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ASSESSING THE ON-FARM IMPACTS OF GROUNDWATER REALLOCATION POLICIES IN THE NAMOI VALLEY

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NSW is in the process of implementing major reforms to the management of water resources. One of the key components of these reforms is that "Groundwater management policies should employ the principles of ecologically sustainable development and should be directed at achieving sustainable use of the resource". The implications of this recommendation vary significantly across NSW according to the level of irrigation development and the environmental conditions of aquifers.

The Namoi Valley is one region where groundwater has been identified as suffering from both over allocation and over use. Without change, groundwater dependant ecosystems, irrigators and other users face further declines in groundwater quality and quantity with potential aquifer collapse. Consequently, changes to the level of groundwater extractions are required and, not surprisingly, there have been various methods put forward by stakeholders as to how the impacts of this reduction should be distributed.

To assess the on-farm economic impacts of groundwater reallocation, a representative farm model was developed for a typical cotton farming system. This paper describes the development of the representative farm model and provides an overview of initial results. Results of the representative farm modeling indicate that reallocation is likely to create significant structural adjustment pressures for some groundwater irrigators in the Namoi Valley and for the local community.

[1] The views expressed in this paper are those of the authors, rather than those of NSW Agriculture or the NSW Government.

1. INTRODUCTION

Reform to the Australian water industry has received considerable attention in recent years. This can be partly attributed to growing community concerns regarding environmental degradation, increasing evidence of the poor state of the natural resource in irrigation areas, increasing competition between users and greater government focus on improving economic efficiency through microeconomic reform. A significant milestone in changing the focus of water resource management in Australia was the agreement by the Council of Australian Governments (COAG) in 1994 to a strategic framework of reforms that call for an integrated and consistent approach to water resource management throughout Australia.

The water reform framework includes pricing reform, clarification of water rights (including specific environmental allocations), improved tradeability, institutional reforms and commitments to greater public consultation and participation in decision making. The importance of these reforms was strengthened in 1995 when the framework was formally linked to the National Competition Policy (NCP) and hence to State Government tranche payments under the NCP. As a consequence, significant financial incentives exist for State Governments to implement COAG water reforms.

NSW, like other States, is in the process of implementing COAG's reforms to the management of it's water resources. Of key concern to this paper is the ARMCANZ recommendation that "Groundwater management policies should employ the principles of ecologically sustainable development and should be directed at achieving sustainable use of the resource" (ARMCANZ, 1996). In the NSW context this is significant in that a number of groundwater acquifers have been identified as having either an existing or potential resource sustainability problem. Those with an existing problem have both allocation and current usage in excess of annual recharge. Those acquifers with a potential problem have allocations which exceed annual recharge but, because not all allocations are fully active, current use is less than recharge. This issue will become more critical as ecological provisions are introduced (NSW has set a preliminary target of 30% of recharge as an appropriate ecological provision pending more detailed scientific analysis for each aquifer – DLWC 1997).

Like surface water, much of the State's current groundwater problems relate to historical allocation policies which, for many systems, granted entitlements in excess of sustainable resource limits. While these policies were based on contemporary government objectives aimed at boosting regional development and employment, the activation of unused licenses over time has created the basis for conflict both within and between water uses. In some groundwater aquifers a significant reduction in entitlements is now required to ensure the sustainability of groundwater dependant ecosystems, to protect users from further declines in groundwater quality and quantity and to avoid the possibility of aquifer collapse.

This paper focuses on the groundwater resource problems which exist in the Namoi Valley of NSW. The objective of the paper is to outline the approach taken by NSW Agriculture to the assessment of different reallocation options, how this fits into the community based approach to water reforms adopted in NSW and to highlight some preliminary results from the analyses currently underway.

The paper is structured as follows. Section 2 provides an overview of the current groundwater situation in the Namoi Valley. Section 3 outlines possible methods of resource reallocation and describes the alternatives being proposed in respect to the Namoi. Section 4 describes our approach to assessing reallocation options based on the development of representative farm models. Some preliminary results for one case study area are presented in Section 5 while conclusions and suggestions for further work are presented in Section 6.

2. GROUNDWATER IN THE NAMOI VALLEY

2.1 The Namoi Valley

The Namoi Valley is located in northern New South Wales bounded in the east by the Moonbi and Great Dividing Ranges, in the south by the Warrumbungle and Liverpool Ranges and in the north by the Nandewars (Figure 1). It has an area of approximately 43 000 km^2 or one sixteenth of the State (Hope & Bennett, 1999).

The Namoi River begins as the MacDonald River in the Northern Tablelands around 50 kilometres east of Tamworth and flows west and north-west until it terminates at its junction with the Barwon River at Walgett.

The economy of the Namoi Valley is heavily dependent on agriculture which was valued at $668m in 1995 (Morison & Zoretto 1995). The value of irrigated agriculture in 1995/96 was listed as $275m (Donovan 1998) or 34% of regional agricultural output. Cotton is the major irrigated commodity contributing $227m or 83% of irrigated output (Donovan 1998). Many irrigators have access to both surface water and groundwater and rely more heavily on groundwater in dry years when surface water availability is reduced.

2.2 Groundwater in the Namoi

The groundwater aquifer in the Namoi Valley is divided into an Upper and Lower section based on distinctly different hydrogeological features. The Upper and Lower Namoi Valley are further divided into 17 management zones also based on hydrogeological distinctions (NGERP 1999). The Upper Namoi valley includes the groundwater resources within the alluvial sediments deposited on the relatively narrow flood plain of the Namoi River upstream of Narrabri and along the Mooki River and Coxs Creek (Figure 1). The groundwater reserves of the Lower Namoi Valley are less confined being associated with the prior streams of the riverine plain to the West of Narrabri (Figure 1).

High yielding bores were first constructed to irrigate cotton in the Namoi Valley in the mid 1960's. The use of groundwater in irrigated agriculture has rapidly expanded since then. Today 460,100ML of groundwater is allocated to 769 properties in the Namoi Valley. This is more than double the estimated average annual aquifer recharge of 210,000ML/yr. While average use since metering was introduced in 1985/86 (160,000ML/yr) has been less than estimated average annual aquifer recharge, this masks major problems for a number of management zones. Water allocations, use and recharge levels for each management zone are illustrated in Figures 2 and 3 for the Upper and Lower Namoi respectively.

Figure 1 – Location Map

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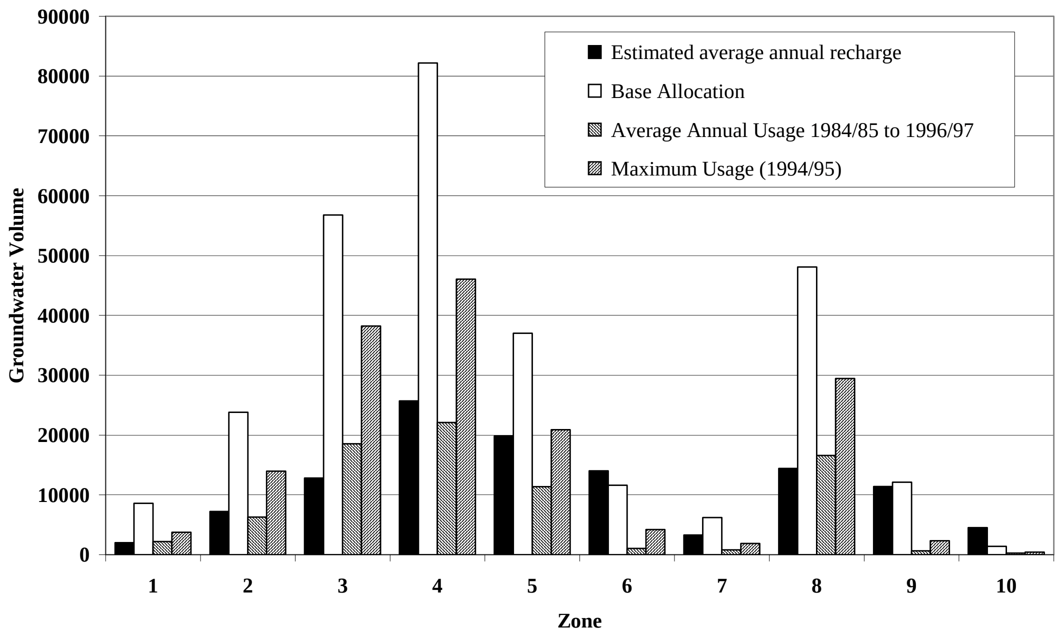
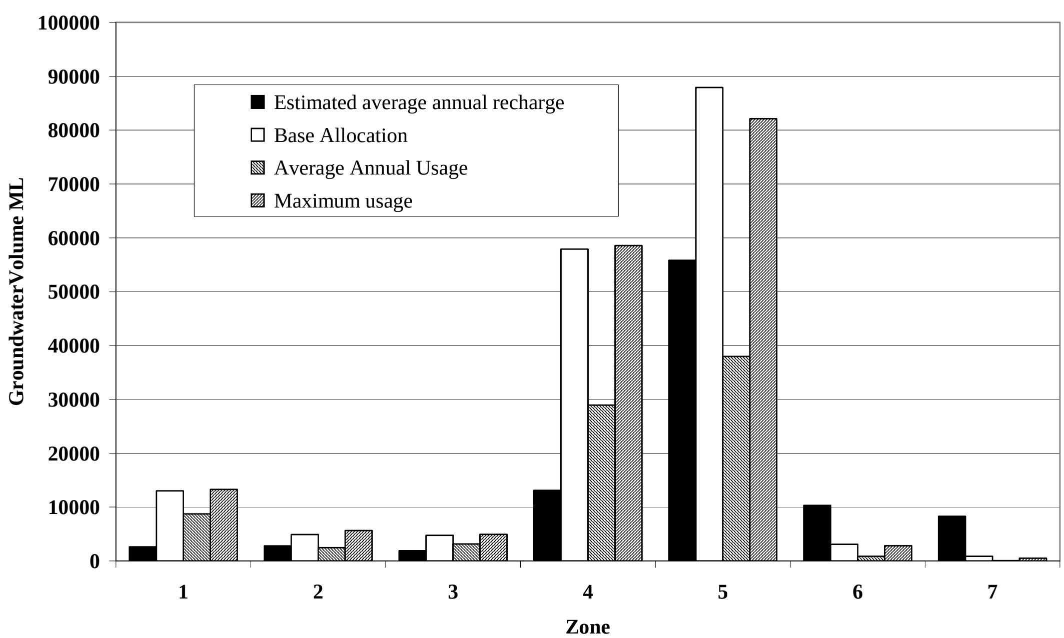
Figure 2: Allocation, Recharge and Usage in the Upper Namoi Valley



Source: NGERP (1999) p20

Figure 3: Allocation, Recharge and Usage in the Lower Namoi Valley



Source: NGERP (1999) p24

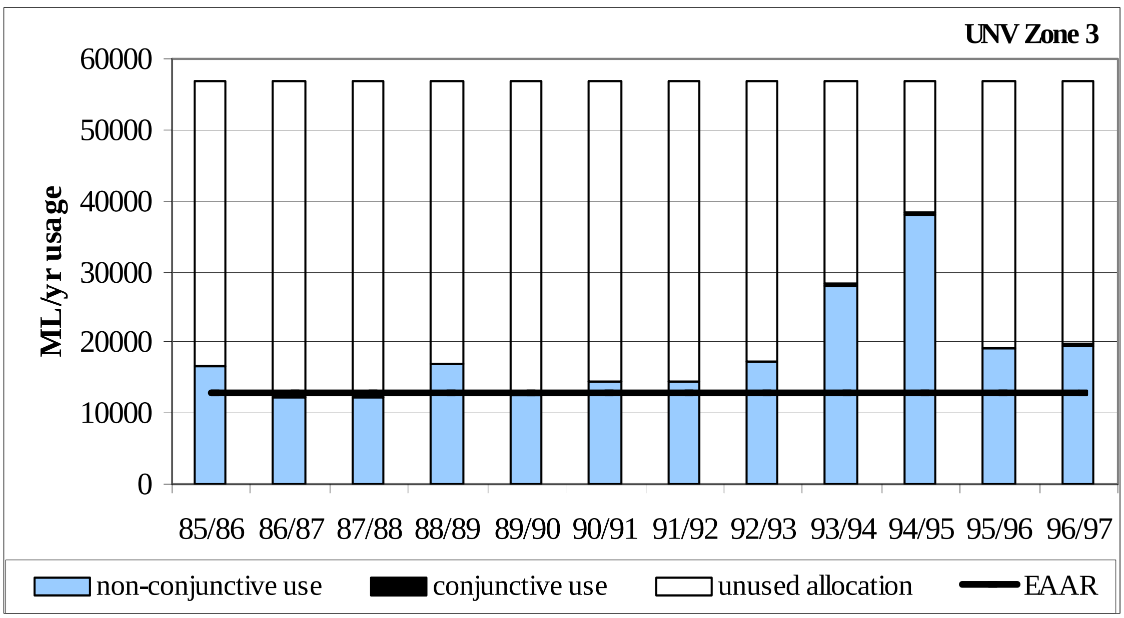
Figures 2 and 3 highlight not only the extent of over allocation in most zones and for the aquifer as a whole, but also the current over use of the resource in some zones. If all allocations were fully activated, 13 of the 17 zones would be unsustainable.

A groundwater management plan was introduced in 1995-96 as a first step in addressing the problem. The plan reduced allocations "across the board" ranging from 10% to 35% for different zones depending on the degree of over allocation. The plan also "protected" small users by exempting irrigators with allocations of less than 500ML from reductions

2.3 Groundwater in Zone 3

Namoi groundwater Zone 3 is located between Gunnedah and Breeza on the Mooki River (Figure 1). Figure 2 indicates that Zone 3 is not only severely over allocated but also over used. Trends in groundwater use in Zone 3 are illustrated in Figure 4. This indicates that use has not only equalled or exceeded recharge every year since records commenced but the level of use is increasing. Further, there is significant scope to increase current useage within existing allocation limits. Zone 3 has been the subject of a number of studies (Nancarrow, McCreddin and Syme 1988, Young 1988) due to the severity of resource over allocation and over use. However, other zones have problems of a similar magnitude (for example, Lower Namoi Zone 4).

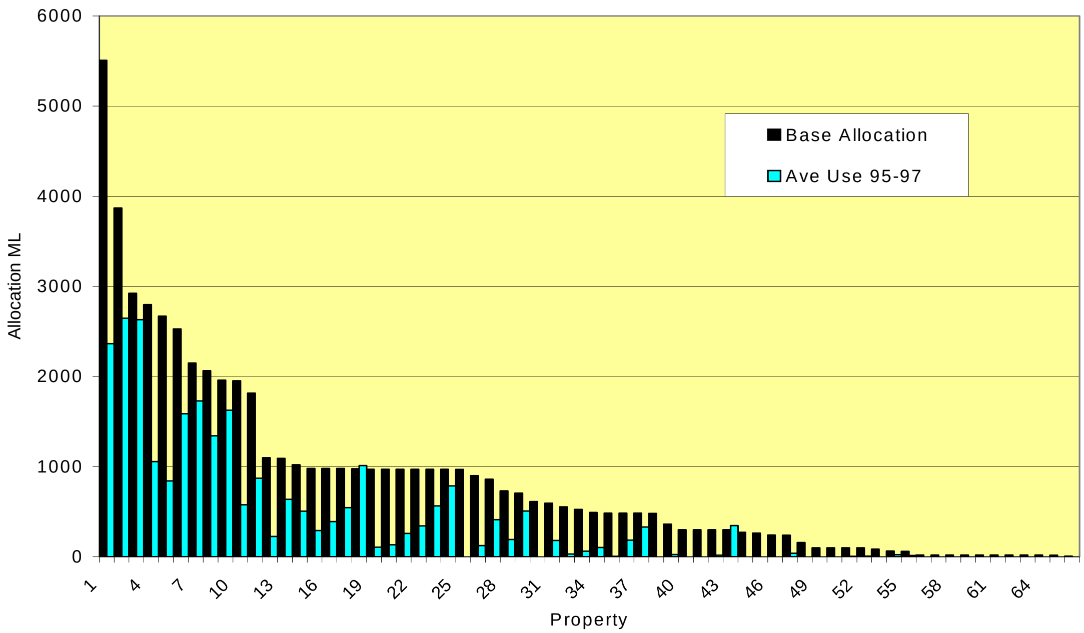
Figure 4: Trends in Groundwater Use – Upper Namoi Zone 3



Note: EAAR = estimated average annual recharge

Zone 3 supports 67 Groundwater irrigators. Eleven of whom also have sporadic access to surface water flows from the (unregulated) Mooki River while two others have access to surface water from the (regulated) Namoi River. Allocation and average use levels for irrigators in Zone 3 are illustrated in Figure 3. This indicates (a) that there is a large range in allocations (from less than 20 ML to over 5,500 ML) (b) there is a large variation in the level of activation of those licences and (c) that most irrigators have both an active and inactive component to their allocation.

Figure 5: Allocations and Use for Upper Namoi Zone 3 Irrigators



Clearly, the groundwater resources of the Namoi are significantly over allocated and, in some cases, over used. Without fundamental change, groundwater dependant ecosystems, irrigators and other users face further declines in groundwater quality and quantity with potential aquifer collapse. Consequently, changes to groundwater allocations are necessary to achieve sustainable groundwater use.

3. REALLOCATION OF RESOURCES

3.1 Re-allocation processes

Resource re-allocation decisions are commonly assessed in a benefit cost analysis framework. The economic efficiency of different allocation policies can be assessed by comparing the social benefits and costs associated with each policy. Underpinning the benefit cost analysis framework is the ‘potential Pareto improvement’ criterion which states that resource re-allocation decisions are efficient if those who are made better off can compensate those who are made worse off and still be in a better situation. Of course, for the criterion to be satisfied it is not necessary for compensation to be actually paid.

The difficulty in applying a standard benefit cost analysis to the re-allocation of groundwater relates to the broader interests of the community which go beyond economic efficiency alone. Of key concern to many stakeholders is how those impacts are distributed amongst different users. A satisfactory solution to the problem will involve some form of agreement between decision makers as to the nature of their objectives (which will incorporate elements of both efficiency and equity) from which alternative options can be assessed.

In general terms there are four main alternatives to address the over allocation of groundwater resources. These are outlined below:

i) As the owner of the water resources of the State[2], the Government makes a decision on how the resources should be re-allocated and modifies individual entitlements accordingly.

ii) A community based process is established to provide recommendations to government on how the re-allocation is to be achieved.

iii) The Government enters the market for groundwater and purchases sufficient entitlement to ease pressure on groundwater resources.

iv) The Government establishes a levy on existing entitlement holders to partly or fully cover the cost of entering the market and purchasing entitlements to ease pressure on groundwater resources.

Once property rights for groundwater resources are redefined the reintroduction[3] of temporary and permanent water transfers can best deal with the allocation of resources amongst users. This may be of greater significance under processes i) and ii) given that active users will be seeking to offset reductions flowing from the redefinition of property rights. Active users will be in a position to purchase water from other active or inactive users (or from surface water users where practicable) either on an annual or permanent basis as permitted by the water trading arrangements implemented. The following section outlines the approach adopted by the NSW Government to the reallocation issue.

3.2 The NSW Government's Approach

The NSW Government has established a community driven approach to water reform issues. A series of community based advisory committees containing relevant government agencies and stakeholder groups has been established for each of the major rivers and groundwater aquifers across the State. These Water Management Committees (WMCs) have responsibility for evaluating the environmental, economic and social impacts of various options to achieve the Government's water reform agenda, for recommending a preferred option and for developing a plan of management for the resource (see Musgrave, Vernon and Pagan (forthcoming) for further detail of the NSW approach. The Government has made resources available to the WMCs to undertake relevant analyses to inform their decisions. While ultimate decision making power remains with the Government, WMC recommendations complying with legislative and policy guidelines have so far been implemented.

The Namoi Groundwater Management Committee (NGWMC) has responsibility for recommending options to address over allocation of groundwater in the Namoi Valley. NGWMC have been assisted in this endeavor by separate social and economic analyses undertaken to provide background information on the impact of allocation reduction and options for achieving it (Nancarrow, McCreddin and Syme 1998, Young 1998). In addition,

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[2] all water is vested in the Crown and State Governments have control over the water resource within their boundaries

[3] trading is currently embargoed in the Namoi pending the redefinition of sustainable groundwater entitlements

the Minister for Land and Water Conservation established the *Namoi Groundwater Expert Reference Panel* (NGERP) in January 1999 to recommend possible options to reallocate groundwater entitlements to sustainable limits. The NGERP report was presented to the NGWMC in October 1999.

The NGWMC are currently engaged in community consultations based on the NGERP report with a view to determining preferred options for allocation reduction.

The NGERP established a number of objectives in determining their preferred options based on extensive public consultation (Nancarrow, McCreddin and Syme 1998). These objectives (in priority order) are:

i. Ensure sustainability of the resource.

ii. Ensure fairness.

iii. Maximise economic output.

iv. Minimise negative social impacts.

v. Mitigate impacts.

Key elements of the final system recommended by the NGERP to achieve these objectives are:

- Allocations should be reduced to achieve sustainable resource use (reallocation);
- Reallocation should recognise the "value of investment" by providing a weighting for "active use" with the weighting to be determined on a zone by zone basis (a preferred weighting of 70:30 was suggested for active:inactive water as this reflected the relative capital investment of active and inactive licence holders);
- "Active use" should be determined by metered usage over the years 1992/3 to 1996/97 adjusted for property amalgamations and subdivisions on a pro rata basis;
- Metered usage over the 1992/93 period should be adjusted for a "stewardship" factor to avoid rewarding inefficient users;

The NGERP anticipated significant economic and social impacts on the local and regional communities as a result of the reallocation process and made a number of further recommendations to mitigate the anticipated impacts. These included:

- All licence holders should be given 12 months notice of any changes to their existing licence conditions (because of forward contracting);
- Reallocation should be phased in over 10 years in two separate phases. Phase 1 ignores ecological needs. Phase 2 (the 2nd 5 years) further adjusts allocations to provide for ecological requirements (which are to be specified during phase 1);
- Carryover provisions should be introduced for unused entitlements of up to 100% of the announced allocation with a facility to bank up to 300% of a licensee's <u>final</u> annual

entitlement and a facility to withdraw carryover in any one year up to 200% of the final annual entitlement;

- A facility for irrigators to transfer entitlements either permanently or temporarily should be introduced as soon as revised allocations are specified;
- An industry funded financial compensation scheme should be introduced for all retired water, whether active or inactive;
- A Government funded structural adjustment package should be available for those with active water retired;

An analysis of the regional economic impact of reallocating groundwater to sustainable levels was undertaken by DLWC using input-output analysis (DLWC 1999). This analysis assumed that allocation reductions in currently over utilised zones would be partially offset by increased use in currently under utilised zones and that operation of the market would redistribute currently inactive water to active users. The analysis predicted that total regional output would fall by $5.8m per year (including flow-on effects) as a result of reallocation.

While the regional impact analysis gives an indication of what communities will face as a result of policy implementation it does not show how reallocation will impact on different water users and whether those users can accommodate the necessary reductions. This distributional impact is an important policy consideration. NSW Agriculture was requested by the NGWMC to prepare a series of representative farm models to determine the impact of groundwater reallocation in the Namoi Valley on different irrigation farming systems. The methodology employed to undertake this analysis is described in the next section.

4. ASSESSMENT OF ON-FARM IMPACTS

4.1 Selection of a methodology

There is a broad range of techniques available for the assessment of on-farm impacts of re-allocation options. These techniques range from simple budgeting methods to formal optimisation models. The applicability and appropriateness of any of these techniques depends ultimately on the purpose of the analysis, the problem being addressed and the nature of the farming system under consideration. These issues are discussed below.

The purpose of the analysis is to provide some tools and analyses to assist the NGWMC assess the farm level financial impacts on irrigators of reallocation options. The NGWMC has specified objectives not only in terms of economic efficiency, but also whether changes are considered to be 'fair and reasonable', incorporating notions of equity between water users within and between zones. A key issue in the decision making process was the large range of options being proposed by the NGERP, the NGWMC and stakeholders. These related to appropriate definitions of active water, various weighting systems concerned with history of use, stewardship and phase in periods. This highlighted the need to develop appropriate tools to enable the impacts of these options on different groundwater users to be evaluated. After considering these elements some initial requirements for the analysis are evident:

- methodology and results should be readily understood by the NGWMC (simplicity and transparency);
- a level of desegregation is required to assess the impact of re-allocation options on different farm types (desegregation);
- easily revisable to handle alternative options and new information (revisability); and
- ability to capture impacts through time (timing).

The problem being addressed is the requirement for significant reductions to groundwater allocations. The magnitude of some adjustments are such that it could easily threaten farm financial viability. While on-farm impacts of policy changes can often be evaluated in terms of gross margin impacts, underlying farm viability is usually assessed in a whole farm budgeting framework. As a consequence, a further requirement of the approach requires the consideration of the overhead cost structure of farms.

The nature of farming systems can also have a significant bearing on the appropriateness of methodologies used to assess impacts. Rainfall is summer dominant in Northern NSW and its availability can have a major impact on crop selection, irrigation requirements and crop yields. This suggests that some representation of climatic variability is desirable to capture variations in farm performance.

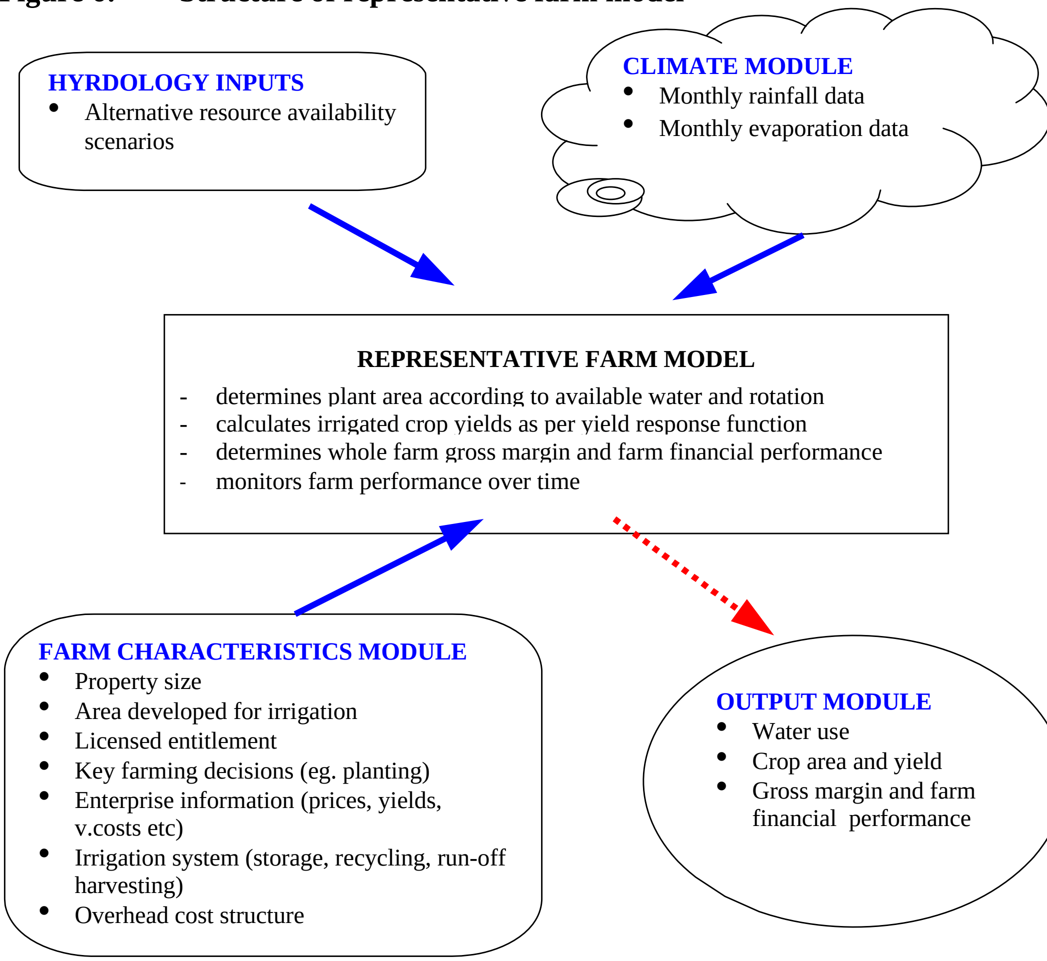
The above requirements led to the development of representative farm models for use in the evaluation of groundwater re-allocation options. The models are spreadsheet based and attempt to capture the key characteristics of irrigation farming in different groundwater management zones. The models are set out as a whole farm budget with key farming decisions based on information elicited from groundwater irrigators and technical experts. Consequently, they differ significantly from formal optimisation models such as linear and dynamic programming models in that they are based on key decision rules rather than profit maximisation objectives. This has both advantages and disadvantages in terms of model development and scenario evaluation. A graphical representation of the model structure is provided in Figure 6 below.

The next section provides a description of some of the data that is required to undertake an evaluation using the representative farm model structure described above.

4.2 Developing the representative farm – data collection

A workshop was held with local irrigators and technical staff of NSW Agriculture and DLWC to develop an understanding of the irrigation farming systems in the Namoi catchment. This consultation identified 9 major irrigated farming systems for the Namoi Valley and specified in some detail the farming systems for these areas. A local consensus data (LCD) workshop was then held to obtain data on a case study farming system in Zone 3 of the Upper Namoi Valley. The LCD technique relies on data gathering from groups of local landholders and has been successfully used to gather farm level data to evaluate a range of water reform issues in other catchments of NSW (see Jayasuriya, Catt and Young - unpublished). Unfortunately, the LCD technique proved only partly successful for the case study area as irrigators could not reach consensus on what farming systems could be considered to be representative.

Figure 6: Structure of representative farm model

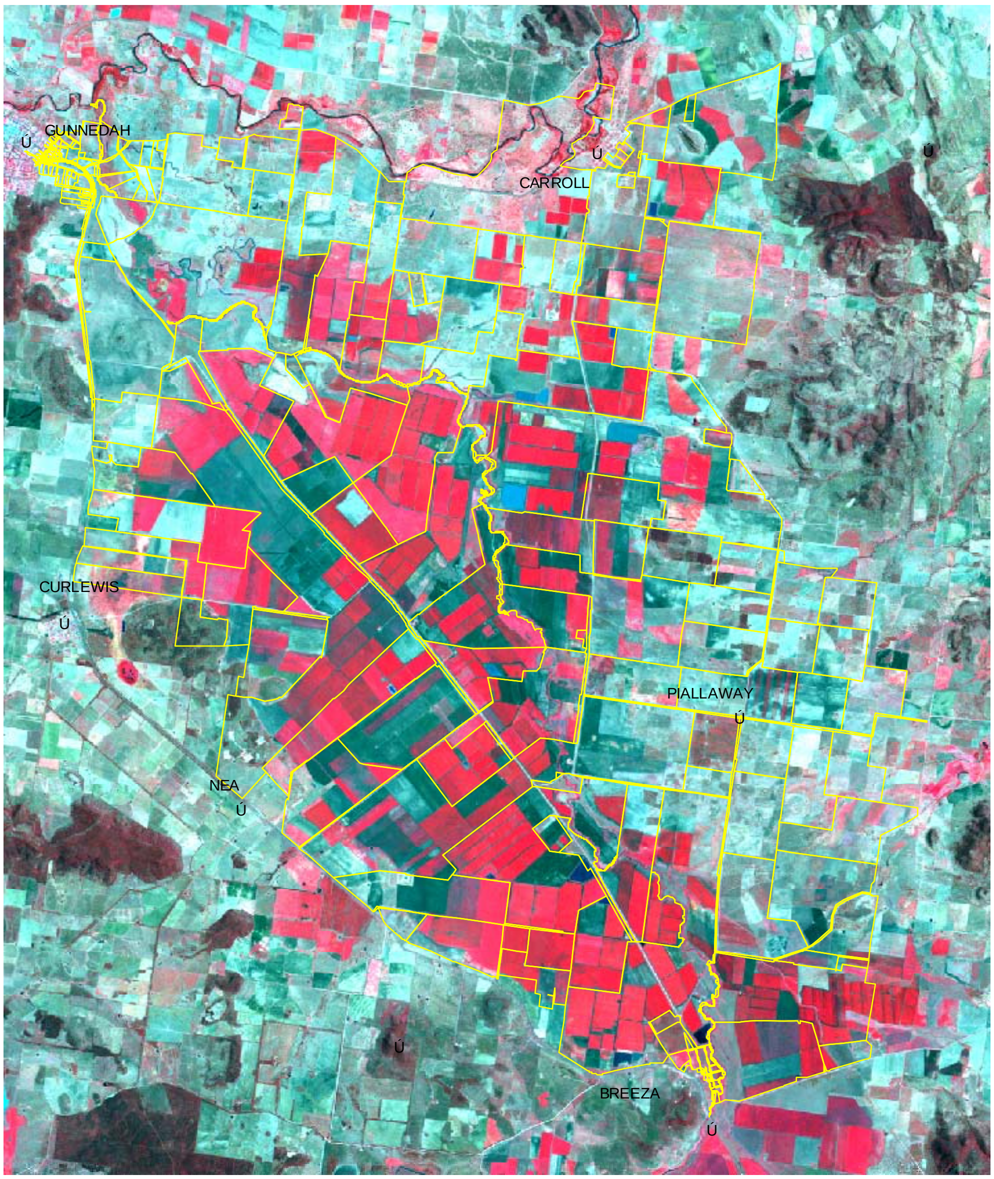


Because of disagreement about the details of the case study farms, a geographic information system (GIS) database was established using ARC/INFO software to obtain objective physical farm data. Data layers entered into the GIS included:

- property boundaries (compiled from digital cadastral data refined by local farmers);
- areas laid out to irrigation for each property (compiled by satellite image analysis);
- areas of summer crops irrigated during 1998-99 (compiled by satellite image analysis);
- the size of on-farm storages (compiled by satellite image analysis);
- details of water licences and historical usage for each irrigator (supplied by DLWC);
- the property location of each groundwater and surface water licence (identified by local farmers).

These data were tabulated for each property in the study area allowing detailed analysis of physical property attributes for any combination of properties selected for analysis.

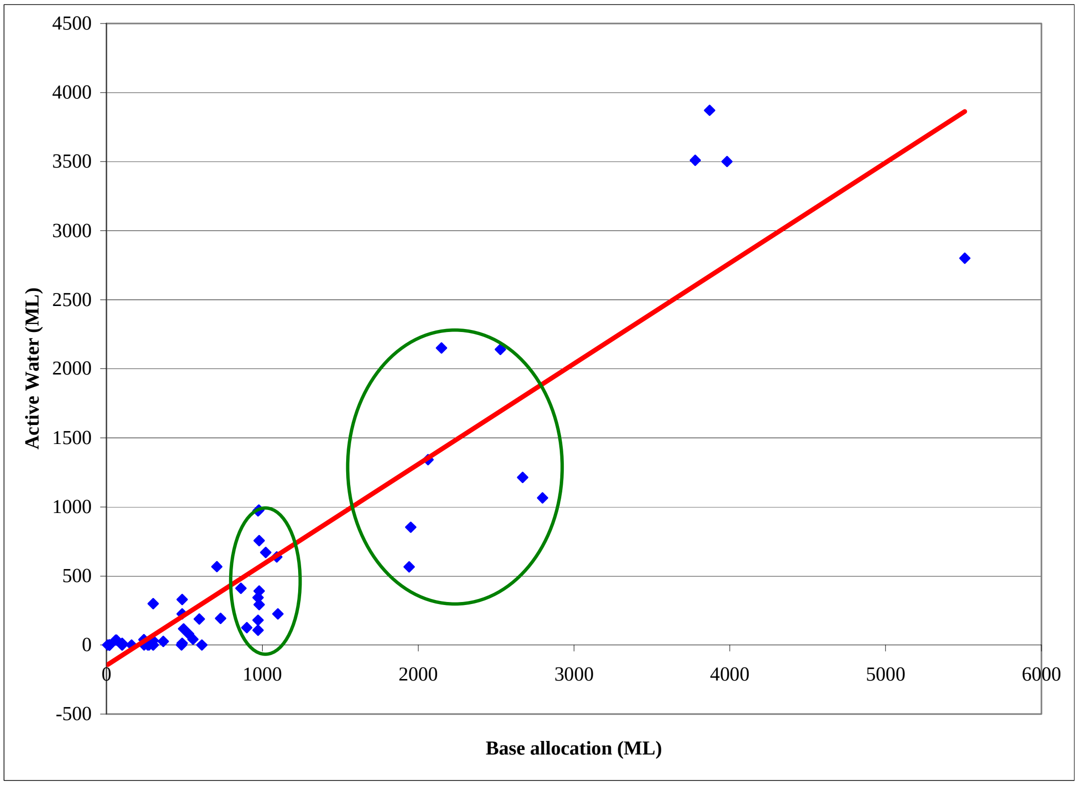
Figure 7: GIS featuring property boundaries for Zone 3



Ú **Localities**
Upper Namoi - Zone 3 Properties

Farms were grouped according to their active water and base allocation as these are two of the critical factors impacted by the reallocation options being considered by NGWMC. Two clusters of farms were identified - those with groundwater entitlements between 900 and 1,100ML and those with entitlements between 1,500 and 3,000ML (Figure 8). These clusters incorporated irrigators with and without surface water access. Physical farm data was initially tabulated for the cluster of irrigators with entitlements of between 900 and 1,100 ML and a representative farm model developed for this group of farms.

Figure 8: Representative Farm Clusters



Crop production and variable cost information was obtained from NSW Agriculture's Farm Budget Handbooks (Scott 1999a and 1999b). Yield response relationships for cotton and wheat were developed on the basis of the proportion of crop water requirements met by rainfall and irrigation. The cotton yield response function was derived on the basis of data from CSIRO's simulated cotton crop growth and yield model (OZCOT). The yield response function for wheat was developed on the basis of discussions with NSW Agriculture technical staff.

Financial information for the representative farm was obtained from two main sources. First ABARE extracted farm physical and financial data from their 1996/97 survey of irrigation farms for several "clusters" of farms in the Namoi valley. These data were used as the primary source of farm financial data. However, because the ABARE data did not exactly match the representative farm descriptions, further data were obtained from local agricultural consultants to supplement the ABARE data. These data were verified by local irrigators then entered into the representative farm model to develop a range of financial performance measures for the key reallocation options being considered by the NGWMC. Results of this analysis are discussed in Section 5.

4.3 The representative farm for Zone 3

To date, one representative farm model has been developed. That is for cotton growers in Zone 3 with a groundwater entitlement between 900ML and 1,100ML with no access to surface water. Two major scenarios were evaluated. First when groundwater is fully active and second when groundwater is only 50% active. The key physical characteristics of the representative farm for each scenario are summarised in Tables 1 and 2.

Table 1: Representative farm physical farm characteristics

Physical Farm Characteristics	**Units**	**Activation Level**	
		100%	**50%**
Total Farm area	Ha	480	480
Irrigation Country			
Area developed for irrigation (ha)	Ha	243	121
Area normally irrigated (ha)	Ha	194	97
Irrigated cotton area (ha)	Ha	146	73
Irrigated wheat area (ha)	Ha	50	24
Dryland cotton grown on area developed for irrigation (ha)	Ha	0	0
Dryland Country			
Workable dryland area (ha)	Ha	213	323
Dryland crop area – wheat (ha)	Ha	85	129
- Cotton (ha)	Ha	43	65
- Sorghum (ha)	Ha	43	65
Dryland area grazing	Ha	43	65
- carrying capacity	DSEs	231	323
- Beef cattle vealers	hd	30	45
- Sheep	hd	0	0

Table 2: Representative farm water use

Activation and Water Use	**Units**	**Activation Level**	
		100%	**50%**
Base Allocation	ML	972	972
Total water use	ML	972	486
Water used on irrigated cotton	%	90	90
Water used on irrigated wheat	%	10	10
Water use on irrigated cotton	ML	875	437
Water used on irrigated wheat	ML	49	48

4.4 Analysis

The evaluation is short run in nature with each scenario run under the assumption that no enterprise adjustment occurs (such as improved water use efficiency or additional allocation purchase) during the reallocation phase in period. For simplicity, results are presented only for average rainfall conditions over the last 20 years for Gunnedah. However, the model is capable of evaluating a range of climatic scenarios.

One of the key elements of the proposed reallocation system discussed in section 3.2 is the weighting of active and inactive water in the reallocation process. This has been highlighted by the NGWMC as having a potentially significant impact on irrigators. To assess this, a number of scenarios utilising different levels of licence activation and different weightings for active and inactive water were evaluated for the 2 situations listed in Tables 1 and 2.

Scenarios results presented include a 90:10 weighting (weighting favouring active over inactive water) and a 50:50 weighting (equal allocation reductions for both active and inactive water). These scenarios are summarised in Table 3.

Table 3: Reallocation scenarios

Scenario	Level of Licence Activation	Weighting
Scenario 1	100%	90:10
Scenario 2	100%	50:50
Scenario 3	50%	90:10
Scenario 4	50%	50:50

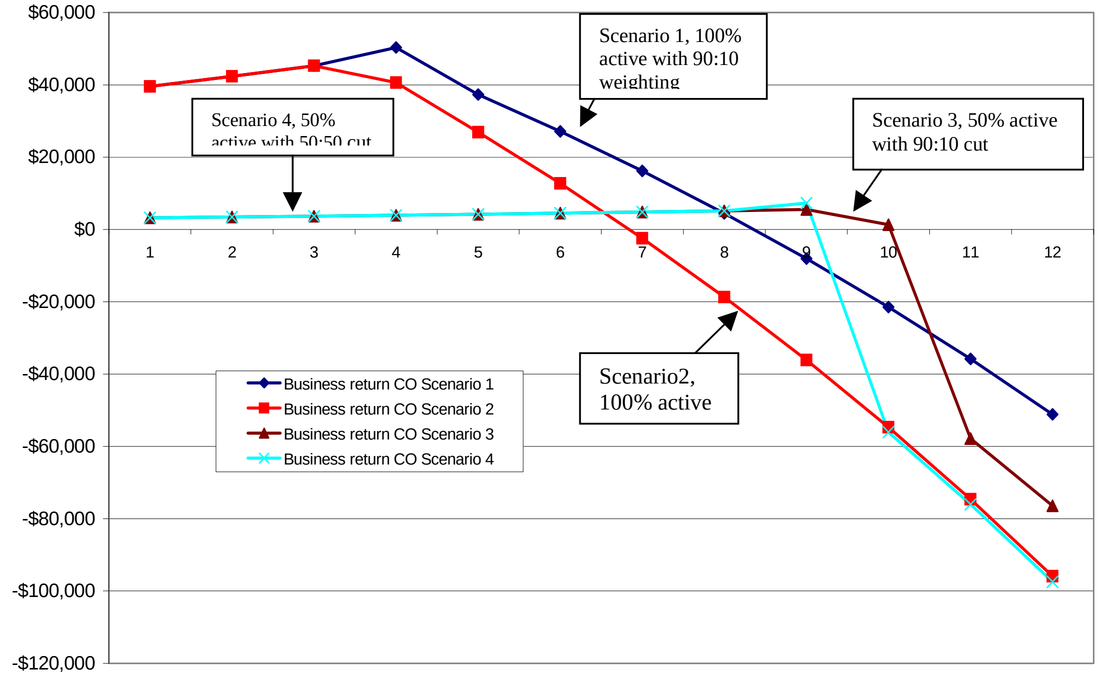
It is important to note that while the reallocation options being considered are based on 100% of existing allocations, all groundwater irrigators have already incurred a 35% cut in that allocation under previous government policy (see Section 2.2). This has obviously had a much greater impact on fully active users than those who were less active. Therefore, although referred to as fully (100%) active, these irrigators are in fact only using 65% of their licence -just 15% more than the group using 50% of their licence.

5. PRELIMINARY RESULTS

Some preliminary results are presented in figures 9, 10 and 11.

Figure 9 indicates that, under each reallocation scenario, business return becomes negative within 7 to 10 years of the reallocation phase in. It should be noted, however, that business return for the representative farm are falling from an existing low level, particularly for irrigators who are currently only 50% active. This reflects the current low cotton price ($450/bale) which was used in this model run. Sensitivity analysis is yet to be undertaken on price and other variables.

Figure 9: Impact of different weightings on current active and inactive users



The impact of weighting in reallocation

The impact of different weightings for active and inactive use is illustrated in Figure 9. For example, reallocation of a fully active licence on a 90:10 weighting delays business return going negative by approximately two years compared to a reallocation based on equal cut backs. Further, a weighting that favours active use causes business return to fall at a slower rate than a weighting favouring inactive use.

Figure 9 also demonstrates that the most favourable weighting for the inactive licence holders is the 90:10 scenario. While this seems incongruous at first glance, it arises because of the 35% cut to entitlements already implemented. As a result, the 50% active irrigator actually has only 15% inactive water remaining (50%-35%).

The impact of carry over.

Carry over allows irrigators to bank unused water in good years to be used in years of lower rainfall or lower phased in allocation. It has been proposed not only as a means of encouraging water conservation but as a means of mitigating the impacts of reallocation. The results of the analysis of carry over provisions are provided in Figures 10 and 11.

The ability to carry water over has no financial impact on fully active irrigators as all allocated water is fully used, leaving none to be carried over. As a result, the business return of the fully active irrigator decreases much earlier in the phase in period compared to the partially inactive.

Figure 10: Gross Margin and business return for scenario 3

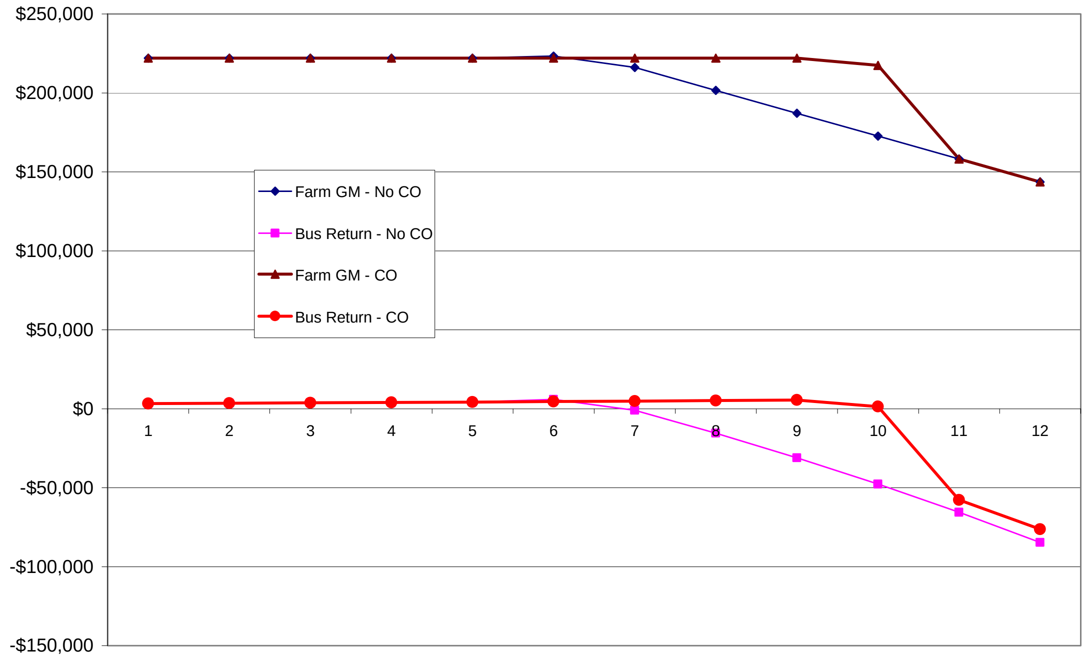
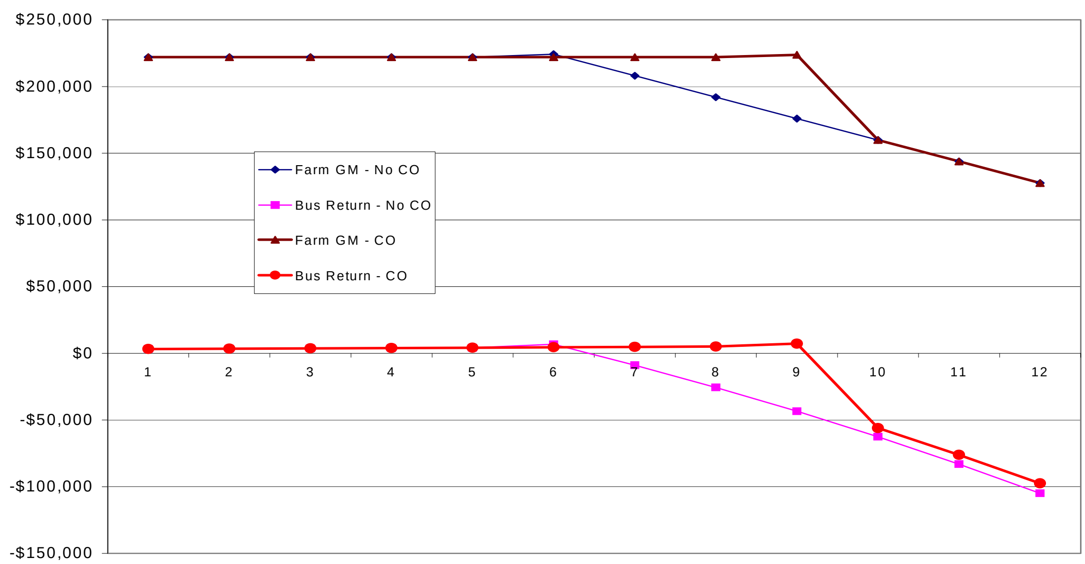


Figure 11: Gross margin and business return for scenario 4



Figures 10 and 11 demonstrate the significance of carry over on less active irrigators. For a 50% active irrigator undergoing reallocation with a 90:10 weighting , carry over maintains positive business return until year 10 of the phase in period. Without this carry over, the irrigator would face negative business returns from year 7 onwards. Likewise, a 50% active irrigator undergoing reallocation with 50:50 weighting would maintain positive business returns until year 9 rather than year 6.

Although carry over maintains positive business returns for a longer period, once carry over water is fully utilised, production declines the next year to the same level as if no carry over water had been available.

6. CONCLUSIONS AND FURTHER WORK

6.1 Conclusions

A number of conclusions can be drawn from the results presented in Section 5. The most obvious is that reallocation of groundwater will have significant financial impacts on irrigators in Zone 3. All scenarios evaluated project business return to become negative within 10 years and, under many scenarios, much sooner. However, this is partially a result of the price scenario used as well as the impact of allocation reduction. Sensitivity analysis needs to be undertaken on price and other key assumptions.

I should also be pointed out that if groundwater allocations are not reduced to sustainable yield levels then business return will also ultimately suffer. While current returns could be maintained (or even increased) in the short term by ignoring sustainability, they would ultimately fall, perhaps to zero as the aquifer became depleted. Unfortunately, current hydrogeological modelling is unable to predict the rate of decline in aquifer levels or water quality. DLWC hydrogeologists hope to have an operational hydrogeology model in the near future capable of quantifying these impacts. It is partly because of this uncertainty that allocation reductions are to be phased in over 10 years with targets continually revised as better data becomes available. Better data will also enable a better financial analysis, not only of options for reallocation, but of the “do nothing” scenario. In the mean time, the results above should be interpreted as a means for evaluating choices between different options for achieving sustainable groundwater use rather than a choice about whether to achieve it or not.

It should also be noted that the modelled results are a worst case scenario. As profitability falls, irrigators will adjust their business operations in an attempt to maintain or increase their returns. Options include:

- investment in more efficient irrigation technology;
- purchase of additional entitlement (surface or GW);
- change in enterprise mix;
- sell remaining irrigation entitlement and switch to dryland farming;
- change in the size of operations;
- obtain off farm income (contracting, non farming, etc); or ultimately
- leave farming.

Each farmer will choose an adjustment option best suited to their circumstances. As the model does not include these options, it presents a worst case scenario.

Any adjustment pressure faced by irrigators is also likely to provide a major stimulus to trading in water entitlements. This will not only increase the value of remaining groundwater entitlements (and surface water entitlements, where these can be substituted), but will lead to the more rapid reallocation of water toward its most economically efficient use.

Of the reallocation options evaluated, it is clear that each option favours different groups of irrigators. For example, those with highly active licences will be better off with a system which gives a higher weighting to active licences while those with largely inactive licences will favour an across the board cut. The difficulty will be in establishing an equitable outcome for all users.

6.2 Further Work

As indicated above, the modelling is still in the development stage and further work is currently under way. As well as developing models for a range of other representative farms, (for which data collection is currently under way) a range of other work is also required.

A major concern is the absence of technical information on trends in aquifer quality and condition should current levels of extraction continue. This work is currently under way by DLWC hydrogeologists and economic analysis will be undertaken as soon as reliable estimates of aquifer depletion rates are available.

Sensitivity analysis will also be undertaken for key input and output variables such as cotton yield, price and water costs.

The discussion above indicated that many irrigators will need to consider available adjustment options. While the choice of options will be made on a case by case basis, an investment analysis could be undertaken of some of the most likely adjustment options such as purchasing additional entitlement. It would also be useful to incorporate some optimisation options in the model to help evaluate on farm adjustment options.

In summary, community based water management committees need appropriate tools help them evaluate options available to achieve the sustainable water management objectives outlined under the COAG water reform program. Representative farm models are seen as one useful tool to assist in this process, particularly in terms of the distributional impacts of water reform options.

REFERENCES

Australian Bureau of Statistics (1998) *Agstats*. Cat. No. 7117.0.30.001, Canberra.

ARMCANZ (1996) *Allocation and Use of Groundwater – A National Framework For Improved Groundwater Management in Australia*. Occasional Paper no. 2. Canberra.

DLWC (1997) NSW State Groundwater Policy Framework Document.

DLWC (1999) *The regional socio-economic impacts of changes in groundwater use for irrigation to sustainable yields in the Namoi groundwater systems.* Socio-Economic Services Unit, Sydney, August.

Donaldson, S., & Heath, T. (1997) *Namoi River Catchment: Report on Land Degradation and Proposals for Integrated Management*. DLWC Gunnedah.

Donovan, G. (1998) *Water and Irrigation:Food and Fibre for a Secure, Caring and Sustainable World*. ANCID 1998 Conference, Sale, Victoria. Aug 2-5.

Hope, M & Bennett, R (1999) *Digging for Data: Irrigation Profile of the Namoi Valley, Northern NSW*, unpublished NSW Agriculture, Orange, April.

Jayasuriya, R., Catt, C. & Young, R. T.(Unpublished) *Local Consensus Data Technique: Applicability in the Socio-Economic Analysis of Water Reforms*). NSW Agriculture internal discussion paper, Orange.

Morison. J. & Zoretto. A. (1995) *The Economic Impact of Irrigated Agriculture in the Namoi Valley Region*. Prepared for DLWC – Water Resources, Sept.

Musgrave, W. F., Vernon, D. M. & Pagan, P. G. (forthcoming). *The role of socio-economic assessment in progressing the NSW water reforms*. Paper submitted to the World Water Congress, Melbourne, March 2000.

Nancarrow, B., McCreddin, J. & Syme, G (1998) *Developing a fair process for the reallocation of groundwater for long term sustainability in the Namoi Valley*. CSIRO Land and Water Consultancy report No. 98-40, Perth.

NGERP (1999) *Report of the Namoi Groundwater Expert Reference Panel on the groundwater allocation adjustment process in the Namoi valley*, NSW. Unpublished DLWC Parramatta, October.

Scott, F. (1999a) Summer Irrigated Cropping for Northern NSW. *Farm Budget Handbook*. NSW Agriculture, Tamworth.

Scott, F. (1999b) Winter Irrigated Cropping for Northern NSW. *Farm Budget Handbook*. NSW Agriculture, Tamworth.

Young, M (1998) *Sharing access to groundwater in the Namoi Valley, NSW: options for Zone 3: Options for Zone 5: A pilot study*. CSIRO Land and Water, Adelaide.