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A BENEFIT-COST EVALUATION OF SOME DROUGHT RELIEF MEASURES

Gary Stoneham, Peter Bardsley and Scott Davenport

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INTRODUCTION

The prospect of severe and widespread drought associated with climatic disturbances on a continental scale remains an ever present risk to Australian agriculture. In the past hundred years there have been major droughts in the eastern States of Australia in 1888, 1902, 1914-15, 1940-41, 1944-45, 1967-68, 1972-73 and 1982-83. The drought in 1982-83 was responsible for a drop of 18 per cent in the net value of agricultural production (Campbell, Crowley and Demura 1983) and a fall of between $2000m and $2700m in national income that year (BAE 1983).

The role of government in preparing for and mitigating the effects of drought continues to be an important issue. In 1984 the National Drought Consultative Committee was established to examine government drought policies and advise the Minister for Primary Industry. The Committee comprised representatives of State and Commonwealth Governments as well as producer bodies. It reported in September 1985, setting out its view of the objectives of drought policy and recommending a range of measures to achieve those objectives (National Drought Consultative Committee 1985). In addition, the Industries Assistance Commission was requested in April 1985 to inquire into crop and rainfall insurance.

Broadly speaking, there are two major issues which bear on the provision of drought assistance. In the first place, is it desirable that government should assist drought-affected producers? Second, if assistance is to be given, what is its most appropriate form?

With regard to the first question, Freebairn (1983) has argued against drought assistance on efficiency grounds. On the other hand, the National Farmer's Federation (1984) argued that the drought assistance measures in place in the 1982-83 drought were cost effective, and that the benefits from increased production after the drought outweighed the costs of the assistance measures. A case for drought assistance may also be argued on welfare grounds. The Bureau of Agricultural Economics in its submission to the Industries Assistance Commission on crop and rainfall insurance (BAE 1986) has pointed out that there may be a market failure in the provision of disaster assistance. There is evidence of community support for assistance to producers suffering hardship caused by drought. However, there is no way of stopping 'free-riders' in the community from benefiting from those donations made by other private individuals. The result is that without government intervention the level of private welfare oriented drought assistance may be too small.

Turning to the second question, there has been quite strong criticism on efficiency grounds of the form in which assistance has been made available, particularly during the 1982-83 drought. Freebairn, for example, argued that the benefits of some assistance measures flowed to only a small proportion of drought affected livestock producers and that input subsidies produced some undesirable effects (Freebairn 1983). He argued that fodder subsidies assisted only those who purchased fodder and did not assist those who had implemented longer term drought management measures such as conservative stocking policies, accumulation of fodder reserves and early selling of livestock. Freebairn also claims that the benefits of fodder subsidies were widely distributed. Recipients included fodder producers, fodder carriers and overseas consumers of livestock products. In addition, because subsidies helped maintain livestock prices during the drought (above what they might otherwise have been because animals were diverted from slaughter) and depressed prices after the drought (due to the sale of retained livestock), there were gainers and losers depending upon livestock buying and selling patterns of individual producers. The BAE (1986) has recently argued that regional rainfall insurance might be a less distortionary means of delivering drought assistance than input subsidies.

In this paper a case study of some of the drought assistance measures which were in place in Australia during the 1982-83 drought is described. The emphasis is not on the general assistance which may be implicit in any drought policy but rather on the specific distortions associated with the form in which that assistance was allocated. The second of the two issues identified above is addressed: if there is a social commitment to the provision of drought assistance, what are the costs and benefits associated with the choice of a particular instrument to deliver it? The instruments examined here are fodder and transport subsidies which were in place during the 1982-83 drought.

Drought and other disaster assistance is primarily a State Government responsibility. In normal circumstances the Commonwealth Government's role is restricted to assisting with the financing of disaster relief measures administered by the States. These Commonwealth-State arrangements are formalised under the Natural Disaster Relief Arrangements and include other climatic risks besides drought. The measures are complex and vary from State to State, but generally speaking they comprise a mixture of concessional finance and subsidies to assist the transport of livestock, fodder and water, as well as other input subsidies. In addition to the National Disaster Relief Arrangements the Commonwealth Government funded a subsidy on interest payments and a subsidy on the purchase of fodder during the 1982-83 drought. These additional measures have since been discontinued.

The focus of this paper is the distortions in the market for fodder in the 1982-83 drought arising from the Natural Disaster Relief Arrangements fodder transport subsidy, from the additional fodder purchase subsidy, and from their interaction. Since the fodder purchase subsidy has been discontinued as a drought assistance measure, this is to some extent a historical exercise. However, transport subsidies are still in place as part of the Natural Disaster Relief Arrangements, and the exercise continues to be relevant insofar as it shows the magnitude of the distortions, the unexpected side effects and the deadweight losses which may be associated with the use of input subsidies as a drought assistance measure.

COST-BENEFIT METHODOLOGY

The first point which must be made about any attempt to investigate the economics of the market for fodder during a drought is that the system under investigation is complex. There are several sources of supply, including hay and straw, coarse grains, feed wheat and molasses. There are also several sources of demand, including the drought affected livestock producers and also the intensive livestock and dairy industries. The interactions are further complicated by the regional distribution of drought and the costs of transport. Some simplifications and assumptions are necessary not only to produce a workable set of concepts and a manageable model, but also because of data limitations.

In principle, there are two techniques which might be used to evaluate costs and benefits. The first is a budgeting analysis of the cost of maintaining a herd through the drought and the benefit of the increased production in the period following the drought. It appears that the argument by the National Farmers' Federation (1984) in favour of subsidies is based on this approach. However, a number of assumptions must be made on the severity and duration of the drought, on the management strategies followed, and on the movement of prices both domestically and internationally, and it is difficult to know which assumptions are justifiable. For the purposes of policy evaluation it would be necessary to evaluate not just one drought scenario, but many, and then to weight the results by probabilities. It is also difficult to measure the indirect effects on other industries such as the intensive livestock industries.

The alternative methodology, and that which is used in the following analysis, relies on the assumption that expectations about the course of the drought, and of future prices, are those which were actually held at the time by participants in the fodder market. If markets are working properly, then this assumption will be embodied in the prices observed. Costs and benefits can then be estimated by the usual measures of economic surplus, namely producer surplus and consumer surplus and their variants. These can be measured as areas under supply and demand curves (Layard 1980; Mishan 1982). It may be useful to review here some of the limitations of this methodology and to comment on the implications for this study. For a full discussion of the issues, see the review article by Prest and Turvey (1965).

The first problem is that the normal cost-benefit approach is based on a partial equilibrium analysis. This means that the effect of distortions introduced into other markets may not be picked up. These neglected effects should be small, except for markets which are fairly closely linked. In the present case, attention is restricted to the fodder market, with the exception of a brief consideration of the market for livestock.

A second problem area is that of the definition of costs and benefits. There is an extensive literature dealing with measures of consumer and producer surplus. The basic issue is how to take account of the varying marginal utility of income in assessing the welfare impact of a proposed change (Currie, Murphy and Schmitz 1971; see also Varian 1978). It is assumed here that producers are profit maximisers, so that the appropriate measures are the usual areas delimited by the normal supply and demand curves.

A third area where there can be problems is in the use of market prices as a measure of value. It is well known from the theorems of welfare economics that under perfect competition market prices are the appropriate measure of the social value of commodities. Decisions made on this basis will lead to an efficient use of resources. However, when markets are imperfect, this is not necessarily so. Government intervention, monopolistic behaviour, externalities and capital market failure can all distort prices, and lead to erroneous valuations. This is sometimes dealt with by replacing the prices used in the analysis by so-called 'shadow prices' which compensate for the distortions and hidden costs. For example, the price of labour used in project evaluation in less developed countries is often adjusted to take account of the extra urban migration and unemployment induced by the project. Of course, given the extensive array of distortions in the economy, it is very difficult to calculate their impact on a single market like the fodder market. The usual principle, and the one adopted here, is to use market prices unless a clear case can be argued that they are non-optimal, and a source of the distortion can be identified.

In the present case, the main area where it may be suspected that hidden costs are not fully reflected in the price system is that of land degradation due to overstocking or the removal of stubble for use as fodder. Clearly a subsidy on fodder will lead to more stock being retained, at least in the short term, and this could be expected to lead to soil degradation. On the other hand, it has been argued (National Farmers' Federation 1984) that purchase of fodder leads to stock being localised for feeding, and that this reduces stocking pressures on extensive pastures; while transport subsidies may reduce stocking pressure in the worst affected areas. In any case, even where there is accelerated land degradation, it is not clear that this is not socially optimal. Common pastures such as roadside verges may be overgrazed because of the 'free-rider' problem, as may short-term leases, but where there is security of tenure, capital values should serve to bring social and private costs into line (McConnell 1983). Because of these uncertainties, the cost and benefit estimates derived below do not include any allowance for land degradation.

Another of the controversial features of many cost-benefit studies is that costs and benefits are aggregated across individuals to give a total, society-wide benefit-cost ratio which ignores or conceals the different effects on different individuals. The justification sometimes given is that the gainers could, in principle, compensate the losers (Layard and Walters 1978). In the present study the distributional effects of the policies being investigated are of considerable importance and are discussed explicitly.

Finally, conventional cost-benefit methodology does not capture the benefits of risk reduction. However, these benefits (which can be regarded as an insurance benefit) are not peculiar to the fodder and transport subsidies but are likely to be a feature of a wide range of drought policy instruments. There is some evidence that these insurance benefits are likely to be small (Bardsley, Abey and Davenport 1984), especially in comparison to the relatively substantial transfers and deadweight losses associated with input subsidies.

THE FEED GRAIN MARKET

The feed grain market includes the intensive livestock industries, specifically the pig and poultry producers who are the major consumers of feed grains, and the suppliers of feed grains, including the wheat and coarse grains industries. As shown in Table 1, a total of 3406 kt of wheat equivalent (we) grain was used for domestic feeds in 1982-83. Of this, approximately 44 per cent or 1490 kt was feed wheat; the remainder was oats, sorghum, barley and maize. There is considerable potential for substitution between these grain types in constructing intensive feed

Table 1: FEED GRAINS: SUMMARY OF SUPPLY, STOCKS, AND END USES OF FEED GRAINS IN 1982-83

		Feed type					
	Unit	Feed-wheat	Barley	Oats	Sorghum	Maize	Total (WE)
Wheat equivalents		1	0.975	0.81	1.05	1.037	
Production	kt	1 490	1 798	829	986	95	
	(we) kt	(1 490)	(1 753)	(674)	(1 035)	(98)	(3 560)
Domestic feed use	kt	1 490	473	811	732	28	
	(we) kt	(461)	(658)	(768)	(29)	(3 406)	
Domestic	kt		355	220	4	57	
Other uses	(we) kt		(346)	(179)	(4)	(59)	(588)
Exports	kt	930	76	275	20		
	(we) kt	(906)	(62)	(289)	(21)	(1 278)	
Opening stocks (1981-82)	kt	50	299	55	10		
	(we) kt	(49)	(243)	(58)	(10)	(360)	
Closing stocks	kt	90	21	30	0		
	(we) kt	(88)	(17)	(31)	0	(136)	
Price	$/t	180	158	163	149	173	
	(we) kt	180	(162)	(200)	(141)	(167)	
Price weighted by domestic consumption	(we)					(170)	

Note: we = wheat equivalent.
Source: BAE (1984a,b); National Academy of Sciences - National Research Council (1963).

Table 2: DEMAND ELASTICITIES FOR FEED GRAINS

Commodity	Author	Estimated elasticity	Data
Wheat	Bain (1973)	0.14	1947-48 to 1969-70
	Spriggs (1978)	-0.72	1949-50 to 1972-73
	Fisher (1978)	-1.03	1950-51 to 1978-79
	Ryan (1981)	-2.67	1950-51 to 1978-79
Barley	Bain (1973)	-1.92	1947-48 to 1969-70
	Spriggs (1978)	-0.85	1955-56 to 1974-75
	Ryan (1982b)	-0.94	1949-50 to 1978-79
Oats	Bain (1973)	-4.95	1947-48 to 1969-70
Sorghum	Spriggs (1978)	-1.10	1960-61 to 1973-74
	Ryan (1982a)	-1.27	1961-62 to 1978-79

Source: Shaw, Dewbre and Foster (1983).

diets and this is reflected in the consistently high estimates of elasticities of demand for individual commodities recorded in Table 2. In Bain's (1973) analysis of the feed grain market, however, in the short term (which is relevant in the case of drought) the flexibility of aggregate demand for feed grains is limited because:

- there are few substitute feeds;
- intensively produced livestock usually require tightly controlled diets; and
- there are usually large fixed costs associated with intensive animal production which would discourage large short term adjustments in throughput.

In the absence of studies of the elasticity of demand for feed grains, an indirect estimate can be obtained for the livestock industry from elasticities of inventory responses for sows. Richardson and O'Connor (1978) estimated short run elasticities for sow inventory responses for a number of variables including a weighted average of grain prices. In their analysis the short run elasticity for sow inventory response to a weighted average of grain prices was -0.35. Given that feed costs represent approximately 80 per cent of total costs of pig production. (J. Sloan Queensland Department of Primary Industries, personal communication, 1985), and assuming that the pig industry is representative of the intensive livestock industry in general, the elasticities estimated by Richardson and O'Connor can be regarded as an approximation of the relationship between feed grain prices and aggregate demand for feed grains. On this basis elasticity of demand for feed grains in the intensive livestock industry was assumed to be -0.35.

The nature of aggregate demand for feed grains can be further investigated by examining the nature of the derived demand for feed grains following the method of Layard and Walters (1978). If, for example, a two factor production function is considered, where capital and feed are the only inputs of the production process, the derived demand for feed grains can be expressed as:

$$1/|E_F| = \frac{V_F}{|D_O|} + \frac{(1-V_F)}{S_{KF}}$$

where

E_F = derived demand for feed grains

D_O = own price elasticity of final product demand. A number of studies listed in Table 3 indicate a price elasticity of demand for pig meat of around -1.42.

V_F = the proportion of total production costs attributable to feed grain costs: for pig production feed costs account for about 80 per cent of total production costs.

S_{KF} = the short run direct elasticity of substitution between capital and feed costs at constant output.

Table 3: ESTIMATES OF OWN-PRICE DEMAND ELASTICITIES FOR PIG MEAT

Author	Estimated elasticity	Data
Gruen et al. (1967)	-2.19	1949-50 to 1964-65
Greenfield (1974)	-1.05	1954-55 to 1971-72
Main et al. (1976)	-1.89	1962 to 1975
Fisher (1979)	-0.95	1962 to 1977
Murray (1984)	-1.39	1949-50 to 1978-79
Dewbre et al. (1983)	-1.34	1964-65 to 1981-82
West (1980)	-1.15	1952-53 to 1974-75
Average	-1.42	

The short-run substitutability between capital and feed at constant output levels is expected to be very low. Although such estimates were not available from the literature, it can be seen from the equation that as the value of S_{KF} approaches zero the derived demand for feed grains E_F becomes increasingly inelastic (see Table 4). On this basis the assumed value of -0.35 does not appear implausible.

On the supply side of the feed grain market, Bain (1973) indicated that the total quantity of grains supplied to the domestic market depends upon the residual stocks of grain from previous seasons; the domestic price of grain; and the export price of grain.

As shown in Table 1, the quantity of coarse grains produced in the 1982-83 season was 3 560 kt(we), of which 2 506 kt(we) remained on the domestic market after allowing for exports and adjusting for opening and closing stocks. For the wheat component of the feed grain market, Freebairn (1983) suggested that, owing to the existing marketing arrangements, there is an interaction between the world feed grain market and the domestic market which results in a highly elastic supply curve. Because wheat is usually regarded as a residual source of supply by the intensive livestock industries (Lovett 1973; Australian Wheat Board 1983), it is convenient to view the supply of feed grains in two parts. There is the aggregate coarse grain component - individual elasticity estimates for the supply of barley, oats and sorghum are shown in Table 5. More appropriately for this analysis, Dewbre et al. (1983), using the EMABA

Table 4: DERIVED DEMAND ELASTICITY ESTIMATES FOR FEED GRAIN

S_{KF}	E_F
%	
20	-0.64
10	-0.39
5	-0.22
1	-0.048
0.1	-0.0049

Table 5: ESTIMATE OF OWN-PRICE SHORT-RUN SUPPLY ELASTICITIES

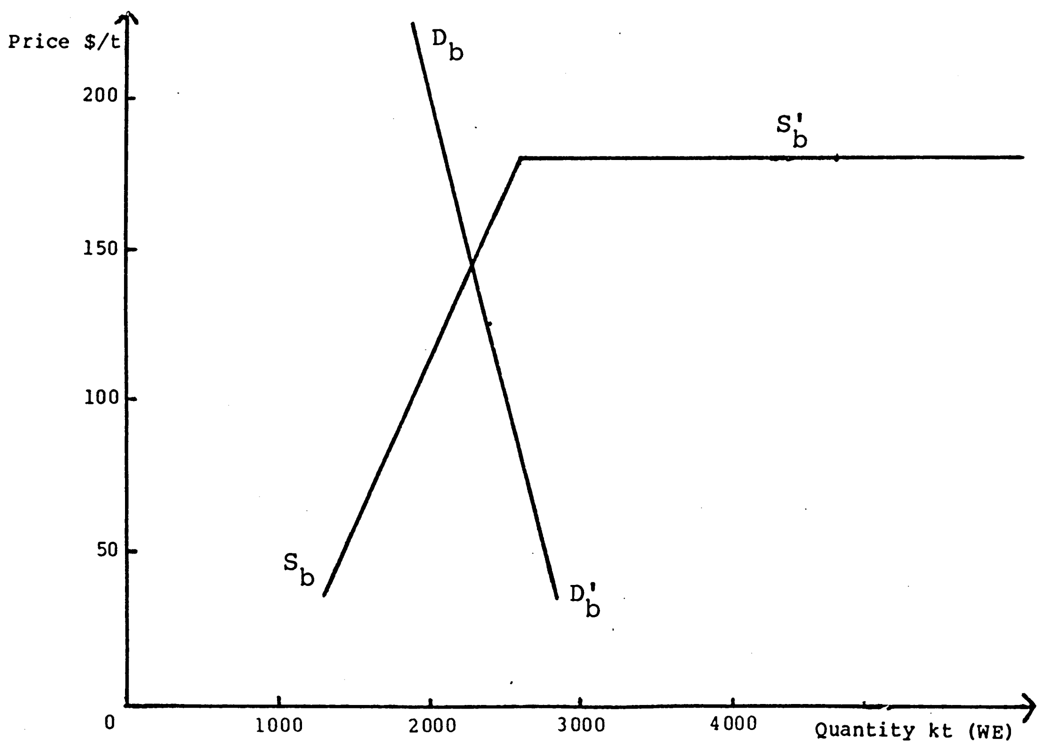
Commodity	Author	Estimated elasticity	Data
Barley	Vincent et al. (1980)	0.50	1952-53 to 1973-74
	Ryan (1982b)	0.55	1955-56 to 1979-80
	Dewbre et al. (1983)	0.25	1957-58 to 1981-82
Oats	Dewbre et al. (1983)	0.20	1957-58 to 1981-82
Sorghum	Ryan (1982a)	0.29	1958-59 to 1979-80
	Dewbre et al. (1983)	0.26	1957-58 to 1981-82
Aggregate coarse grains	Dewbre et al. (1983)	0.70	1957-58 to 1981-82

Source: Shaw, Dewbre and Foster (1983).

model, estimated the short-run aggregate supply elasticity of coarse grains to be 0.7. There is also the feed wheat component - supply can be regarded as approaching a perfectly elastic state.

The feed grain market can then be diagramatically represented as shown in Figure 1, where D_bD_b' and S_bS_b' represent the demand and supply curves for feed grains. The supply curve has been represented as kinked at the intersection of the supply of coarse grains and wheat.

Figure 1: REPRESENTATION OF THE FEED GRAIN MARKET



THE EXTENSIVE FODDER MARKET

A second sector of the fodder market which can be identified is the extensive fodder market. Included in this sector are the systems which normally produce animals by range feeding on the demand side and producers of hay on the supply side. Under normal seasonal conditions, hay forms the major source of supply of fodder in the extensive industries with some grains utilized on a contingency basis. In drought conditions the demand for hay may exceed supply, forcing the price of hay upward until the price of feed grains becomes competitive. In this case, feed grains form part of the supply of fodder in the extensive fodder market with the mix of feed types used being determined by the relative prices of hay and grain adjusted for nutritional quality and transportation costs. For the purpose of maintenance feeding of extensive livestock, hay and grains can be regarded as close substitutes (E. Powell, Queensland Department of Primary Industries, personal communication, 1984).

The total demand for fodder by the extensive sector in times of drought can be expected to be influenced by:

- expectations concerning the length of the drought;
- fodder prices;
- drought livestock prices; and
- expected post-drought livestock prices.

Because of the lack of information on the demand characteristics of this sector, one of the BAE's farm level models was adapted to investigate the relationship between fodder price and fodder consumption in drought conditions. The short-run elasticity of demand for fodder in the extensive fodder market was estimated using the BAE's FARM model. The FARM model is a stochastic multiperiod linear programming model of the farm firm (Clark, Johnston and Matuska 1984) upon which droughts of varying duration and probability of occurrence were imposed. Using a sensitivity analysis of fodder price a demand schedule for fodder was developed with an estimated elasticity of -0.84 for a one year drought.

Supplies of fodder to the extensive livestock industries usually come from hay production although there may be cases where commodities such as crop residues or failed crops, not normally traded as fodder, could be diverted to the fodder market. In 1982-83 the total quantity of hay of various qualities supplied was 1100 kt in wheat equivalents (see Table 6).

Table 6: HAY PRODUCTION FROM PASTURE

Year	Lucerne hay	Other hay types	Total	Wheat equivalent (a) total
	kt	kt	kt	kt
1979-80	483	2428	2911	1484
1980-81	500	2758	3258	1656
1981-82	602	2982	3584	1828
1982-83	538	1577	2115	1100
1983-84	801	4593	5394	2739

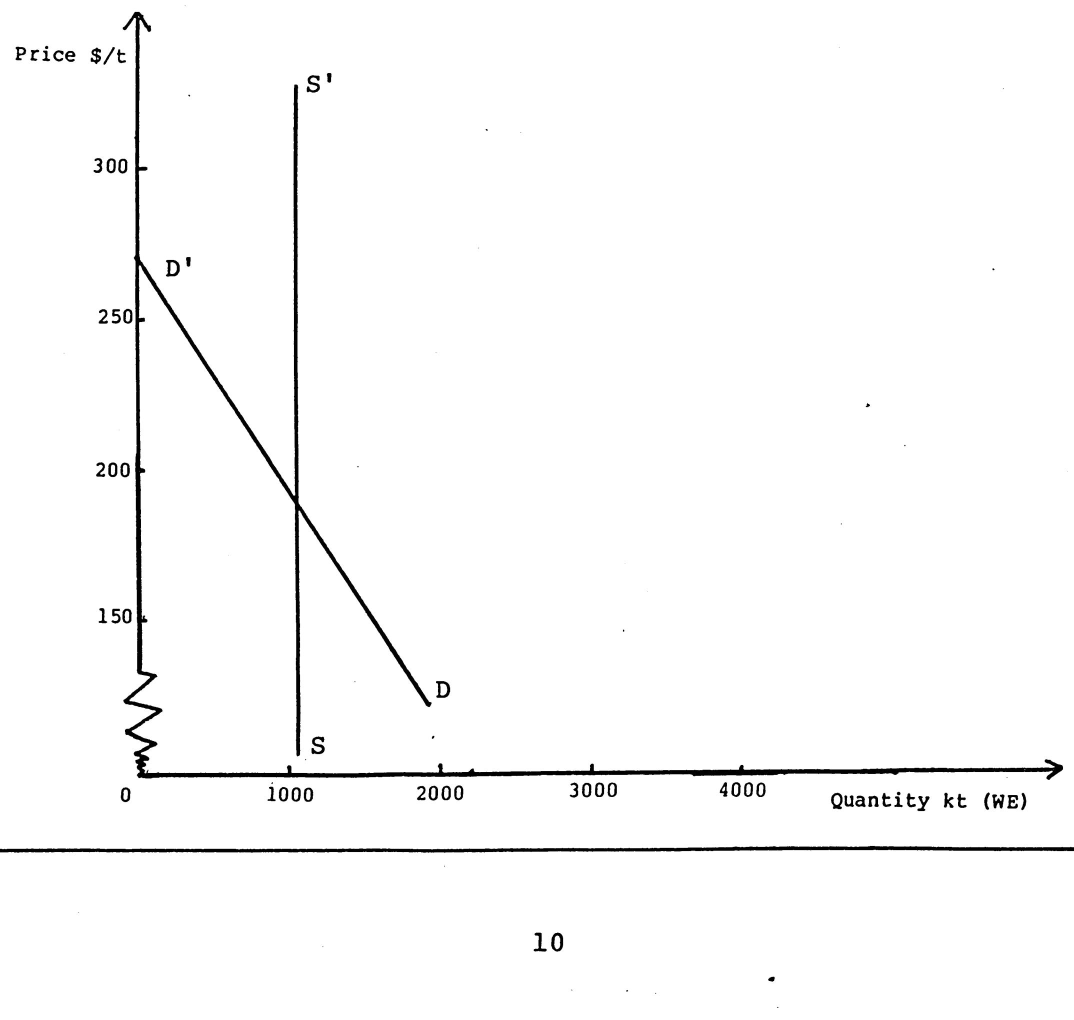
(a) conversion factor 0.61 for lucerne, 0.49 for other hays
Source: Australian Bureau of Statistics.

Of this quantity 328 kt(we) was lucerne hay and 772 kt(we) was supplied from other types of hay. Hay production fell in 1982-83, and increased sharply in the following good season. While price response cannot be distinguished from weather effects in such a series, the data are consistent with an inelastic short term response and a stronger lagged response the following year. In a short term sense the quantity of hay supplied during a drought could be expected to be relatively unresponsive to price as there are clearly few opportunities with the exception of irrigation to increase hay production once drought conditions prevail (Freebairn 1983). Supply of hay was therefore assumed to be perfectly inelastic at the quantity produced in the drought (Stott 1983). A sensitivity analysis discussed below shows that the model is robust with regard to this assumption.

THE FODDER PURCHASE AND FODDER TRANSPORT SUBSIDIES

In the preceding discussion it was established that there is an interaction between the feed grain and the extensive fodder markets due to trade between the two markets. The nature of this interaction is therefore likely to effect the proportion and distribution of benefits and costs relating to the fodder purchase and transport subsidies which operated during the 1982-83 drought. By adapting the back-to-back international trade model framework, described by Currie et al. (1971), to a two sector trade model of the feed grain (Figure 1) and extensive fodder markets (Figure 2) as shown in Figure 3, the effects of the fodder purchase and

Figure 2: REPRESENTATION OF THE EXTENSIVE FODDER MARKET

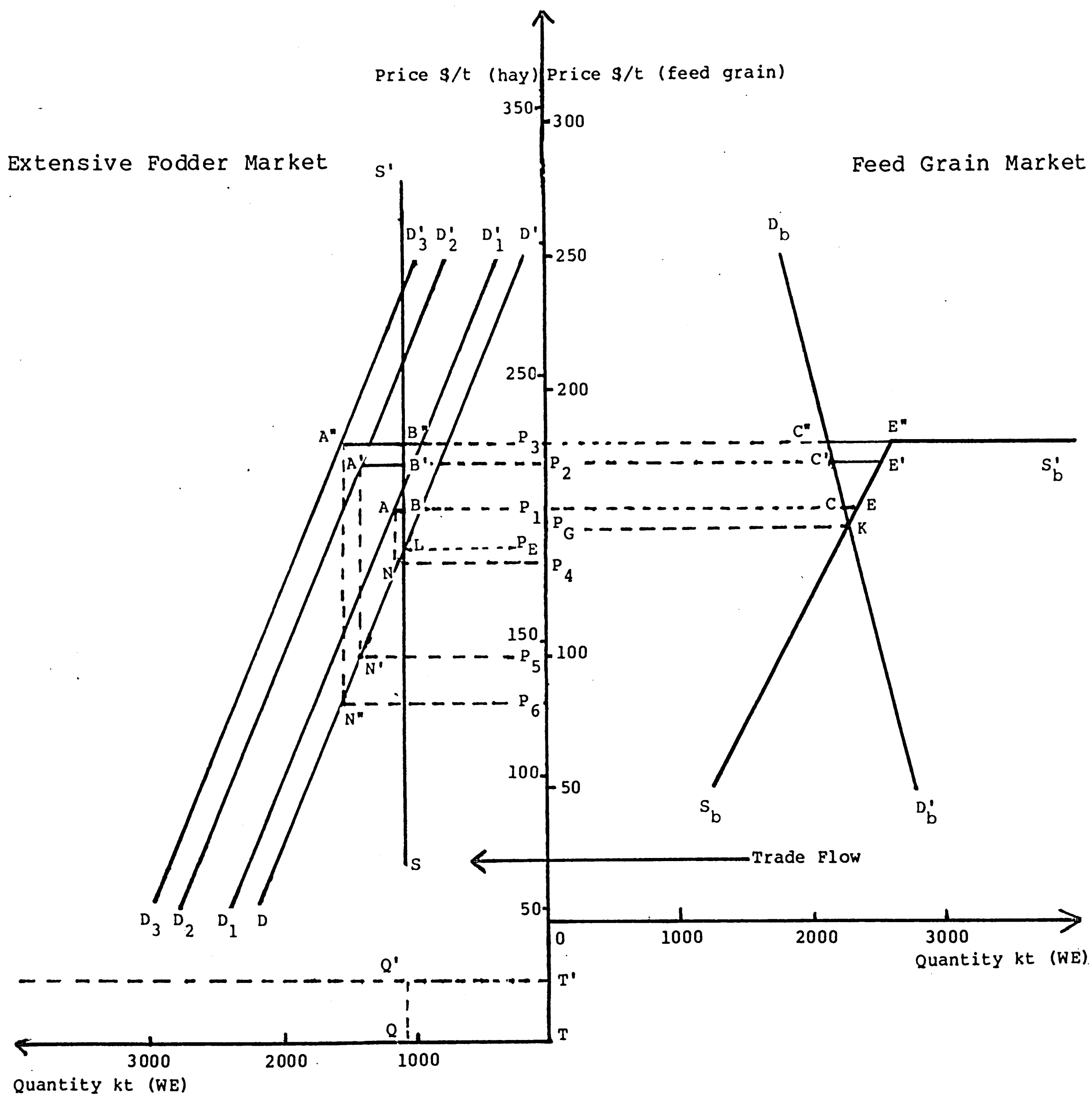


transport subsidies can be modelled. The simplifications made in achieving this representation of the markets included:

- fodder transport costs (determined from the fodder subsidy payout) were averaged so that there is an average transport differential OT between the two markets (see Figure 3); and

- demand and supply curves were assumed to be linear except in the case of feed grain supply which is represented as kinked.

Figure 3: REPRESENTATION OF THE FODDER PURCHASE AND FODDER TRANSPORT SUBSIDIES



In Figure 3, DD' represents the short-run aggregate demand for fodder by extensive livestock producers in drought conditions, before the fodder purchase and fodder transport subsidies. D_bD_b' represents the short-run aggregate demand for feed grains. The cost of transport in the extensive livestock industries is represented by OT. All fodder is measured in wheat equivalents. Trade flows will occur when there is a price differential between the two markets. In this analysis, trade flows are feasible only in the direction indicated in Figure 3. That is, feed grains can be used by the extensive livestock industry but hays are unsuitable feeds for intensive livestock.

The introduction of a 50 per cent subsidy on transport costs of fodder can be illustrated in Figure 3 by reducing the average transport differential OT to OT', where OT' = 0.5 OT. That is, the demand curve is shifted from DD' to D_1D_1', a vertical distance equal to half the average transport cost of fodder. Using the demand curve D_1D_1' trade will occur at a level where AB (the excess of demand over supply in the extensive fodder market) equals CE (the excess of supply over demand in the feed grain market) at a price P_1. Similarly a 50 per cent subsidy on fodder purchases can be shown to shift the demand curve from DD' to D_2D_2', a vertical distance equal to half the price of fodder. In this case, trade between the two sectors can be shown to occur where A'B' is equal to C'E' at a price P_2. The demand curve D_3D_3' represents the combined effects of the fodder purchase and the fodder transport subsidies. The relevant trade level established for this demand curve occurs where A"B" = C"E" at a price P_3. Fodder prices eventually reach a level equal to the price of feed wheat on the world market (the perfectly elastic part of the feed grain supply curve) after which all additional trade will occur at a price equal to the world feed wheat price.

ESTIMATION OF CONSUMER AND PRODUCER SURPLUSES

Using the framework established in the discussion of Figure 3, the usual benefit-cost procedures can be applied through the estimation of economic surpluses. These are made up of consumer surplus, which may be depicted as the area under the demand curve and above the price line; and producer surplus, the area above the supply curve and below the price line.

The fodder transport subsidy (represented as a shift in the demand curve from DD' to D_1D_1') will cause an increase in price from P_G to P_1 in the feed grain market, as a result of trade (AB) between the two markets. The resulting change in economic surplus can be illustrated as follows:

- an increase in consumer surplus in the extensive fodder market of LP_EP_4N where P_4 is the actual price paid by livestock producers;
- an increase in producer surplus in the extensive fodder market of BP_1P_EL;
- a decrease in consumer surplus in the feed grain market of P_1CKP_G;
- an increase in producer surplus in the feed grain market of P_1EKP_G;
- a subsidy Q'T'TQ.

Similarly, shifts in the demand curve from DD' to D_2D_2' in the case of the fodder purchase subsidy and from DD' to D_3D_3' as a result of both fodder transport and fodder purchase subsidies produce changes in economic surplus measures shown in Table 7.

When the estimates of elasticities of supply and demand presented earlier in this paper are employed in this analysis, the results are as shown in summary in Table 8. From this table it can be seen that in an unsubsidised market no trade was predicted to occur between the two markets because the price of hay ($191/t we) was lower than the price of feed wheat ($150/t we) plus the average cost of transportation ($45/t we). The introduction of a fodder transport subsidy of 50 per cent of transport costs resulted in a trade of 98 kt(we) from the feed grain market to the extensive fodder market. At this quantity of trade, prices in the two markets are equal (allowing for transportation costs) at $156/t (we) in the feed grain market and $201/t (we) in the extensive fodder market. These changes in the price and quantity of fodder result in gains in economic surplus to both consumers and producers of fodder in the extensive fodder market of $12.8m and $11.3m, respectively. In the feed grain market, consumers of feed grains were worse off by an estimated $15m and suppliers of feed grains gained by $15.3m as a result of the fodder transport subsidy. The estimated cost of the fodder transport subsidy in isolation from the fodder purchase subsidy was $25.7m, resulting in a net social loss associated with the scheme of $1.3m.

The fodder purchase subsidy considered in isolation from the fodder transport subsidy can be shown to have resulted in a trade of 368 kt(we) from the feed grain market into the extensive fodder market, resulting in an increase in price of feed grains to $174/t (we) and an increase in the

Table 7: REPRESENTATION OF CHANGES IN ECONOMIC SURPLUS AS A RESULT OF THE FODDER PURCHASE AND TRANSPORT SUBSIDIES

Item	Fodder transport subsidy	Fodder purchase subsidy	Fodder transport and purchase subsidies
Extensive fodder market			
Consumers' surplus	LP_0P_4N	LP_0P_5N'	LP_0P_6N''
Producers' surplus	BP_1P_0L	$B'P_2P_0L$	$B''P_3P_0L$
Feed grain market			
Consumers' surplus	P_1CKP_G	$P_2C'KP_G$	$P_3C''KP_G$
Producers' surplus	P_1DKP_G	$P_2D'KP_G$	$P_3D''KP_G$
Trade level	AB=CD	A'B'=C'D'	A"B"=C"D"
Subsidy	Q'T'TQ	$A'P_2P_5N'$	$A''P_3P_6N''$

Table 8: ESTIMATED CHANGE IN ECONOMIC SURPLUS RESULTING FROM DROUGHT ASSISTANCE MEASURES

Item	Unit	No subsidy	Fodder transport subsidy	Fodder purchase subsidy	Fodder transport and purchase subsidy
Subsidy	$m	0	25.7	123.2	157
Feed grain price	$/t(we)	150	156	174	180
Hay price	$/t(we)	191	201	219	225
Quantity traded between markets	kt(we)	0	98	368	511
<u>Extensive fodder market</u>					
Consumer surplus (drought affected livestock producers)	$m	-	12.8	54.1	79.5
Producer surplus (Hay producers)	$m	-	11.3	30.3	36
<u>Feed grain market</u>					
Consumer surplus (grain-fed intensive livestock producers)	$m	-	-15	-55.3	-67.3
Producer surplus (grain suppliers)	$m	-	15.3	60.1	74
Net social gain/loss	$m	-	-1.3	-34	-34.8

price of hay to $219/t (we). The consequent changes in economic surplus included:

- a gain of $54.1m to consumers of fodder in the extensive fodder market (that is, drought affected livestock producers);
- a gain of $30.3m to producers of fodder in the extensive fodder market (mostly hay producers);
- a gain of $60.1m to producers of feed grains; and
- a loss of $55.3m for consumers of feed grains (that is, intensive livestock producers).

The estimated cost of the fodder purchase subsidy in isolation from the fodder transport subsidy was $123.2m, resulting in a net social loss of $34m when the above gains and losses are considered.

The combined effect of the two drought policy measures, as show in Table 8, was to increase the quantity traded to 511 kt(we) and to increase the feed grains price to the ceiling feed wheat price set by the Australian Wheat Board. The fodder policies as shown in Table 8 can be shown to have:

- benefited consumers of fodder in the extensive fodder market by $79.5m,
- benefited producers of fodder in the extensive fodder market by $36m,
- benefited producers of feed grains by $74m; and
- resulted in consumers of feed grains paying higher feed costs so that they were disadvantaged by an estimated $67.3m.

The total cost of the subsidy measures was $157m (if tax revenue collection costs are ignored) resulting in an estimated net social loss of approximately $35m or 22 per cent of the total subsidy.

SENSITIVITY ANALYSIS

A sensitivity analysis was undertaken to test the stability of the economic model used in the analysis. This was achieved by varying the value of key parameters by a small amount and recording in Table 9 the percentage change in economic surplus resulting from a percentage increase in the value of key variables. The response to a change in the elasticity of supply of hay is recorded in Table 9 as an absolute value rather than as an elasticity, since an elasticity at zero is not defined. The response of the model to parameter perturbations is quite linear in the neighbourhood of the parameters used, so that the effect of larger changes is approximately proportional. The key variables considered in the sensitivity analysis were:

- the elasticities of supply and demand in each market; and
- the price of feed wheat administered by the Australian Wheat Board

Table 9 contains results of the sensitivity analysis. From this table it can be seen that the initial estimates of economic surplus were quite unresponsive to changes in the assumed slopes of supply and demand curves. The response to a 10 per cent change in the slopes of the supply and demand curves ranged from 11.7 per cent to a negligible percentage. Estimates of the net social loss remained relatively unresponsive to changes in supply and demand assumptions with the largest change of -16.3 per cent resulting from a 10 per cent change in the slope of the demand curve for fodder in the extensive fodder market. Increasing the elasticity of supply for hay from 0 to 0.1 resulted in a decrease of the net social cost of 0.92 per cent.

On the other hand, as shown in Table 9, the model was quite responsive to changes in the price of feed wheat. A 10 per cent increase in the price of feed wheat was shown to benefit producers of fodder in the extensive fodder market by 52.3 per cent and feed grain suppliers by 63.6 per cent,

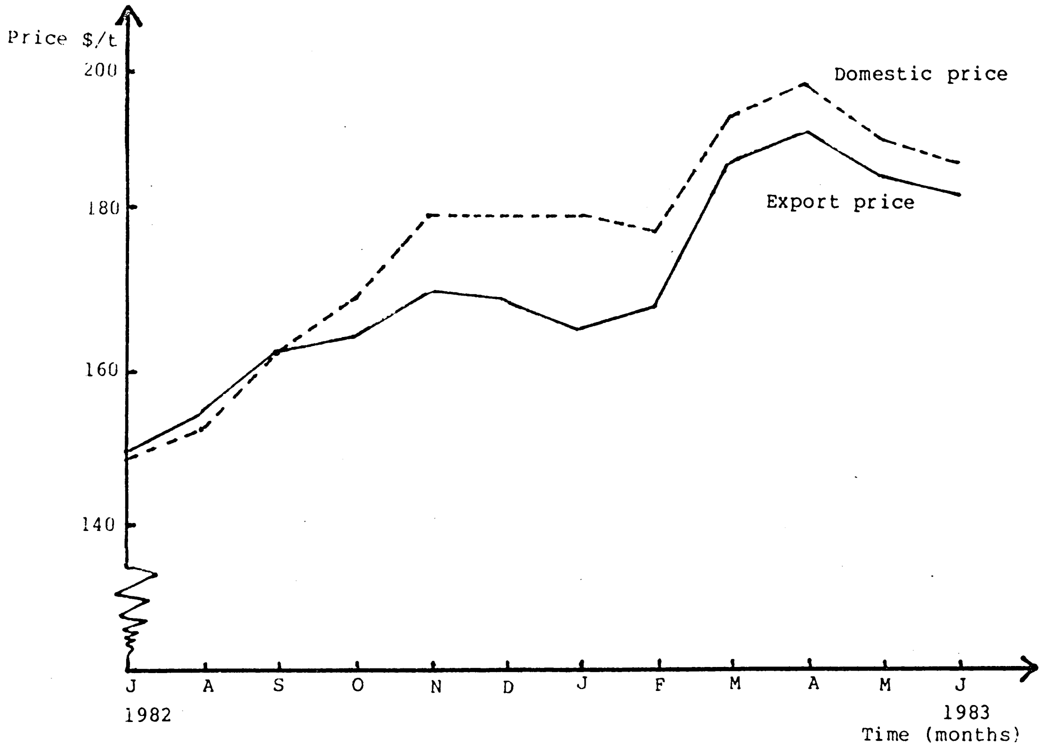
Table 9: ANALYSIS OF THE SENSITIVITY OF THE MODEL TO CHANGES IN KEY PARAMETERS: SENSITIVITY ELASTICITIES (a)

Item	Extensive fodder market		Feed grain market		
	Fodder elasticity of supply(b)	Fodder elasticity of demand	Feed grain elasticity of demand	Feed grain elasticity of supply	Feed wheat price
Assumed value of parameter	0	-0.84	-0.35	0.7	180
Extensive fodder market					
Consumer surplus (drought affected livestock producers)	0	-0.98	0	0	-3.51
Producer surplus (hay producers)	0.40	-1.17	0	0	5.23
Feed grain market					
Consumer surplus (grain-fed intensive livestock producers)	0	0	0.21	0.47	-5.77
Producer surplus (grain suppliers)	0	0	-0.19	-0.46	6.36
Net social loss	-0.92	-1.63	0	-0.06	0.23

(a) The sensitivity elasticity is the percentage change in the estimate produced by a 1 per cent change in the parameter. (b) For this parameter the sensitivity measure recorded is the percentage change in the estimate produced by a variation in the parameter from 0 to 0.1.

consumers of fodder in the extensive fodder market were disadvantaged by 35.1 per cent and consumers of feed grains were disadvantaged by 57.7 per cent. From Figure 4 it can be seen that the feed wheat price during the 1982-83 drought was generally set at a level above the export price of Australian Standard White wheat determined in the world market. The weighted average price of Australian feed wheat over this period was $180/t compared to $170/t for Australian standard white wheat sold on overseas markets. If there had been a reduction in the feed wheat price from $180/t to $170/t in the drought, it would have resulted in an additional benefit of $16m and $22m to consumers of fodder in the extensive market and feed grain consumers, respectively, and a reduction in the benefits to fodder suppliers to the extensive market and to feed grain suppliers of $10.4m and $25m, respectively. The net social loss would have declined by $1.8m.

Figure 4: EXPORT AND STOCKFEED WHEAT PRICES



CONCLUSION

This case study indicates that drought assistance measures introduced substantial distortions into the market for fodder in the 1982-83 drought. Of the total subsidy of $157m only about 51 per cent or $79.5m was actually received by the target group of drought affected livestock producers. About $36m was captured by hay producers, and about $74m was captured by feed grain producers. Neither of these groups was necessarily affected by drought. In addition, a substantial uncompensated cost was imposed on intensive livestock producers (mainly pig and poultry producers) of about $67m. Overall there was a net social loss of about $35m. This distribution of benefits and costs is summarised in Table 10.

Several types of costs and benefits have been excluded from the above analysis. The cost of any excessive land degradation induced by these policies has been ignored. So have the benefits to the producer of risk reduction associated with the subsidy to risk taking implicit in any drought assistance policy and the costs of risk bearing imposed on the community. This is appropriate, since the analysis is concerned with the costs and benefits associated with the use of particular instruments for delivering drought assistance, and the risk benefits associated with other instruments would probably be similar. In any case the study of drought insurance by Bardsley, Abey and Davenport (1984) suggests that the net risk benefits might not be large.

This study suggests that, if drought assistance is to be made available, then there may be substantial costs associated with the particular instrument chosen for delivering that assistance. Hence, there may be significant social benefits if instruments can be chosen which minimise these costs. One possible policy which could circumvent many of these costs, a rainfall insurance scheme, is outlined in BAE (1986).

Table 10: DISTRIBUTION OF COSTS AND BENEFITS OF THE DROUGHT FODDER AND TRANSPORT SUBSIDIES

Item	Benefit	Proportion of total subsidy
	$m	%
Extensive Fodder Market		
Consumers of fodder (drought affected livestock producers)	79.5	51
Producers of fodder (hay producers)	36	23
Feed Grain Market		
Intensive feed grain consumers	-67.3	-43
Feed grain producers	74	47
Net Social Losses	34.8	22
Total Subsidy	157	100

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