations, risk status, number of wheat varieties kept on hand and distance from primary information source. Except for the scale of wheat cropping operations which was a continuous measurement, the other variables where categorical.

The dendragram was then examined for potential patterns or groupings amongst the growers. Given that network position was included in the analysis, the dendragram exhibits results broadly indicative of there being a small group of 'innovators' and a larger group of followers.

The analysis that has been utilized in this instance can be enhanced through further exploration of the techniques that pattern analysis provides. These techniques are powerful and used in a number of biological systems, their usage in rural socioeconomic studies is yet to be fully explored.

Network Analysis

The communication networks evident between wheat growers in the northern study area are partially presented in sociogram form in figure 8. There are a numerous points to consider in examining the information, both at a macro scale and at individual group or clique level.

Broadly there are four apparent major sociometric divisions in the study area. Two in the Bruce Rock Shire, one centred around Kwolyn and Shackleton, the other in the East section of the study area. Two groupings occur in the Quairading shire, one centred around Yoting and Pantapin to the East and those closer to the town site in the west.

There are a number of influential growers whose roles are pivotal in each of the groupings that occur within the areas. For example for the group in the western most portion of the Northern study area, grower #125 is considered by a majority of the growers to be the most valid and reliable source of information about wheat varieties. That particular grower has a large wheat growing enterprise, with holdings in a number of locations in the centre of the Quairading shire and is a registered grower. This grower has been discussed previously as having been likely to have introduced a number of new varieties to the area. Notably the introduction of South Australian varieties grown in the area have been attributed to that grower.

Grower #60 located in the centre of the Northern study area has a broad sphere of influence across the whole of the area either directly or indirectly. A number of growers considered this grower to be a little eccentric in his cropping activities yet considered both the research he undertook and the results achieved, which are the basis for his, opinions to be reliable and of value.

The most striking of the patterns to emerge is that associated with grower #41 in the central north of the Northern area. This grower has extensive holdings over a wide area of the north - eastern partition and is respected for both knowledge and practice of wheat growing by many of the surrounding growers.

In analysing the apparent patterns in the communication networks it is critical to consider the other influences that may not appear to be evident. There are likely to be underlying influences that effect who certain individuals are likely to be talking to about wheat variety selection and performance.

Those who individuals would normally socialize with are in a position of more frequent contact, yet the frequency of contact may not be a primary determinant of information transmission.

The social groupings of which the wheat grower is a member can influence the contacts that are made, however as has been noted earlier it is likely that the most significant influences with respect to variety choice and performance indications are sporadic contacts with other growers at receival points and observations of harvest performance. These contributions to the decision making process are however late in the process. They are determinants of final choices in the process, giving guides to potential tactical choices, not fundamental determinants of the growers strategic cropping plan.

The key influences in each cell - the 'gate keepers' - are often the primary determinants of the level of adoption.

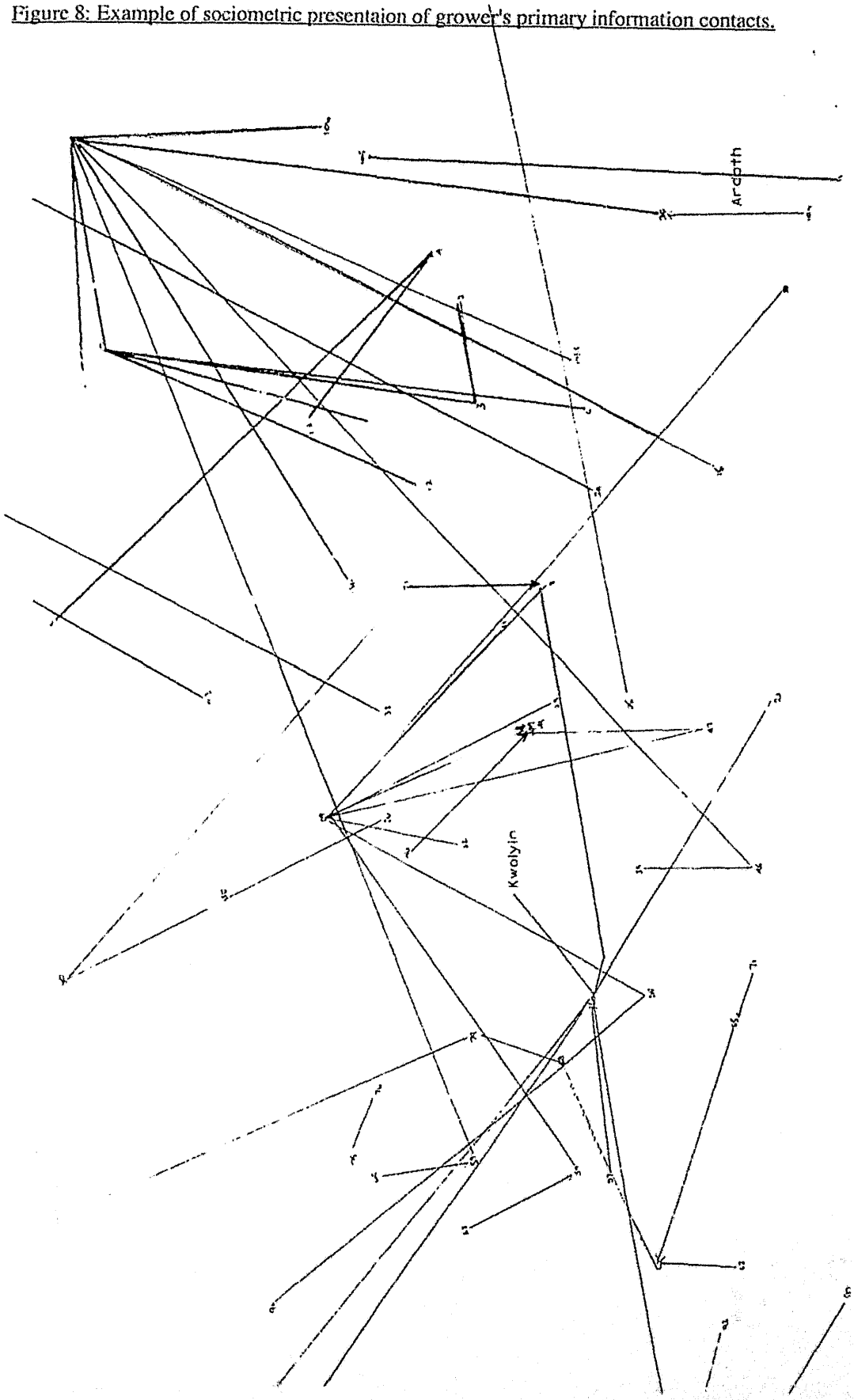
Key findings of the survey

There is a greater awareness of Western Australian bred cultivars at an earlier stage in the adoption process relative to cultivars bred outside the state. This supports the findings of Brennan and Cullis (1987). It is apparent that a higher proportion of growers became aware of the more recently released varieties before they were officially released. The variety Reeves is an example of such pre-release awareness.

The majority of producers will decide which varieties they will have on hand for seeding in the next season in the spring of the current growing season. Judgements of how much of each variety to have on hand are made as the last of it is harvested, if the variety had been grown in that season. It is clear that the exchange of information at delivery points during harvest is a major component in the final decision process about the relative performance of different varieties. It is at or near that stage that critical strategic decisions will be made about which varieties will be held in the growers seed inventory for use in the following seasons.

In the past the majority of growers had not used Department of Agriculture sources / advisers as their primary source of contact about new varieties. However, a higher proportion of growers indicated that in the future they would have primary access to information about the new varieties through Department of Agriculture sources. Nevertheless, a majority do consider

Figure 8: Example of sociometric presentaion of grower's primary information contacts.



the District Office Memos very good sources of information, and those who receive the Crop Variety Sowing Guide consider it a very good source of information. Only 65% of those in northern area and 45% in the southern area receive the Crop Variety Sowing Guide.

The Crop Variety Sowing Guide was generally either received or consulted after the time at which decisions about the oncoming seasons varietal choices had been made. This publication should be made available to growers as early as possible in the growing season.

Growers selectively seek the opinions of other growers in the district who they regard as valid and reliable sources of information about new cultivars. It is essential that those opinion leaders are either fully informed or have access to information about variety performance form accurate and creditable sources.

Except for the 'innovators' there is a very poor knowledge of the location of crop variety trial sites and demonstration plots. Few growers actually look at the trials or plots. It is the trial plots that give the growers the ability to build up there knowledge base about both the performance of their current varieties under a range of agronomic conditions and the performance of new varieties under the same range of conditions..

Growers who are more readily disposed to seeking information from primary sources of information about new varieties are more likely to be the growers who trial the new varieties. Encouragement of the search for information may bring about changes in the pattern of usage of varieties. Continued expansion of the regime of payment based on quality issues should bring about such a change.

Misconceptions about the herbicide tolerance of new varieties were found to be widespread. The need for continued coordination of the extension effort in these related crop production fields of herbicide application and varietal tolerance is essential.

Misconceptions about the agronomic practices associated with the crop variety testing program of the Department of Agriculture that were first identified by Lewis (1989) still continue to be widespread. This fact is likely to be linked to levels of visitation of both the trials and filed days. Unfortunately specific data on this matter was not collected.

Some 35% of growers were unable to identify a nearby registered grower. Some registered growers were well respected, with some being completely rejected as information sources.

Not withstanding the character of the individuals concerned, this variation in the acceptance of the Registered Crop Seed Grower Scheme should be of concern to those involved in the conduct of the Scheme.

Building a Model of Adoption

The methodology that was undertaken in the modelling exercise was designed to confirm or reject the validity of the 'time lag' model in a Western Australian wheat variety adoption context and where possible to build on the Lindner model.

Data from the survey questions were used to derive a number of variables for correlation with time to discovery, time to evaluation, time to trial and finally time to adoption, the stages in the 'time lag' model, which equate to the time in years from the release of a variety to the time at which discovery through to adoption takes place. This undertaking allows the development of the Baysian approach of the Lindner *et al.* (1982) model to consider the position of the grower within information networks.

The dependent variables in the model were the same as for the Lindner model (Lindner *et al.* 1982), with the inclusion of the trial stage lag, they were

- Time to discovery - the discovery stage lag - DSL
- Time to evaluation - the evaluation stage lag -ESL
- Time to trial - the trial stage lag - TSL
- Time to adoption - the adoption lag - AL

The dependent variables are determined by the amalgamation of the all varieties.

The independent variables that were included in the Lindner *et al.* (1982) model of trace element fertilizer adoption were reconsidered in terms of their validity in developing a model of wheat variety adoption. Variables were either removed, modified or added from the trace element fertilizer model.

The new or modified variables are

[a] scale of operations measured by the area of wheat crop averaged over the previous four years.

It was considered that the areas for consideration in data acquisition would be balanced for rainfall. The cropping activities over a four year period were adjusted to represent the medium term cropping objectives of the wheat growers examined. As a consequence an approximation of the level of production of each growers holdings is indicated. The sign of this coefficient should be negative.

[b] decision maker's capacity to process information or the cost of 'human capital';

As the variable to measure the decision makers capacity to process information or its proxy were dropped from the trace element modelling the inclusion of such a variable in this analysis is diffi-

cult. Although better correlates for education have been established in other modelling exercises (Thomas *et al.*, 1990). It is possible to construct two variables similar to the proxy, farm magazine subscription, proposed in the trace element model. Through an examination of growers perception of the usefulness and reliability of such publications, information for building such a proxy was collected for the cost of human capital. The additional or substitute proxy is subscription to the Department of Agriculture, Western Australia's Direct Mail Service. The sign of this coefficient should be negative.

[c] for DSL, the cost of acquiring information, as measured by distance to the original innovation source.

The variable for assessing the distance from the primary sources of information about the innovation, i.e., the new varieties, remained the same. That is the distance from primary sources of information, in the case of new wheat varieties the primary sources are assumed to be Western Australian Department of Agriculture's district offices or associated research facilities. While the Department is the predominant source of information, it is not the only source, therefore there is a confounding influence from other sources that can not be easily considered. Hence the distance to information variable was computed based on the shortest distance to a Department of Agriculture district office. This variable was treated categorically rather than as a continuous variable. The sign of this coefficient should be positive.
There are a number factors such as geographic barriers, demographic barriers, social constraints and logistic influences - such as shopping and all other contacts occurring at centres away from the primary information sources - that can influence the distance between 'source' and 'target'. Thus, distance from source may not necessarily correlate with the cost associated with collection of information.

[d] for DSL, the cost of acquiring information, as measured by the network nodes to the original innovation source.

The key specification change in the wheat variety adoption model is the addition of the above variable. The addition of the variable enables the measurement of the distance through network nodes to quantify its effect upon the Discovery and Evaluation Stage Lag's. The Lindner *et al.* (1982) model used the distance to the nearest know adopter at the time of awareness as explanatory variable. However, due to social networks or geographic impediments, a grower may reside in a location adjacent to an early adopter and never speak to that grower or see any of the crops grown by that grower. Hence the network position of the grower is postulated as a more reliable and relevant measure of information about innovations. The sign of this coefficient should be negative.

[e] the decision maker's attitude to risk.

As the decision makers attitude to risk is perceived to be of importance in the decision making processes associated with adoption, this variable was included even though it was discarded in the trace element model. This variable will be measured by the responses given to two questions eliciting the wheat growers averseness to growing hypothetical wheat varieties with variable yields under favourable and unfavourable conditions on different land types. This test - test methodology enables the elicitation of a more valid indication of the growers risk averseness.
The levels of risk averseness were measured by presenting the growers with a choice between four varieties in a light land cropping situation and a heavier land situation. The likelihood of good, average and poor seasons were associated with hypothetical wheat varieties that had performances from a low mean yield with low variance of yield with fluctuation in season, to a higher mean yield with a higher variance in yield dependant upon season.
For example one variety may yield 1.1t/Ha in a poor year 1.3 t/Ha in an average year and 1.5 t/Ha in a good year. Another variety may have may yield 0.9t/Ha in a poor year 1.4 t/Ha in an average year and 1.9 t/Ha in a good year in each instance the probability of an average or better season is 0.7. In this context the first variety would be considered to be a 'safe' variety that would be grow by risk averse producers and the second variety would be considered less 'safe' and grown by less risk averse producers. To obtain a spread of responses to enable the grouping of the respondents in seven risk classifications the growers were given a choice between four varieties under the two land types. This coefficient should have a negative sign.
As the variable to measure the productivity associated with the innovation had proved to be inconsequential in the trace element fertilizer model and the difficulty of objectively measuring such a variable, it has not been included in the wheat model.

and

[f] the number of varieties held for seeding to account for time of sowing and soil type.

The preparedness of the grower to hold seed stocks of different varieties and the number of varieties that they had is used as a measure of the 'innovativeness' of the grower. This characteristic measures preparedness for variable seasonal scenarios and the capital capacity of the enterprise to have the varietal choice available to it. The sign of this coefficient should be negative.

These variables were selected to augment the procedure that had failed to produce meaningful results in the 1982 work of Lindner *et al.*. The concerns expressed by Lindner (1987) about poor model specification and the dynamism of the learning process should be alaid by this approach, a fully specified model should be developed.

The development of the model was undertaken in the light of the comments on the sometimes heated debate on research methodologies in rural sociology expressed over the past fifteen years (Harper 1991) and the shift to the 'new rural sociology'. The three key elements of Harper's concerns are

Research problems may be selected by their 'fit' to available and seemingly successful methods, rather than the reverse of selecting a method this is the most strategic for studying a particular issue.

..imprecise measurement and low levels of predictability are an often discussed problem in survey research.

....most studies in *Rural Sociology* give far more attention to the practical dimensions of measurement than to the concepts being measured....while some concepts are easily transformed into numbers, many of the concepts are squeezed, pushed, shoved and distorted into quantifiable categories in order to make quantification work. Because rural sociologists seldom perform tests of reliability or validity

...the social survey tends leads to social psychological research focused on the individual, rather than the social structure or social process.

Outcomes

Attempts to build a model based on the multiple linear regression (MLR) techniques used in the Lindner *et al.* (1982) model were little more successful that those attempts. The results of the MLR are presented in table 2. The inclusion of the network position variable did prove valuable and this point will be discussed later.

The proxy for education that was derived from the growers response to reliability questions about information sources produced results similar to those achieved by others (Thomas *et al.* 1990).

The risk explanatory variable, while following the predicted coefficient sign, had the lowest coefficient levels of all the independent variables, with the exception of the measurement of the scale of the wheat cropping operation. The scale of cropping operation variable has no bearing on the model.

The t scores were generally poor and not significant.

The network position variable was used to try and more accurately predict the distance to information ef-

Table 2: Determinants of Adoption - Multiple Linear Regression

Nature of Lag - All 132 Growers									
Explanitory variable	Units	AL	*t*	DSL	*t*	ESL	*t*	TSL	*t*
Scale of wheat croping operations	('000 ha)	-0.000	*0.603*	-0.000	*1.09*	-0.000	*0.065*	-0.000	*0.311*
Education		0.527	*1.84*	0.238	*1.074*	0.446	*1.902*	0.418	*1.392*
Distance to innovation source	('000 km)	0.289	*0.667*	0.444	*1.322*	0.39	*1.1*	0 263	*0.58*
Distance through network nodes	(Node points)	0.33	*0.808*	0	*0.001*	0.074	*0.222*	0.581	*1.36*
Attitude to risk	-	-0.084	*0 677*	-0.019	*0.199*	-0.023	*0.221*	-0.13	*0.994*
Number of varieties	-	-0.181	*0.945*	-0.214	*1.441*	-0.254	*1.615*	-0.17	*0.844*
Constant	-	2.926	*1 496*	1.769	*1.168*	1.184	*1.333*	2.525	*1.232*
R^2				0.035		0.045		0.037	

t = t values, none are significant.
The dependent variables are measured in years from release of the variety

fect. Therefore the next step in the development of the modelling process was to use the network position of the growers and to select only those growers who were in position one or two in the network (Table 3). This produced a slight improvement in the goodness of fit of the model. By even further reducing the network position variable to those who were first in the linkages away from the primary information sources - which required the removal of the network position variable from the model due to colinearity - the goodness of fit improved some eight fold for most of the stage lags (Table 4). Again while there is an improvement the goodness of fit is still not good. However the use of the network position variable proved to be able to shift the fit from very poor to approaching acceptability. Future examinations of this type of model could continue to use this approach to improve there goodness fit.

The goodness of fit of the model has been dramatically improved by segregating the dependent variables into individual varieties. This approach is currently under further examination and is not reported here.

Lindner and Gibbs (1985) conclude that more work was required to fully investigate the use of the Baysian approach, this instance has again resulted in such a case. They also conclude that it may be possible that farmers are not Baysian. This suggestion has been supported by others (Burnside 1994) and this too may well be the case. A continued investigation of the data may prove either of these situations to be the case.

In conclusion the empirical model has a poor fit for all of the growers, however, the network variable was successfully used to bring about an eight fold increase in the predictive ability of the model. The use of individual varieties as dependent variables has shown an ability to improve the goodness of fit.

Table 3: Determinants of Adoption -Based on Network Position - Multiple Linear Regression

Nature of Lag - Network node 1 & 2 growers									
Explanitory variable	Units	AL	*t*	DSL	*t*	ESL	*t*	TSL	*t*
Scale of wheat croping operations	('000 ha)	-0.000	*-0.824*	-0.000	*1.09*	-0.000	*-0.272*	-0.000	*-0.598*
Education		0.044	*0.037*	0.927	*0.925*	1.141	*1.043*	-0.392	*-0.265*
Distance to innovation source	('000 km)	-0.555	*-0.405*	-1.106	*-0.094*	-0.587	*-0.469*	-0.18	*-0.108*
Distance through network nodes	(Node points)	0.266	*0.18*	-1.651	*-1.356*	-0.712	*-0.536*	0.749	*0.418*
Attitude to risk		-0.157	*-0.522*	-0.276	*-1.116*	-0.308	*-1.139*	0.117	*0.321*
Number of varieties		0.063	*0.161*	-0.042	*-0.132*	-0.333	*-0.951*	0.272	*0.576*
Constant		6.46	*1.210*	3.777	*0.858*	4.23	*0.881*	3.678	*0.568*
$\bar{R}^2$		0.064		0.189		0.146		0.039	

t = t values, none are significant

Table 4: Determinants of Adoption -Based on Network Position 1 only - Multiple Linear Regression

Nature of Lag - Network node 1 growers only									
Explanitory variable	Units	AL	*t*	DSL	*t*	ESL	*t*	TSL	*t*
Scale of wheat croping operations	('000 ha)	-0.001	*-1.259*	-0.000	*-1.055*	-0.000	*-0.74*	-0.001	*-0.884*
Education		0.988	*0.742*	1.127	*0.942*	2.002	*1.741*	0.69	*0.374*
Distance to innovation source	('000 km)	-0.55	*-0.302*	-0.483	*-0.294*	-1.27	*-0.806*	0.374	*0.148*
Attitude to risk		0.881	*2.166*	0.304	*0.831*	0.426	*1.213*	1.281	*2.269*
Number of varieties		-0.115	*-0.22*	-0.471	*-0.998*	-0.461	*-1.018*	0.0372	*0.511*
Constant		0.009	*0.001*	1.628	*0.265*	-0.457	*-0.077*	-5.45	*-0.574*
$\bar{R}^2$		0.369		0.339		0.441		0.307	

t = t values, Risk is significant at the 0.05 level for AL and TSL.

Implications for the Extension Agent

There is a considerable gap between those who receive 'quality information ' about new cultivars from the Department of Agriculture and other primary sources and those who don't. Those who receive the 'quality information' tend to be the innovative growers. The majority of growers use the information provided by the Department of Agriculture in concert with information from other sources. There is considerable scope for a reduction in the time between growers first discovering new varieties and actual on farm trial. This is the period in which information about the variety is only available from off farm sources. This could perhaps be best brought about by the reduction in the number of nodes in the network that information passes through between the 'source' and 'target' growers. This could best be achieved through the provision of more readily digestible information about the performance of trials, passed through the off farm sources of information closer to growers in their networks. The targeting of opinion leaders who are central to the networks or the provision of trials that more readily influence the decisions of the later adopters may reduce the time to adoption. 'Paddock scale trials' in the district may provide one way to achieve a greater influence, as these appear to be the preferred methods by which the majority of growers make decisions about new varieties. The relative advantages of 'better' cultivars are evident in their greater adoption and diffusion in areas where there appears to be an effective extension effort, as exemplified in the uptake of the variety Reeves.

The information contained in publications such as the Crop Variety Sowing Guide and Growing High Yielding Wheat Crops needs to be widely distributed before the spring of the growing season in preparation for the following season. This would enable as growers to more accurately compare variety performance throughout the growing season before strategic decisions - based on yield performance, weight and grain quality - about which varieties are to be kept in the growers inventory of seed are made.

From both the collected data and anecdotal evidence it was notable that growing importance was being placed on protein levels. The issue of payments based on protein levels, in accompaniment with other quality issues, are likely to have a major influence on the growers search for new information. The shift in the need for reliable accurate information should see an increase in both the frequency and duration of the growers search for information.

I would suggest that publications such as 'Quest for Quality: Operation Quality Wheat' (Bestow 1992) are appropriate mediums through which to convey the information pertinent to improved cropping practices. The continued expansion of the Crop Variety Sowing Guide could be of concern. I would suggest that growers could become somewhat daunted by the task of picking up the current Crop Variety Sowing Guide (Crooks *et al.* 1994) and eliciting the information that they are seeking. The guide, while bring an excellent tool for the extension agent, may well appear to be to voluminous and complex for the 'average' grower. Discussions with a cross section of grain growers appears to validate this suggestion. The cost of production and distribution of the Crop Variety Sowing Guide in its present format has been questioned in the past (Lawson 1991). A detailed review of the current publication and distribution policy associated with the guide would appear to be appropriate.

The key point at which strategic decisions are made is at the time of delivery of final loads of varieties. Across the period when growers harvest, the majority of extension agents are also involved in harvesting of Crop Variety Testing Program and other trial plots of their own. Given the importance of the communications that take place at this stage some effort should be made to more formally tap into the grower networks at this stage.

The linkages between the availability of extension products, be they publications or Department of Agriculture staff, and the adoption of new varieties has been made. Those who direct those extension activities should consider reviewing the activities in the areas that have been highlighted.

Conclusion

In seeking funding from the State Wheat Research Committee of Western Australia for the field components of this study four questions were posed.

> How do Western Australian farmers use and value the information on new wheat varieties that is available to them from a range of sources?
>
> What is the credibility of local trials relative to more distant but possibly more prestigious sources?
>
> How does extension effort affect adoption rate across regions in Western Australia?
>
> To what extent is the slow adoption of recommended variety due to poor relative performance in a given environmental niche?

These questioned were raised in asking the further question, why are there anomalies in the varietal deliveries to adjacent receival points?

The conversion of data provided by Cooperative Bulk handling made it possible to examine the rates of adoption and disadoption of varieties across Western Aus-

tralia. It was then possible to classify the receival points on the associated cumulative adoptive behaviour of the growers delivering to them.

From the detailed examination it has been found that the growers do differentially use and value the information on new wheat varieties that is made available to them from a range of sources. The differential usage may be either area; grower or variety specific. This is a complicating factor that needs further consideration.

Growers placed more credibility on local trials and field day information when compared to more distant trials and field days.

Areas where there has in the past been low levels of adoption of new wheat varieties have in general been shown to have had poorer contact with the major extension providers.

The slow adoption of recommended varieties due to poor relative performance in a given environmental niche has not been fully explained. However given the dominance of the variety Halberd in this category and its propensity to be 'throw in' when compared against the tighter regime required for sowing other more recent varieties, coupled with Halberd's capacity to 'do well' in a range of season types for which the newer varieties have not been fully tested - by the growers, a partial explanation has been found.

Many questions still remained unanswered. Through further investigation the richness of the data set acquired in the study may indeed provide the answers to some of the questions either partially answered or unanswered at this stage

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