New Zealand Agricultural and Resource Economics Society (Inc.)

# Modeling the Regional Economic Impacts of the 2007/08 Drought: Results and Lessons

**G.V Butcher**
Butcher Partners Ltd.
e-mail: gvbutcher@xtra.co.nz

**Stuart Ford**
The Agribusiness Group
e-mail: stuart@agribusinessgroup.com

**Paper presented at the 2009 NZARES Conference**
**Tahuna Conference Centre – Nelson, New Zealand. August 27-28, 2009.**

*Copyright by author(s). Readers may make copies of this document for non-commercial purposes only, provided that this copyright notice appears on all such copies.*

# MODELING THE REGIONAL ECONOMIC IMPACTS OF THE 2007/08 DROUGHT:

# RESULTS AND LESSONS

**G.V Butcher : Butcher Partners Ltd. gvbutcher@xtra.co.nz**
**Stuart Ford: The Agribusiness Group. stuart@agribusinessgroup.com**

## KEY WORDS

Economic Impact, Drought, Modeling.

## SUMMARY

The 2007-08 drought affected a large area of New Zealand. This paper describes the analytical framework used to estimate the associated regional and national economic impacts. Results suggest that calculating drought economic impacts by applying standard farming industry multipliers to changes in farm gate output can greatly overstate both regional and national economic impacts. Calculating impacts using differences between forecast and actual farm production and expenditure by farm type is both feasible and produces far more reliable impact estimates.

# INTRODUCTION

This paper is based on a research project undertaken for MAF by Butcher Partners Ltd, with the farm modeling component being undertaken by Stuart Ford of the Agribusiness Group. The full report of that project is available on the MAF web site. This paper summarises the results of that research, focusing on the process and the differences in results obtained compared to the results that would have been obtained by simply applying standard input – output model farming multipliers to the changes in farm gate output arising from the drought.

# METHOD

MAF wanted to know the regional economic impacts of the drought, both at the farm gate and on the broader regional economy. The primary method of direct impact analysis was to compare forecast budgets with actual outcomes for relevant farm types in each affected region. In simple terms we used a forecast income and expenditure budget for each of 22 farm models, and then rated the relevant models up to the total area in that land use in each of 14 regions. The forecast made before the drought took place was used as a proxy for expected outcomes without drought. We compared this with the budget based on actual farm outcomes, which is the "with drought" budget. The difference between the "with drought" and "without drought" financial outcomes was the net impact of the drought.

## ADJUSTING MODELS TO CONSTANT PRICES

Prices for fixed quality and quantity units (e.g. 1 kg of P.M. lamb) are shown in the "with" and "without" drought models. Comparisons of these prices gives a price deflator for that product so that the "without" model outputs can be converted to the same prices[1] as the "with drought" outputs. Prices are also specified in the models for units which are of variable quantity and quality (e.g. per store lamb), where the variation is due to the drought. In these cases we applied the same price deflator as had been applied to the relevant fixed quantity and quality product. So, for example, the value of store lambs was adjusted by the change in the P.M. lamb schedule. It is possible that the store lamb price is affected by demand and supply effects during the drought, as opposed to being affected purely by weight and quality effects, and hence we are combining both quantity and price effects which are due to the drought.

We did not adjust input expenditure for price changes[2]. This could have led to an over or underestimate of the drought effects. However, we included in our analysis only changes in inputs which the farm model commentaries identified as being related to the drought.

---

[1] This is to ensure that changes in income due to general price changes are not attributed to the drought. We assume that international prices are not affected by the drought.

[2] Stored feed is much more expensive during droughts, but this cost reflects the holding costs and risks associated with stored feed, and hence is the true cost of consuming that feed. Even if there is an element of "profiteering" / economic rent, this is in any case a transfer between participants in the same broad sector rather than a net cost to the sector as a whole.

## CONSIDERATION OF THE EFFECTS ON PRICES AND INCOMES.

While the models identify some farm gate price changes, we have been unable to allocate these between:
Shifts in final market demand, including exchange rate effects;
Shifts in competitive advantage between meat processors and farmers due to destocking because of drought; and
Shifts in competitive advantage between meat processors and farmers due to destocking because of the decision of some farmers to convert from sheep and beef to other land uses (e.g. exiting cattle to enter dairy grazing).

After a review of price changes during the drought years, discussions with industry participants and consideration of transfer effects between farmers, we concluded that price changes arising from the drought had little effect on production, and that the primary effect of such price changes was a transfer of wealth between buyers and sellers. In the case of store stock, both parties were in the pastoral sector and / or in the same region. In the case of stock going to slaughter, the transfer is between farmers and meat processors. In both cases, a transfer should not be included as a net cost of the drought.

We have assumed that the entire price effect is due to changes in the market environment rather than the drought. Our reasons are as follows:
We think it unlikely that a change in supply of the magnitude due to the drought would significantly affect the international price of sheep, beef and dairy;
Even if there is a price effect, no one has estimated what that might be;
Drought-induced price effects are just as likely to be reversed in the following year as supply is reduced due to restocking. Ignoring the effect in both years leads to a realistic estimate of the net effect on farmer income.

For all the above reasons we have ignored any price effects of the drought on farm and national income.

## MODELING REGIONAL IMPACTS

We derived regional economic impact models from a national 2005-06 input – model developed by Stroombergen and Nana[3]. The regionalization process estimates regional output by allocating national output on the basis of physical output parameters or labour inputs, and estimates regional input coefficients by adjusting national input coefficients for estimated regional self-sufficiency by industry. The process has been widely used in New Zealand for more than 20 years. Individual industry multipliers (income, output and employment) were calculated for each region and for New Zealand.

Changes in farm output by category and drought-related farm expenditure by category were calculated for each farm type within each region, and then the results were

[3] Unpublished tables developed as part of a FoRST project, and using the resources of the Statistics New Zealand data lab.

combined for all farm types in that region[4]. Regional expenditure within a category was then allocated to the appropriate industry groups[5], and for each industry group a decision was made[6] as to what proportion of the production was likely to take place within the region. Where appropriate, some or all of this production was allocated to other regions according to their share of national output of that industry. For example, Southland does not produce agri-chemicals, so an increase in demand for these was allocated to the regions which do produce them.

Appropriate regional multipliers were applied to each expenditure and output value to estimate total regional economic impacts of the changes in farm output and expenditure.

National economic impacts were also calculated by applying national multipliers to the various changes in outputs and inputs. Individual regional multipliers are lower than national multipliers because some of the multiplier effects are felt beyond the region. Having calculated regional impacts using regional multipliers, we summed the impacts and compared them to the national impacts calculated using national multipliers. The difference between the two figures represents effects which have been "exported" from the regions to other regions, and this difference should be included in the total impacts on those regions. We allocated the difference across regions on the basis of regional shares of GDP. Given the relatively modest sums involved and the error margins inherent in any distribution process, it was not considered worthwhile to use a more sophisticated regional impact distribution algorithm.

## PROCESSING IMPACTS

The level of physical activity and hence employment and household income at meat works is strongly dependent on the number of head of stock killed. The level of value added depends primarily on the value of meat processed. We have assumed that in year 1 of the drought (2007-08), the value of the change in meat works livestock inputs for the purpose of calculating employment and household income effects is equivalent to the change in value of capital stock in the farm models over that year[7]. The change in livestock inputs for the purpose of calculating value added effects is equivalent to the change in the value of farm gate sales of livestock. In the post-drought year 2008-09, the value of the change in meat works stock inputs is equivalent to the decline in farm sales of sheep and beef. This reflects the lower number of lambs and calves born, but at this stage does not assume any restocking on farms.

---

4 So for example fertilizer use per Ha was calculated for each farm type, it was grossed up to the total amount of fertilizer on all the Ha represented by that farm type, and then fertilizer use was combined over all the farm types to get total fertilizer use for the region,

5 E.g. fertilizer is allocated to a combination of fertilizer production, wholesale trade, transport and farm contracting.

6 Using a simple location quotient as a measure of regional self-sufficiency.

7 NZ Meat and Wool Economic Service suggest that 40 per cent of the decline in stock numbers in that year was due to a change in farming policy. However, the farm model stock number changes are likely to relate primarily to the drought, because the MAF Farm Monitoring models are for a "typical average" or median farm, and as such are likely to exclude farms which have substantially changed land use. Hence it is appropriate to use the change in farm model breeding stock as an approximation of the increase in stock going to meat processing.

The change of meat processing industry outputs is based on the average ratio between stock inputs and meat processing outputs, which is 0.49. We have allocated a proportion of the change in processing activity to the region in which the change in livestock production took place, where the proportion reflects the assessed regional self-sufficiency in meat processing of that region. Any remaining proportion was spread across other regions according to their share of national meat processing capacity.

We followed a similar process for dairy processing, except that in that case the ratio between inputs and outputs is assumed to be 0.6.

# RESULTS

As is shown in Summary Table 1, output declined by $1.49 billion over the two year period of the drought. The impacts of the drought on output are a combination of the difference in farm gate sales and the difference in changes in capital livestock[8].

Farm value added (net income) declined by $1.89 billion over the two year period of the drought. This arose from a combination of the decline in output and an increase in the cost of inputs. There was a further loss of value added associated with a run-down in reserves of on-farm feed, and this was probably about $0.1 – 0.2 billion. There was little discernible change in direct farm employment or household income.

In financial terms, the impacts of the drought were felt most heavily by dairy farmers, who suffered almost 80 % of the loss in value added (see Summary Table 2). This impact was focused in Waikato, which suffered 44 % of the national costs of the drought

**Summary Table 1. Cost of the Drought by Farm Type**

| **2007-08 & 2008-09 combined** | ***Dairy*** | ***Sheep & Beef*** | ***Deer*** | ***Total*** |
|---|---|---|---|---|
| ***Loss of income ($m)*** | (927) | (262) | (1) | **(1,190)** |
| ***Change in Capital Stock ($m)*** | - | (303) | - | **(303)** |
| ***Decline in output*** | (927) | (565) | (1) | **(1493)** |
| ***Expenditure Impact ($m)**** | (550) | 161 | (4) | **(392)** |
| **Total Drought Cost *($m)* (Loss in Value Added)** | **(1,476)** | **(404)** | **(5)** | **(1,885)** |
| **Sector share of total cost** | **78 %** | **21 %** | **1 %** | **100 %** |
| **Cost as % of production in the two drought years** | **8 %** | **4 %** | | |

* A negative value implies an increase in expenditure. Excludes run-down in on-farm stocks of feed

[8] Generally sales fell as a result of the effects of the drought on production, but rose as a result of destocking. Sales of capital stock do not reflect changes in production, but reflect changes in ownership of the asset base.

**Summary Table 2 Cost of Drought (Direct Value Added) by Location**

| | Dairy | Sheep & Beef | Deer | Total | Share |
|---|---|---|---|---|---|
| Northland | - | - | (0.0) | (0) | 0.0% |
| Auckland | (14) | 5 | (0.1) | (9) | 0.5% |
| Waikato | (799) | (37) | (0.6) | (836) | 44.4% |
| Bay of Plenty | (155) | (9) | (0.3) | (164) | 8.7% |
| Gisborne | (1) | - | (0.1) | (1) | 0.0% |
| Hawkes Bay | (14) | (61) | (0.5) | (76) | 4.0% |
| Taranaki | (181) | (26) | (0.1) | (207) | 11.0% |
| Wanganui / Manawatu | (91) | (133) | (0.5) | (225) | 11.9% |
| Wellington | (21) | (43) | (0.1) | (64) | 3.4% |
| Tasman | (17) | (2) | (0.1) | (19) | 1.0% |
| Marlborough | (1) | 1 | (0.1) | 0 | 0.0% |
| Canterbury | (35) | (6) | (1.6) | (43) | 2.3% |
| West Coast | (51) | (1) | (0.1) | (53) | 2.8% |
| Otago | (26) | (35) | (0.7) | (62) | 3.3% |
| Southland | (71) | (56) | (0.7) | (127) | 6.8% |
| New Zealand | (1,476) | (404) | (5.4) | (1,885) | 100.0% |

## TYPICAL ANALYTICAL FRAMEWORK FOR REGIONAL IMPACT

Up until the mid 1990s, typical drought economic impact analysis in New Zealand related primarily to sheep and beef farms. Total impacts were calculated using average farming multipliers, which implicitly assumed that farm inputs declined by the same proportion as farm outputs. Hence there were calculated to be significant flow-on effects in the rest of the economy. On sheep and beef farms in severe and prolonged drought or when farmers are in a weak financial position, this tends to be the case, as is borne out by casual observation and anecdotal information. However the direction of expenditure shift is less certain where the drought affects dairy farms that are less able to change inputs without severely affecting output in the short term, are not used to coping with drought, or when the drought occurs at a time when farmers are in a strong financial position.

## THE 2007-08 FRAMEWORK

In the case of the 2007 – 2008 drought, dairy farmers were getting exceptionally high prices for milksolids. Their response was to spend heavily on feed to maintain production as much as possible and then to spend on pasture resowing to restore lost production as quickly as possible after the event. Sheep and beef farmers had already been financially squeezed for some time with low profitability and had limited opportunity to reduce costs further. Sheep and beef farmers sold capital stock in 2007-08 hence improving cash flow. In 2008-09 they enjoyed a substantial improvement in product prices, but did not restock to the same extent as they destocked, hence again enabling them to maintain expenditure in other areas. For all of these reasons the drought led to an increase in farm spending.

To estimate the flow-on effects of changes in farm spending we estimated changes in farm spending by category of spending and by region. We allocated this spending to generate estimates of changes in production by industry by region[9], and applied relevant industry regional and national multipliers to estimate total indirect and induced economic impacts associated with this change in spending.

Milk for processing declined significantly. We have converted this to changes in output of processed dairy products and applied dairy industry multipliers[10] to estimate the regional economic impacts of this reduction. Meat processing increased in 2007-08 as farmers killed capital stock, but declined in 2008-09 as livestock production declined with a smaller base of breeding stock and poorer reproductive performance. We converted the change in the value of livestock going to slaughter to a change in the output of meat processing works and applied meat industry multipliers to estimate the total regional and nation economic impacts of this.

We estimate that the total loss of off-farm value added as a result of the drought was $887 million (see Summary Table 3). This large loss was predominantly due to the impacts of the drought on dairy processing (down in both years) and meat processing (up in 2007-08

---

[9] In some case to imports or to changes in stocks of feed, which have little flow-on impact apart from on the transport sector.

[10] In order to avoid double counting of on-farm economic impacts, we calculated modified dairy and meat processing multipliers, which excluded backward linkages through farms.

and down in 2008-09). The negative impacts of this reduction in processing sector activity completely swamped the small positive effect associated with increased farm spending on such items as pasture restoration. It is also possible that the loss of off-farm value added is understated, because some costs are fixed overheads and the marginal value added : output ratios are higher than the average ratio.

**Summary Table 3. Direct, Off-Farm & Total Output and Value Added Impacts of Drought, by Region ($m)**

| Region | Output ($m) | | | Value Added ($m) | | |
|---|---|---|---|---|---|---|
| | Direct | Off-Farm | Total | Direct | Off-Farm | Total |
| Northland | -0 | -34 | -34 | -0 | -14 | -14 |
| Auckland | 1 | -132 | -130 | -9 | -76 | -85 |
| Waikato | -624 | -1,449 | -2,073 | -836 | -384 | -1,221 |
| Bay of Plenty | -107 | -230 | -337 | -164 | -68 | -232 |
| Gisborne | -0 | -3 | -4 | -1 | -2 | -3 |
| Hawkes Bay | -100 | -17 | -117 | -76 | -49 | -125 |
| Taranaki | -154 | -278 | -432 | -207 | -91 | -298 |
| Wanganui / Manawatu | -211 | -46 | -258 | -225 | -89 | -314 |
| Wellington | -62 | -40 | -102 | -64 | -41 | -105 |
| Tasman | -9 | -10 | -18 | -19 | -3 | -21 |
| Marlborough | -1 | -2 | -3 | 0 | -1 | -1 |
| Canterbury | -44 | 186 | 143 | -43 | 3 | -40 |
| West Coast | -19 | -21 | -40 | -53 | -6 | -59 |
| Otago | -55 | 15 | -40 | -62 | -27 | -89 |
| Southland | -109 | -6 | -115 | -127 | -38 | -165 |
| **New Zealand** | **-1,493** | **-2,068** | **-3,561** | **-1,885** | **-887** | **-2,773** |

We estimate that the drought led to a potential loss of almost 3,000 job-years[11] of work off-farm and a loss of $143 million of household income (see Summary Table 4). This is equivalent to 1,500 full time jobs being lost for the duration of the drought. Given that there are 9,500 people employed in milk processing, 24,000 in meat processing and probably twice as many in the various support industries for these sectors, the numbers seem realistic.

In many cases the impacts on jobs will have been felt as shorter working periods in the seasonal industries or on fewer hours per day. It is also probable that our estimates of potential lost household income and employment overstate the actual impacts because average multipliers will not be the same as marginal multipliers. For example, tanker drivers may face only a small reduction in hours, even if they are picking up 10 % less milk at each farm, and the processing sector will be reluctant to make staff redundant if they see that the downturn is likely to be short-lived. This means that business will not

[11] A job-year is one person working full time for one year; 4 persons working full time for 3 months etc. etc.

have been able to adjust completely to the reductions in throughput caused by the drought and will most probably have reduced productivity rather than reduced employment by the amount reported here.

The probable overstatement of lost household income off-farm is a partial offset to the likely understatement of lost household income on-farm. Anecdotal evidence is that even although the model farm budgets show little change in farm drawings, some families had a very severe drop in disposable income and household spending.

**Summary Table 4. Direct, Off-Farm & Total Employment and Household income Impacts of Drought, by Region ($m)**

| Region | Employment (job-years) | | | Gross House-hold Inc ($m) | | |
|---|---|---|---|---|---|---|
| | Direct | Off-Farm | Total | Direct | Off-Farm | Total |
| Northland | 0 | -100 | -100 | 0 | -4 | -4 |
| Auckland | 0 | -460 | -460 | 0 | -21 | -21 |
| Waikato | 0 | -2,728 | -2,728 | 0 | -126 | -126 |
| Bay of Plenty | 0 | -438 | -438 | 0 | -20 | -20 |
| Gisborne | 0 | -13 | -13 | 0 | -1 | -1 |
| Hawkes Bay | -0 | -67 | -67 | -0 | -3 | -3 |
| Taranaki | 0 | -395 | -395 | 0 | -18 | -18 |
| Wanganui / Manawatu | -0 | 106 | 106 | -0 | 1 | 1 |
| Wellington | 0 | -144 | -144 | 0 | -7 | -7 |
| Tasman | 0 | 20 | 20 | 0 | 0 | 0 |
| Marlborough | 0 | -4 | -4 | 0 | -0 | -0 |
| Canterbury | 0 | 818 | 818 | 0 | 36 | 36 |
| West Coast | 0 | 67 | 67 | 0 | 2 | 2 |
| Otago | 0 | 143 | 143 | 0 | 6 | 6 |
| Southland | 0 | 240 | 240 | 0 | 12 | 12 |
| **New Zealand** | **0** | **-2,959** | **-2,959** | **0** | **-143** | **-143** |

The estimates of economic impacts ignore any restocking in 2008-09, and any associated reduction in meat slaughtering. While comprehensive data is not yet available, initial indications are that many sheep and beef farmers have only partially restocked. Reasons include:

- Some land is still in drought and restocking is not appropriate;
- Some land has converted to other uses such as dairy grazing;
- Some farmers have decided to retain fewer capital stock but try and achieve higher reproduction rates and slaughter weights; and
- Some farmers are simply waiting to see whether the recent upturn in stock prices will continue and whether it is worth remaining in sheep and beef farming.

## LIMITATIONS OF THE STUDY

While the process adopted for the analysis had its limitations with regard to accuracy, particularly in estimating results at a regional level, we were unable to identify any method of estimating drought impacts at a regional level other than to use the MAF farm models. While this study converted forecast model values to reflect changes in international commodity prices, no other parameter values were changed. Future analysis could consider re-running the "without drought" forecast budgets using the same non-drought-affected parameter values as were revealed by the "actual" budgets.

## ADVANTAGES OF THE PROCESS USED.

Advantages of the approach used are:

- The inclusion of the benefits which accrue to those finishing farms which benefit from the purchase of store stock at very low prices, hence avoiding potential overstatement of drought costs;
- The only simple and moderately accurate way of calculating regional impacts;
- Includes adjustments for sales of capital stock, hence avoiding understatement of drought impacts during the destocking phase and overstatement during a restocking phase;
- Avoids the need for one-off large-scale surveying of individual farm types by taking advantage of the existing on-going surveying which underlies the various farm models. The down-side is that specific questions directly relevant to the impacts of the drought are not asked. Impacts have to be inferred from data which might also incorporate other impacts.