WATER RESEARCH COMMISSION

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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Irrigation agriculture

Market risk, water management & the economy

This project investigated the inter-linkages between market risk, irrigation management and the multiplier effects on the economy.

Exploring the links

Water shortages are a looming threat for agricultural as well as urban users in South Africa. Irrigated areas account for about 30% of agricultural production in South Africa, so growth in irrigated crop output per unit of land and water is essential. Furthermore, in areas where irrigation agriculture makes a substantial contribution to the local economy, as it does in the Northern Cape, the economic welfare of the community is largely dependent on the welfare of the irrigation farmers.

This makes it essential that responses to major risk factors, such as market risk, which can impact negatively on irrigation farming profitability and viability, the effective and efficient use of water, as well as the economic welfare of the community and the broader economy, be managed in such a way that potentially serious impacts are minimised.

Market risk-focused research

To acquire the necessary knowledge to enable effective management of market risk and its potential impacts on the viability of irrigation farming, a detailed research project was planned and executed. There were two sets of objectives:

- The first set focused on the **micro-economic and regional economic levels** and consisted of the identification and quantification of risk factors in irrigation farming, identification of optimal risk-reducing water use practices and how current water use practices deviate from the optimum, and finally, the development of decision-making and policy frameworks for reducing risk and increasing viability of both irrigation farmers and irrigation schemes.
- The second set focused on the macro-economic level, comprising the quantification of the impact on the wider economy of the area, of changes in market risk factors that affect irrigation agriculture, in order to develop a policy framework for effective water management in regions where irrigation agriculture makes a major contribution to the economy.

Modelling tools

Numerical models are highly appropriate tools for analysing risks and exploring consequences of alternative risk management and water management practices. Consequently, appropriate modelling frameworks with which to address both sets of objectives were developed.

Framework for micro- and regional economic modelling

The dynamic linear programming (DLP) technique was used for micro (farm) scale modelling. For regional modelling, several DLP whole-farm models were embedded within a spatial framework. This modelling framework was applied to the system comprising irrigation agriculture in the Northern Cape (an area of about 143 000 ha), appropriately demarcated into seven modelling regions.

A farm survey of the regions revealed major differences in farm structure and economies of scale: this necessitated making provision in the decision-making framework for 22 typical farms having wide variations in farm structure, labour use and ratio between canal abstraction and direct river abstraction of water.

Macro-economic modelling framework

A Social Accounting Matrix (SAM) Computable General Equilibrium (CGE) modelling framework was selected for the macro-economic component of the research project. This GCE modelling approach yielded several advantages, among the more important being the much more detailed analysis than obtainable with the alternative (input-output modelling) approach and the much greater value, for policy purposes, of information consequently generated.

The CGE model was calibrated to a SAM for South Africa, implying that the base solution of the CGE model effectively duplicates the original SAM database. The SAM also provided the departure point for calculating economic multipliers that typically measure the nature and extent of the impact of an autonomous change or shock in a specific economic quantity (i.e. market price) on other economic quantities (i.e. employment or production).

Market risk: potential impacts and management responses

Micro-economic, farm level

Models of typical farm scenarios revealed the effect of market risk (reflected in the stability of local farm-level price of table grapes) on profitability: a reduction of 20% in price lowers the return on investment from 37,4% to around 18,5%, a reduction of more than 50% in net farm income. The results also clearly indicate that a more diverse farming structure is a key strategy when it comes to reducing marketing risks.

This enables farmers to absorb market failures more efficiently than with a specialised farm structure based, for example, on table grape production alone. In-season decisions, depending on current prices, to convert part of the table grape crop to raisins or sultanas, would reduce the impact of market failure but would not constitute an optimum market risk-reduction strategy, since farmers need to produce what the market wants.

From a risk management point of view, this makes it important for farmers to get involved in the marketing side of the supply chain. It also emphasises the importance of training farmers in market analysis and market intelligence, as well as providing training in whole-farm planning and in methodologies to analyse alternative crops and introduce them into an existing farm structure.

With regard to the value of irrigation farmland, the model results are consistent with what has been observed in practice. With a 20% reduction in the price of table grapes, the average capitalised marginal land value decreased almost 50% from R204 000 per ha (base value) to R107 000 per ha, which makes obtaining of finance on the basis of land value extremely risky. One way of managing this risk is to ensure that financing decisions are highly conservative and that there is always greater emphasis on the ability to pay than on property value.

Capitalised marginal water value is found to decrease with a reduction in the price of table grapes on a farm not structured for diversified production. Since national water policy supports the use of water at its highest value, an inability to manage market risks, either through a lack of structural flexibility that restricts diversification, or not pursuing a reduction in the farm cost structure, has the unintentional effect of opposing policy by indirectly creating the potential for inefficient water use.

Micro-economic, regional level

In the regional context, application of the DLP modelling framework has proved extremely useful in indicating the routes along which trading in water or water markets will be able to remove inefficiencies from overall water allocations. In general, water trade is towards the regions with the highest marginal value for water, i.e. from the western regions to the north-eastern regions of the Northern Cape.

The analysis showed that when trade in water is possible there would in fact be a substantial increase in land and water use in the water-deficient Vaalharts region. The overall water-use efficiency increases that accompany relocation from water-surplus regions to water-shortage regions include a decrease in the irrigation water requirement per hectare, even though water markets may cause total water usage to increase.

The modelling results also indicate that high water tariffs in agriculture are not necessarily an effective tool for inducing more efficient water use; other market-related factors may carry more weight when farmers make crop-production decisions. Providing farmers with better market information is likely to be more effective when it comes to improving the efficiency of water allocation and water use.

Macro-economic level: impact on broader economy

The results for the first of the two macro-economic methodological approaches, i.e. the CGE model, are based on the assumption that, because of the low rainfall of the area, all arable crops grown in the Northern Cape are irrigated.

Among the many outcomes of simulating the impact of a 20% decrease in the world price of fruit was, for example, the result that, nationally, GDP is reduced by 0,027%, with the main fruit producing areas of South Africa being impacted most. Furthermore, within the Gordonia-Namaqualand-Kenhardt region of the Northern Cape, where most of the province's fruit production is concentrated, the regional GDP declines by 15,7%.

Impacts on the GDP of other Northern Cape regions are much smaller and in most cases negligible. The decline in total value added by agricultural production in the Gordonia-Namaqualand-Kenhardt region amounts to an estimated R199-million as a result of the fruit price decrease.

The above-mentioned results are sensitive to inclusion in the simulations of two employment scenarios (full employment or employment of unskilled labour categories), negative impacts being substantially smaller in the case of the full employment scenario.

With regard to the Equivalent Variation (a welfare measure expressed as a money equivalent), households in the Northern Cape would be R31-million worse off as a result of the 20% fruit price shock.

Macro-economic level: economic multipliers

Three sets of economic multipliers, i.e. labour, production and value-added multipliers, were calculated and then used to quantify the macro-economic impacts of the micro-level (farm and regional) simulations. Given a scenario in which the price of table grapes is reduced by 20% (allowance being made for a 20% deviation in the long-term crop area), thereby reducing the total worth of irrigated agricultural output in the Northern Cape by R316-million (33%) from a base of R1 264-million, the main multiplier impacts are the following:

- *Labour impacts*: Of the 33 955 full-time jobs created by irrigated agriculture, a total of 8 505 are lost, consisting of 4 465 farm-level (direct) jobs, 897 input-supplying industry-level (indirect) jobs, and 3 143 induced job opportunities.
- *Production impacts*: Total production decreases by R969-million from R3 869-million. However, when water trade is allowed, the impact is less severe, with the decrease then being R793-million.
- *Value-added impacts*: The R1 880-million worth of direct, indirect and induced value added as a result of irrigated agricultural outputs is reduced by R471-million, but when trading of irrigation water is possible, the reduction is only R386-million.

Policy framework

A major output of the research is a proposed policy framework consisting of the combination of two component frameworks, namely one intended to ensure effective water management in regions such as the Northern Cape where irrigation agriculture contributes significantly to the larger economy and the other to assist individual farmers and irrigation schemes to reduce risk (specifically direct and indirect market risks) and improve their financial viability.

In managing water risks, there are clear roles for individual farms, industry organisations and organised agriculture, provincial government and national government. There should also be opportunities for public-private partnerships to address and reduce many of the marketing risks. A major recommendation is the establishment of marketing risk forums at various different levels, as required, for identifying and quantifying potential risk factors and developing strategies and responsibilities for coping with these risks.

The policy framework with regard to achieving effective water management in agriculture, which is in alignment with the National Water Act and the National Water Resource Strategy, proposes desirable management responses at all levels, from farm level, through industry and organised agricultural level, to government (provincial and national) level.

The link to market risk lies in the fact that the inability to manage such risk creates a potential for inefficient agricultural water use. Since inefficiency in the allocation and use of water is a national issue, there is a good argument for government to support innovative ways of reducing market risks. For instance, as previously indicated, when it comes to improving the efficiency of water allocation and water use the enabling of farmers to respond more appropriately to market risks by providing them with better market information is more likely to be effective than tariff increases.

Conclusion

The results illustrate the extremely useful role that models can play in farm planning and the formation of agricultural policies. Although an analysis of several additional risk scenarios would have added great value to the investigation, the study can best be taken forward within a technology-transfer context, where specific scenarios can be analysed in detail in conjunction with a view to immediate application of results to guide actual planning and policy formation.

Further reading:
To obtain the reports, *Market Risk, Water Management and the Multiplier Effects of Irrigation Agriculture with Reference to the Northern Cape: Micro and Regional Models* **(Report No: 1250/1/08)**, and *Market Risk, Water Management and the Multiplier Effects of Irrigation Agriculture with Reference to the Northern Cape: Macro Modelling* **(Report No: 1250/2/08)** contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za