"On-farm economic evaluation of sheep enterprises: *Sheep Cents* an integrated program for the economic analysis of wool and meat sheep enterprises".

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Abstract

The difficulty with livestock gross margin budgeting is that unlike crop gross margins whose returns are measured on the most limiting resource, land; livestock gross margins have conventionally been reported on a per animal basis. This means the gross margin is reported on the basis of its productive unit, not its limiting resource. To be an effective tool for economic analysis, a gross margin budget should allow its user to determine the total production of the enterprise being analysed. It should also enable some comment on the efficiency of that production when compared to alternative uses of the resources.

To achieve this, a macro-driven spreadsheet model was constructed which conducts a gross margin analysis based on the enterprise the operator defines. To enable accurate comparison of resource usage, estimations of the feed requirements of the enterprise are calculated dynamically. This spreadsheet-based gross margin analysis is called "Sheep Cents".

The "Sheep Cents" program has been developed for research purposes only, and at present there are no plans to commercialise the software. The "Sheep Cents" model has been used in a number of on-farm technology assessment research projects as well as in preparing gross margin budgets for sheep enterprises for the NSW Agriculture State-wide sheep budget book (released in June).

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Introduction

The on-farm analysis of sheep enterprises in this paper is conducted using a modified format of the traditional gross margin analysis. The purpose of the paper is to report an improvement in the traditional gross margin budget format made possible by the improvement of computing and software power. This paper will provide a description of the gross margin budgeting approach outlining the main components of an on-farm economic evaluation of sheep enterprises. The Sheep Cents model is then described and is presented as an improvement on the traditional gross margin budgeting method of analysing alternative sheep enterprises.

Gross margin analysis is one of a series of partial planning techniques used by farm management economists to analyse financial and resource allocation implications of farming activities. If we take the definition of economics as the "study of production possibilities and the allocation of a society's resources" (Carew 1988). Then, to be an effective tool for economic analysis, a gross margin analysis must enable its user to determine the total production of the enterprise being analysed as well as enabling us to make some estimate of the efficiency of that production when compared to alternative uses of the resources employed by that enterprise. This is supported in Heady (1948) who saw the specific objectives of farm management research as "(1) to guide individual farmers in the best use of their resources and in a manner compatible with the welfare of society and (2) to provide fundamental analysis of the efficiency of farm resource combinations which can serve as a basis for bettering the public administration of resources where agricultural policy or institutions which condition production efficiency are concerned". This is also supported in Smith (1988) who stated that "The objective in livestock improvement is to improve the economic efficiency of production, defined as the cost per unit of product value".

This paper will examine the on-farm economic analysis of sheep enterprises. Firstly the paper looks at the traditional approaches used by farm management economists and looks at the components of resource usage by sheep enterprises, by doing so we are able to then compare sheep enterprises on an equal basis. The method of conducting a farm-based economic analysis is to determine resource usage, determine costs of production and determine total returns from the enterprise, and combine this into a meaningful result. The paper then discusses a method of combining this economic analysis into a spreadsheet-based model and finally looks at the introduction of risk into this model. Some example sheep enterprises are included in Appendix 1.

On farm Economic Analysis of Sheep Enterprises - The Gross Margin Approach

Farm management economists have for a number of years used gross margins to analyse the financial aspects of livestock production. The gross margin is the difference between the revenue raised by an enterprise and the variable costs attributable to that enterprise. Rae (1977) defines the equation for a gross margin as:

Gross Margin[1] = Total Revenue minus Total Variable Costs.

A gross margins analysis of livestock production in its simplest form is the total income from the sale of the livestock and their associated products (in the case of sheep, goats and dairy cows for example) minus the variable costs of producing the saleable commodities, such as veterinary expenses, husbandry operations, transport, replacement animals and so on. A gross margin budget does not include the overhead costs of running the farm such as interest repayments on capital, shire rates, rent etc; nor does the gross margin traditionally account for the costs of feeding the livestock, apart from some supplementary feeding costs which are over and above the average or long run pasture requirement.

Gross margins analysis has been effective in comparing the costs and returns from similar livestock enterprises, that is livestock enterprises whose overhead requirements are equal. Where overhead resource requirements are not identical the gross margin analysis is not effectively comparing the returns from the same resource input. To use the cliche, we are "not comparing apples with apples". The main difficulty with livestock gross margin budgeting is that unlike cropping gross margins whose returns are measured on the most limiting resource, land (in $ per hectare), livestock gross margins have conventionally been reported on a per animal basis. For example, a sheep gross margin budget would report the gross margin on a per enterprise (typically a thousand sheep) or per sheep basis. A gross margin which is reported in this manner does not report returns on the basis of the most limiting resource (ie land). By reporting returns on a per animal basis, the gross margin is reporting returns from the enterprise on the basis of its productive unit, not its limiting resource. An analogy would be to report crop returns based on the gross margin per plant rather than per hectare. What is required of us as economists, is to report returns on a basis which would enable an accurate comparison of the economic rent returned from the most limiting resources.

To address this shortcoming, we require a base from which the relative economics of all extensive agricultural enterprises capable of being produced in a particular region can be evaluated.

A Basis for Economic Comparison - the Importance of Calculating Feed Requirements

To analyse the relative economics of different agricultural enterprises, it is important to compare different enterprises from a similar base. Obviously you can not directly compare returns per cow with returns per sheep or returns per hectare (in the case of cropping enterprises). In order to accurately compare different enterprises we need a similar base over which all enterprises can be rated. Selecting the appropriate base depends on the most limiting economic resource. In Australian agriculture, it can be argued that ultimately the most limiting resource is the area of land. In the case of cropping enterprises the land limitation is obvious, that is, to expand the scale of production you need to increase the area of land. Consequently cropping enterprises have their economic returns commonly reported on a per hectare basis. In most grazing enterprises land is a limiting factor only because it supplies pasture (in the housed or feedlot case land becomes a limiting resource because it provides physical space). In livestock enterprises the demand for land is a derived demand, derived from the demand for livestock or livestock products (eg. wool and meat in the case of sheep).

Reporting livestock enterprises in terms of the gross margin per unit of land requires an

[1] For more detail on gross margins and their use in farm management and budgeting see Dent et al. (1986) and Rickards and McConnell (1968).

estimate of the carrying capacity of the land. There is a problem here, and that is you have two unknowns. First is the quantity of feed required by the livestock enterprise and second is the amount of pasture produced per hectare. Quantity of feed demanded by livestock enterprises varies with animal production, topography, climate, breed, as well as the age and weight of stock. To date, this has been handled rather poorly using manual methods of calculating the feed requirements of particular livestock enterprises. A unit of feed demand or production conventionally used in Australian agriculture is the DSE which stands for *dry sheep equivalent*.

Using the gross margin per DSE as a comparison between livestock enterprises, we can think of the cost of feeding livestock in terms of the number of animals we are able to sustain on a given area. For example, if we are trying to maximise farm income, considering the returns on a per feed unit or (DSE area) basis rather than a per sheep basis then becomes a more accurate estimate of the econom'c performance of the farm.

A less cumbersome and time consuming approach to gross margin analysis was required, one which precisely calculated the feed requirements as well as the traditional gross margin of the livestock enterprise being analysed and one which would dynamically adjust the feed requirements when any changes to the enterprise were contemplated. A system which determined the amount of pasture different livestock enterprises require to achieve certain levels of production was needed. Once we know the pasture requirements of a livestock enterprise we then need to combine this with the pasture production from a hectare of land and we can then calculate then have a dollar return per hectare for 'ivestock enterprises. We then have a base for comparing livestock returns with cropping returns.

If we consider the relative economic merit of livestock enterprises is the efficiency with which they convert feed resources available to them into net farm returns (economic efficiency of feed conversion), we are able to think of the cost of feeding livestock in terms of the number of animals we can carry on a given area (known as carrying capacity). When trying to determine the most economically efficient livestock enterprise we are not necessarily interested in the enterprise which returns the highest gross margin or the highest gross margin per sheep, but the production system which returns the highest gross margin per unit of feed consumed.

The approach taken to achieve this for sheep enterprises[2] was to use a spreadsheet based computer model which performs a gross margin analysis based on the enterprise the operator defines. Estimation of the feed requirements of the sheep enterprise are then calculated dynamically using the metabolisable energy requirements system to determine the energy demands of grazing animals. The main components of a farm-based economic analysis are outlined below. The first and most important is calculating the feed requirements.

Calculating Feed Costs - The Metabolisable Energy Requirements System

The importance of calculating feed requirements has been explained above. There are a number of systems of calculating the energy requirements of livestock, two of these which have been widely used by farm management economists in Australia are Rickards and Passmore (1977), and Muir and Simpson (1990). Both these systems convert energy requirements of ruminant grazing animals into DSE or LSM (livestock month) ratings. These systems rely on the manual calculation of the energy needs based on the sheep's weight.

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[2] The author has also developed a similar system for the analysis of the economics of beef cattle production. This system is again spreadsheet-based and is called "Cattle Cash". See Bootle (1992).

The problem with both these systems is they are too simplistic for an accurate estimate of feed requirements and they do not readily enable the dynamic calculation of ruminant feed requirements which is necessary for the accurate economic evaluation of alternative sheep enterprises. These systems even have a different definition of the energy requirements of a DSE. Rickards and Passmore (1977) call their feed unit a LSM (which is one twelfth of a DSE), and it is defined as the amount of feed required to maintain a 50 kilogram dry sheep for one month. Muir and Simpson (1990) define a DSE as "the amount of feed required to maintain a 45 kilogram fleece-free adult dry sheep for 12 months". The latter definition seems to be inappropriate as there are few 45 kilogram adult sheep, let alone "fleece free" sheep.

Other systems of calculating energy requirements such as Ministry of Agriculture, Fisheries and Food (1984) and Standing Committee on Agriculture (1990) rely on a system of equations to calculate the energy requirements. They require accurate information on animal weight, physiological status, growth rates, and energy values of pasture, and in the Standing Committee on Agriculture case also require estimates of environmental conditions such as temperature and daily distance animals have travelled. These systems while more theoretically rigorous, are tedious to calculate manually and consequently have not been widely used in economic analysis to date. However it should be noted the equation referred to in Rickards and Passmore (1977) for estimating feed requirements were based on a 1977 version of Ministry of Agriculture, Fisheries and Food (1984). Therefore the equations presented below are an update on that presented in Rickards and Passmore (1977).

The Sheep Cents model uses the metabolisable energy allowance system of calculating the energy requirements of the sheep flock. The system is based on that developed by Ministry of Agriculture, Fisheries and Food (1984) but includes allowances for Australian conditions adapted from Rickards and Passmore (1977) and Standing Committee on Agriculture (1990). The Ministry of Agriculture, Fisheries and Food system, being British and therefore a different production environment, tends to underestimate actual sheep energy usage in an Australian environment. To illustrate this, Standing Committee on Agriculture (1990) estimates the Ministry of Agriculture, Fisheries and Food calculation for a dorset wether's metabolisable energy requirement is approximately 4 percent below what would be expected under Australian conditions.

The problem of tedious calculations when estimating the feed requirements of different sheep flocks is overcome in the Sheep Cents model by the linking of the sheep flock production assumptions to a separate section of the spreadsheet which contains the metabolisable energy allowance equations. The unit of feed used in these calculations is the megajoule (Mj) of metabolisable energy. Mj of metabolisable energy are then converted into LSM, which are in turn summed to give an annual DSE requirement for the specified flock. The presentation of feed requirements in DSE rather than Mj terms is done for familiarity and for ease of farmer use. However, Sheep Cents retains the ability to report feed requirements and gross margins on a Mj basis.

The metabolisable energy requirements method of calculating energy requirements of sheep uses the sheep's weight to determine the maintenance energy requirement for that animal. Here maintenance is assumed to mean status quo, that is, the amount of energy required to keep an animal at its current weight and maintain all bodily functions with minimum exercise[3]. Once we know the animals weight and therefore the maintenance energy requirement there are a number of additions to make for growth, pregnancy, lactation, exercise, quality of feed, and efficiency of feed

[3] Assumed in Ministry of Agriculture, Fisheries and Food (1984) to be a penned or yarded animal.

conversion. The equations used by Sheep Cents to estimate energy requirements of sheep are explained in below.

1. Maintenance Energy Requirements:

The calculations required to determine maintenance are made up from the following three formulae. Firstly Ministry of Agriculture, Fisheries and Food (1984, pp. 51) gives the formula for fasting metabolism as:

$$FM\ (MJ/day) = (0.23*W^{0.75})*1.05 \qquad (1)$$

Where: W is kilograms of body weight, and
1.05 is a safety allowance.

Ministry of Agriculture, Fisheries and Food recommend a safety allowance of five percent be added to the fasting metabolic rate of sheep. This is provided to ensure feed requirements are not underestimated. Equation (1) gives the fasting metabolic energy requirement of the sheep. The first allowance which must be added to this is an activity increment (also referred to as an exercise allowance in Rickards and Passmore 1977).

The formula for the activity increment is adapted from that given in Ministry of Agriculture, Fisheries and Food (1984) and Rickards and Passmore (1977). Ministry of Agriculture, Fisheries and Food (1984 pp. 51) indicate that activity increments had to be allowed for over and above fasting metabolism, these were:

- 0 % for housed animals (ie. maintenance at fasting metabolism plus the 5% safety allowance)
- 15% for yarded animals (see also Rickards and Passmore 1977 pp. 8),
- 35% for foraging animals grazed under favourable conditions (ie intensively grazed animals - R&P 1977), and
- 60% for foraging animals grazed under extensive grazing conditions (Rickards and Passmore 1977 pp. 8). (2)

The third allowance which makes up the energy requirement of maintenance is the efficiency of feed utilisation[4]. Rickards and Passmore (1977 pp. 8) noted that the efficiency of utilisation of metabolisable energy for maintenance varies with the ME (metabolisable Energy) content of the feed ration. They estimated the following efficiencies of conversion for various qualities of feed:

- 66% poor quality feed,
- 68% medium quality feed,
- 71% good quality feed, and
- 74% concentrated rations. (3)

These qualities of feed correspond to the following metabolisable energy levels:

Poor quality feed	=	7.11 MJ of ME per kilogram of dry matter (MJ ME/ Kg DM),
Medium quality feed	=	8.37 MJ ME/ Kg DM,
Good quality feed	=	10.04 MJ ME/ Kg DM, and
Concentrated rations	=	11.72 MJ ME/ Kg DM.

Using equations (1) to (3), and the sheep weight, grazing environment and quality of pasture or feed, we are able to determine the maintenance energy requirements of dry adult sheep.

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[4] Ministry of Agriculture, Fisheries and Food (1984) use the efficiency of utilisation of metabolisable energy for sheep as a constant 0.7. This is considered too inaccurate under Australian conditions where feed quality (MJ ME/ Kg DM) varies widely throughout the year (Standing Committee on Agriculture 1990).

Maintenance is only part of the total energy requirement of a sheep enterprise depending on the type of enterprise and the age of sale progeny. For example, in a merino self-replacing flock producing 23 micron wool and selling 36 kilogram male weaners at 30 weeks of age and cull ewe hoggets at 45 kilograms at 75 weeks of age, the maintenance feed requirements of the flock accounts for 70 percent of total feed requirements. The next addition to maintenance feed requirements is the energy required for gestation (or pregnancy).

2. Gestation Energy Requirements:

A gestating ewe uses extra energy in the production of the foetus. This extra energy is used by the growing foetus as well as by the ewe for the production of tissue and membranes associated with pregnancy. The amount of energy required by the growing foetus has been estimated by Standing Committee on Agriculture (1990 Table 1.11) and is presented in Table 1.

Table 1 - Metabolisable Energy required per day for pregnancy by ewes (weekly basis).

Weeks before term	12	8	6	4	2	Term
ME (Mj/day) required	0.4	1.1	1.7	2.6	3.8	5.3

As the Sheep Cents model's feed requirements are based on daily energy calculations which are then summed to give monthly averages. The values presented in Table 1 were adapted to give the figures presented in Table 2, displayed on a monthly basis.

Table 2 - Metabolisable Energy required per day for pregnancy by ewes (monthly basis).

Months Before Term	3	2	1	Term
ME (Mj/day) required	0.4	2.8	6.4	5.3

The gestation increment is added to the maintenance figures for a gestating ewe. The ME requirement given as *Term* represents the energy expended at birth by the ewe and is carried forward as extra energy demand for half of the first month of lactation.

3. Lactation Energy Requirements:

As with pregnancy, lactating ewes expend extra energy on milk production. This is included in the Sheep Cents model's energy calculations as a lactation increment. The formula for the calculation of the extra energy required for lactation comes from Ministry of Agriculture, Fisheries and Food (1984) and is given as:

ME (Mj/day) Milk (1 Kg) = 4.6 Mj ME / Efficiency of Utilisation of ME (0.62) (4)

The formula used in Standing Committee on Agriculture is given in equation 5. This Standing Committee on Agriculture (1990) formula gives an energy value of milk production which is 6 % higher than the Ministry of Agriculture, Fisheries and Food figures.

ME (Mj/day) Milk (1 Kg) = 4.72 Mj ME / Efficiency of Utilisation of ME (0.6) (5)

The Sheep Cents model uses the Standing Committee on Agriculture figures as these are more current and were developed for Australian conditions. Estimates of a ewe's milk production are given in Table 3. The estimates are from Ministry of Agriculture, Fisheries and Food (1984, Table 16, page 55):

Table 3 - Milk Yield in Kilograms per day.

Lactation Month	1	2	3
Milk Yield in Kg's/day - ewes with singles - ewes with twins	1.34 2.24	1.29 1.85	0.95 1.26

The Sheep Cents model allows the operator to specify actual milk production where these figures are known, otherwise the values in Table 3 are used as defaults. These are then converted into the additional ME required by the lactating ewe. These converted figures for the milk yields in Table 3, are presented in Table 4.

Table 4 - ME Requirements for Milk Production.

Lactation Month	1	2	3
Milk Yield (Kg/day) - ewes with singles - ewes with twins	10.54 17.62	10.14 14.55	7.47 9.91

It should be noted that to avoid double counting the energy requirements of lactating ewes, the ME value of milk is subtracted from the ME requirement for lambs pre-weaning. This means that the energy requirements of growing lambs (pre-weaning) are met partially by the energy value of milk from lactating ewes and partially by the pasture grazed by the lambs. Rickards and Passmore (1977) stated that as a rule of thumb "it is not too inaccurate" to assume that the energy requirement of a ewe plus lamb till weaning is the same as the ewe at peak lactation. This would give a total energy requirement for a ewe and lamb(s) till weaning, slightly lower that the figures which are calculated using the above method.

4. Energy Requirements for Growth:

The calculations for the energy requirements for growth are more complex than those given in equations (1) to (5) for maintenance of adult sheep. Firstly the equation used to calculate the energy required for fasting metabolism for growing sheep (FM_g) is different from that given above in equation (1)

$$FM_g\ (Mj/day) = (0.29*W^{0.73})*1.05 \qquad (6)$$

Where: FM_g is fasting metabolism for growth,
W is kilograms of body weight, and
1.05 is the safety allowance.

Again this gives just the fasting metabolic energy requirement of the growing sheep. The activity and efficiency allowances described in equations (2) and (3) must be added to FM_g to obtain the maintenance energy requirement for growing sheep (Mm_g). The allowance for growth or weight gain must be added to Mm_g.

As the Sheep Cents model calculates the daily weight gain of animals based on specified target weights, the approach used to predict the energy value of liveweight gain is different to the approach typically used. Normally, when calculating energy requirements we are trying to predict the liveweight gain of a specified animal given the following three variables; ME content of the feed, the liveweight of the animal, and dry matter intake. However, in the Sheep Cents model, because we already know the liveweight gain of the animals (which is calculated by dividing operator specified target weights by animal age at target weight), what we are trying to determine is the amount of ME that *would*[5] have been required to enable the animal to grow at that target or predicted growth rate.

Ministry of Agriculture, Fisheries and Food (1984) states that liveweight gain (LWG) that can be achieved from energy stored can be calculated using the formula:

$$LWG = \frac{\text{Energy Stored}}{\text{Energy Value of Gain}} = \frac{E_g}{EV_g}$$

The energy value of liveweight gain by lambs is given by Ministry of Agriculture, Fisheries and Food (1984, Formula (44), page 58) as:

$\log_{10} EV_g = 0.11 \log_{10} LWG + 0.004W + 0.88$ (MJ/kg) (7)

Where: W is weight in kilogram, and

LWG is liveweight gain in g/day.

With substitution of E_g / LWG for EV_g, equation (7) may be rearranged to give the following formula to estimate the liveweight gain of growing sheep (Ministry of Agriculture, Fisheries and Food 1984 page 58):

$\log_{10} LWG = 0.9 \log_{10} E_g - 0.0036\ W + 1.91$ (8)

Equation 8 predicts the sheep's liveweight gain. What is required by the Sheep Cents model is the energy stored E_g from a given liveweight gain. We can calculate this by rearranging formula (8) to get:

$\log_{10} E_g = (\log_{10} LWG - 1.91 + 0.0036\ W) / 0.9$ (9)

Which may also be rewritten to give us:

$E_g = 10\hat{}(\log_{10} LWG - 1.91 + 0.0036\ W) / 0.9$ (10)

Consequently from a given liveweight gain and ME content of the feed we can calculate the ME requirements of a hypothetical animal on a particular pasture. The next addition to calculating the energy requirement of sheep is the energy requirement for the growth of wool.

5. Energy Requirements for Wool Production:

Rickards and Passmore (1977) state that the accuracy of estimates of the energy required by sheep over relatively short periods of time (ie periods of one month):

> "...will not be improved significantly by treating wool growth and gain in body tissues as separate entities. It is suggested therefore, that all the gains in overall liveweight be treated as if they were gains in body tissue...".

In order to reduce the complexity of calculations in the Sheep Cents model this assumption was adopted. It should be remembered that a 5% safety allowance is already added to the maintenance requirements of all sheep, in light of the above this would be expected to allow sufficient leeway for wool production.

6. Energy Value of Weight Loss:

In order to simplify the calculations in the Sheep Cents model weight loss is not considered. Where weight loss occurs in adult sheep the weight change from one month to the next is only considered in terms of the decreased ME for maintenance of those sheep. It should be pointed out that there is little loss of accuracy excepting the case where there is extreme and continued weight loss such as in a drought period. Sheep Cents was not constructed to calculate the feed requirements of sheep affected by drought but to analyse the impact of changes in technology on, primarily steady state sheep enterprises. There are several models which address

[5] Note that in the Sheep Cents model it is up to the operator to specify realistic target weights for target ages. There is no limitation of daily intake assumed in the model.

the problem of calculating the drought feed requirements[6] of sheep enterprises such as SheepO, Droughtpac, Jumbuck and CSIRO's Grazplan.

7. Definition of a Dry Sheep Equivalent:

There are 250.7[7] MJ of ME in a LSM, this figure is calculated from the definition of LSM in Rickards and Passmore (1977 pp. 14). Their full definition of a LSM is "the energy required to maintain a 110 pound (50 kilogram) dry sheep grazing 'medium quality' pastures for a 30-day month, after allowing for 35% of fasting metabolism for exercise. This is given in equation 11 below:

One LSM = 30 days fasting metabolism x exercise factor x efficiency of feed conversion. (11)

Rickards and Passmore use 1.35 as the exercise factor, being equivalent to that of an intensively grazed animal. They use 68 % as the efficiency of feed conversion, this is for an animal grazing pasture with a ME content not less than 8.37 MJ ME, or "medium pasture" by Rickards and Passmore's definition.

The feed requirement calculations in the Sheep Cents model is based on a 30.4 day month (ie 365.25 days in a year divided by 12 months) not a 30 day month as in the Rickards and Passmore definition of a LSM. The daily energy requirement of the sheep defined by Rickards and Passmore is 8.3579 MJ. Thus, the energy requirement of a LSM in the Sheep Cents model is 254 MJ of ME. The energy required for a DSE is twelve times that required by a LSM. That is, 3052 MJ of ME (i.e. 365.25 days multiplied by 8.3579 MJ).

The definition of a DSE for the purposes of the Sheep Cents model and this analysis is the amount of energy required to maintain a 50 kilogram dry sheep grazing 'medium quality' pastures for a 30 day month, after allowing an additional 35% of fasting metabolism for exercise.

Estimation of Livestock Labour Requirements and Costs

The amount of labour used by individual farm activities varies widely. The variation in labour requirements is due to a number of reasons. Some of these reasons include; different machinery or capital equipment and therefore different work rates, different methods of completing similar operations (such as an injectable drench versus a traditional oral drench), contractors are used for the operation, machinery or equipment failure or inexperienced operators, or climate or physical difficulties. Whatever the reason for the variation in the labour required to complete a particular task the operation must be completed. As a consequence the farm manager must plan for the labour time required. Labour budgeting is a vital part of farm business management, both for strategic production planning and financial management.

The amount of labour used in livestock enterprises is difficult to calculate precisely. The difficulty with planning labour use for general farming activities is exacerbated in livestock production because of the unpredictable nature of animals. While the labour requirements for farming activities such as ploughing a field may be difficult to precisely time because of unknowns such as ground hardness, tractor wheel slip, machinery overlap, routine equipment maintenance,

[6] For more information on how to calculate the energy requirements of drought affected stock see Oddy (1978).

[7] 59,951 kcal = 250.7 MJ

operator skill and risk of equipment failure, the number of unknowns in livestock operations are usually far greater. Whatever the husbandry or management activity that is undertaken, the unpredictable nature of animals affects the manager's ability to budget the labour time required. For example, the time required for a simple task such as mustering a paddock depends on a number of factors; initial location of the animals, pasture condition, climatic conditions, operator skill, equipment reliability, physiological status of the animals, whether or not there are young animals present, animal temperament, animal condition (relative fatness), topography, and so on. For this reason it is not uncommon for the labour requirements for a particular operation to be twice or half as much as initially estimated.

The Sheep Cents model collects labour times required in terms of operator supplied labour for all husbandry operations based on an estimate the operator makes for each husbandry operation. In the case of contracted operations such as shearing or crutching, the operator specifies only the labour required for the operations that are not contracted, such as mustering and yard work. Labour times are required by the Sheep Cents model for the following sheep husbandry activities; drenching, jetting, lice control, vaccinations, crutching, shearing, mulesing and lamb marking. The Sheep Cents model prompts the operator to estimate the number of hours the husbandry operations takes per one thousand sheep. Other labour requirements needed in the Sheep Cents model are; the supervision of joining, lambing, water, pasture and other labour requirements not elsewhere specified. An example of the other "not elsewhere specified labour" would be the additional labour required for pregnancy scanning if it were undertaken.

For the husbandry activities, the model then calculates the number of sheep on which the husbandry operation is performed and then calculates the labour required for that operation on an annual basis. The supervision labour times are then added to the husbandry labour times to give a total labour requirement for the flock specified. Sheep Cents does not calculate the cost of labour in the gross margin but reports the net return to labour for the enterprise specified in terms of gross margin per operator supplied labour hour. If it was desirable for labour to be included as a cost this can be manually calculated as long as the hourly labour cost is known. The reason for reporting gross margins per operator labour hour is so the operator can use this as an indication of the opportunity cost of his/her time and plan accordingly. A secondary benefit is so accurate labour times are calculated for linear programming purposes.

Assessing the Capital Value of Livestock

Calculating the capital return to livestock enterprises can be quite complicated in the case of mixed farming enterprises. The complication arises when determining the proportion of total capital invested in livestock enterprises and the proportion which is invested in non-livestock enterprises. The approach used in the Sheep Cents model is to calculate the annual capital return for capital invested only in the livestock portion of the farm. This ignores capital which is invested in land, machinery, and buildings etc. In order to make accurate comparisons of different livestock enterprises, the return from the capital invested in livestock is used as an indicator of the relative rate of capital return.

This comparison is accurate as long as the different livestock enterprises do not have other associated investments which are required for them to be undertaken. An example of this would be a farmer considering an enterprise shift from an all sheep enterprise to a sheep and cattle enterprise mix. The cattle enterprise would require additional capital investment such as cattle yards and handling facilities (if they did not previously exist). The same comparison can be made for moving from all cattle production to some or all sheep production, as the sheep enterprise requires specialist sheep handling and shearing facilities. However, in the majority of the NSW sheep-wheat belt mixed enterprise farms, additional investment is not required because facilities already exist on the farm or they can be readily hired or borrowed from neighbouring farmers. Under these circumstances the comparison of annual return to capital invested in livestock is valid.

There is one other precaution which should be mentioned when comparing the annual return to capital invested in livestock, and that is that you must compare the returns not just on the percent return but also on percent return from area of land or quantity of feed that is required by the specified enterprise. This is calculated in the Sheep Cents model by determining the livestock capital invested per DSE and dividing this into the gross margin returned per DSE. This gives the annual return per DSE on capital invested in livestock and gives a clearer indication of the total resources, both financial and physical (pasture), that are required by the enterprise specified.

The Effect of Risk[8] on the Economics of Livestock Production

Risk analysis is incorporated into the Sheep Cents gross margins because "the outcomes of most agricultural production systems are characterised by uncertainty, risk analysis is an important component of the process of economically evaluating a new production technology" (Vere, Bootle and Griffith 1992). There is a difference between what economists refer to as risk and that referred to as uncertainty. The difference between risk and uncertainty, described by Malcolm (1992), is "risk [is about] the prospect of something happening about which the person concerned could guess some probability of occurrence. Uncertainty [is] the term used to cover all things which could happen, whose likelihood the decision maker could not even hazard a guess about". Malcom's approach is similar to that taken by Anderson (1988) where risk is described as another potentially unclear concept; "In fact it is likely to remain so even after the following but, to pin things down a little, risk is taken here to mean uncertainty with teeth". Anderson goes on to point out that there is a difference between variability and risk and this is that "if something is quite variable but highly predictable, it is not [necessarily] risky". Malcolm states that "nowadays it is usual to speak of risk as being all-encompassing". This is the approach used in this paper.

Risk plays a vital role in the economic analysis of all agricultural enterprises. All risk has an associated cost to the farm business. It could be argued that risk is a major determinant of the farmer's decision to invest in particular forms of agriculture. The importance of risk according to Malcolm (1992) is that:

> "there is a possibility that planned-for yields, prices and costs do not eventuate, this consequently affects the business' ability to pay for the inputs used, to service debt and to appropriately reward labour, management and capital. Unexpected variations in climatic conditions, yields, prices, costs etc result in the farm manager having to vary actions that had been planned to be done before the expected event or combination of events, failed to eventuate. Price and production risk is incorporated into producers' planning and actions. Therefore variability of net cash flow *per se* is not the major problem due to risk; unpredicted variability of net cash flow, which is a consequence of risk and which has costs, is the problem".

This is why risk is considered important in evaluating the relative economics of livestock production. Risk affects different agricultural enterprises differently, even enterprises which are on the same farm in the same area have different levels of exposure to risk. In assessing the importance of risk in farm business management Malcolm (1992) takes the view that "Factors beyond the farm gate, and thus beyond the farmer's control, are more important determinants of

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8 For a more complete look at risk and uncertainty in agricultural decision analysis see Anderson, Dillon and Hardaker (1977).

survival and success than what farmers actually do (although this increases the importance of making good decisions about the things which farmers do have control)."

"@ Risk"[9] - Spreadsheet Risk Analysis

Risk analysis was considered an important part of the on-farm evaluation of sheep enterprises. The risk analysis was undertaken using a computer software package called "@ Risk". This package is an "Add-in" to the Microsoft[10] Excel spreadsheet and allows probability distributions to be used for variables where risk is present, instead of average or expected values. This means important parameters not usually varied can be risk sensitised. Consequently we are able to analyse the risk associated with each enterprise by getting a range of results for gross margin and feed use parameters. Sensitising the gross margin to risk is seen as being a more thorough approach than the traditional parametric risk analysis which only varies price and yield (in sheep enterprise gross margins usually the quantity of wool shorn per sheep).

The @ Risk program allows you to define the shape of the probability distribution as well as defining its parameters. The physical process of incorporating risk into the analysis is quite simple. First the Sheep Cents program creates a spreadsheet template of the enterprise being analysed. This model is then saved as a separate spreadsheet. @ Risk is then loaded into the spreadsheet, this activates the risk programming features of the program, and allows the probability distributions to be specified. A probability distribution can then be defined for each of the parameters being risk sensitised.

Once the probability distributions are set up for all relevant parameters, a number of iterations (user set) of the model are conducted automatically by @ Risk. @ Risk samples randomly from each of the probability distributions and then recalculates the spreadsheet, saving the results from each of the selected output cells. Once all the iterations are completed, graphical representation of each output variable is presented and the statistics of the simulation recorded.

The whole process takes a fraction of the time which would have been previously required to conduct such an exhaustive risk analysis. If you take a simulation with 1,000 iterations (as was the case in this analysis) with four probability distributions and did the analysis manually, this would represent 10^{12} separate budgets. The random sampling and recording of results would also have to be conducted manually for each of the probability distributions and each separate budget. It is therefore difficult to estimate the amount of time which can be saved and therefore the value of using the @ Risk program when conducting such an analysis.

Appendix 1 contains an example budget and risk analysis. The budget is based on a Northern New South Wales prime lamb producing flock. The risk analysis sensitises the following parameters:
1. Lambing % - Truncated Normal Distribution - mean 120%, SD 30%, min 90%, max 150%.
2. Lamb Prices - Uniform Distribution - min 70% of mean, max 130% of mean.
3. Wool and Mutton Prices - Uniform Distribution - min 60% of mean, max 140% of mean.
4. Supplementary Feed - Truncated Normal - mean 100%, SD 50%, min 0%, max 200%.

The @ Risk analysis results and the graphical representation of the above distributions are presented in Appendix 1.

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[9] Pronounced "at risk".

[10] For more information on Excel Version 4 see Microsoft (1992).

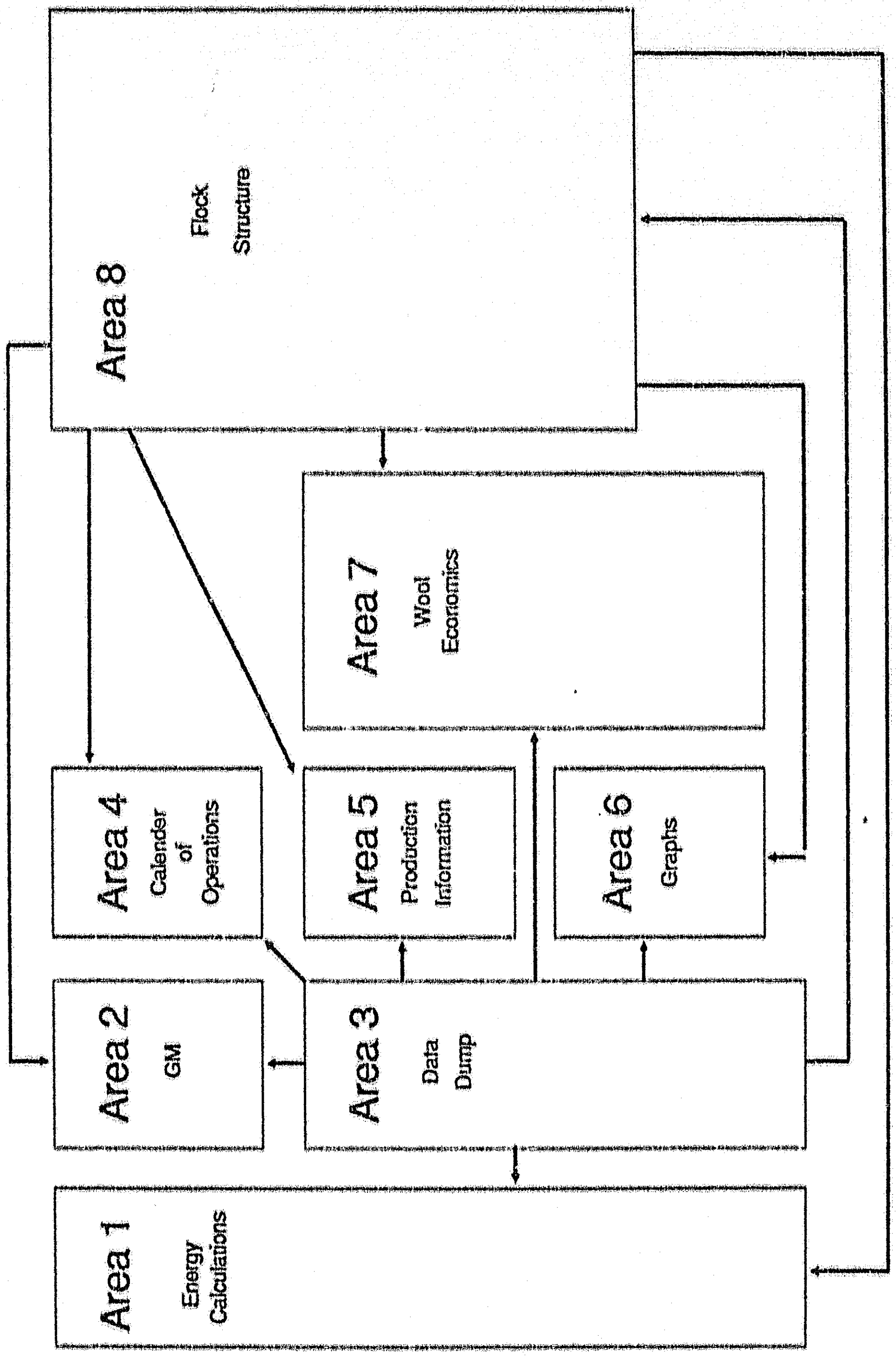

Figure 1 - Sheep Cents Template Spreadsheet Structure

How Sheep Cents is Structured

In order to understand how Sheep Cents operates it is necessary to explain the components of the model. Sheep Cents is made up of two spreadsheets and a macrosheet. The names of these spreadsheets are:

. Sheep Cents spreadsheet template - "SHEEP.XLS",
. Sheep Cents input prices spreadsheet - "INPUTS.XLS", and
. Sheep Cents controlling macro - "SHEEP.XLM".

To explain how Sheep Cents operates each of the components will be outlined separately.

Firstly, the main spreadsheet SHEEP.XLS is a template into which data is "dumped" or arranged from the controlling macrosheet (SHEEP.XLM). Figure 1 illustrates the structure of the spreadsheet template. The first area of importance is the data-dump area, identified as Area 3 in Figure 1. This is where all the assumptions about the sheep enterprise being analysed are entered into the spreadsheet. All input data is arranged in this area by the controlling macro. There are no links between the macro and the spreadsheet, this enables the template to be saved as a free-standing spreadsheet, which is not reliant on the macro for any of its input data. Information from this data-dump area is required throughout the template spreadsheet. In Figure 1, arrows indicate the flow of data. Area 8 in Figure 1 is the next most important region of the template spreadsheet. This area is where the flock parameters and structure is defined. This structure is a month by month tally of sheep numbers and weights by category (ie lambs, ewes and rams) and by sub-category (ie singleton male lambs from second joining, or twin male lambs from main joining, or ewes from main joining which are in their third month of lactation etc). It includes information on growth rates per month and mortalities per month. Information in this area is vital for the calculation of metabolisable energy demands and sheep husbandry operations' costs. Information flows from Area 8 to all other areas of the spreadsheet except the data dump area.

Area 1 in Figure 1 is the metabolisable energy demands calculation area. Here all the categories and sub-categories of sheep as well as information on pasture conditions and animal's grazing environment are combined to determine the feed demanded by the sheep enterprise. Area 1 receives information from the data dump area as well as the flock structure area (Area 8). Area 2 is the first page of the gross margin analysis, see the example gross margin in Appendix 1. Area 4 is the Calender of Operations page of the gross margin. Area 5 is the Production Information page of the gross margin. Area 6 is the Capital Valuation page of the gross margin, this area also displays graphically the sheep numbers and feed demands of the flock. Area 7 is the Wool Production Information area of the gross margin. Arrows in Figure 1 show the general flow of data between areas.

The second spreadsheet is the input prices spreadsheet (INPUTS.XLS). The input prices spreadsheet can be viewed in Appendix 8. This input prices spreadsheet is a reference spreadsheet for the Sheep Cents spreadsheet template, it provides all the information on current chemical and other input prices. Unlike the controlling macro, every saved template spreadsheet is linked to the inputs spreadsheet. This is so that current input prices can be updated and the affects of this on the gross margin of individual sheep enterprises saved (in separate templates) determined. If historical input prices are required to calculate the economics of a specific sheep enterprise, the saved template spreadsheet can be linked to the input spreadsheet which can then be renamed and saved with historical prices.

Finally the controlling macro, SHEEP.XLM. This macro is the basis of the Sheep Cents model. It controls the order of operations in the two spreadsheets and dumps collected data into the correct area of the SHEEP.XLS spreadsheet template. It is an auto-execute macro, which means when opened it takes control of the Excel spreadsheet program and dictates what operations occur and the timing of these operations. All the input questions and their "Dialog boxes"[11] come from within the macrosheet, the information once entered and saved, automatically becomes the default vale until changed and re-saved by the operator.

Conclusion - Sheep Cents a Comprehensive Gross Margin Analysis System

Sheep Cents is a feed requirements gross margin analysis package. It was developed to facilitate the analysis of the effects of technical change in livestock production, and to provide a dynamic gross margin budgeting tool which can be used to analyse the economics of a large number of alternative sheep enterprises quickly and accurately.

Sheep Cents is similar to the traditional sheep gross margin budget in many ways however it has a number of unique features, the most significant of which is that it calculates the feed requirements of the sheep flock being analysed. This difference means the financial returns from the sheep enterprise can be specified in the traditional terms of gross margin (net returns) per sheep (or sheep flock) and also in terms of gross margin per DSE (unit of feed consumed), gross margin per operator labour hour and return on capital invested in livestock.

There are a number of novel reporting systems in Sheep Cents which allow a more accurate economic evaluation of the sheep enterprise, these are; a livestock trading account, a list of flock production assumptions, sheep flock structure, livestock capital inventory, calender of operations, veterinary products information, a catalogue of shearing, crutching and mulesing operations, a labour roster, comprehensive wool production information, pasture quality calender, grazing intensity calender, a list of ewe physiological status, and calculations of metabolisable energy allowances for all categories of sheep.

The justification for using this type of gross margin analysis, as opposed to the traditional analysis, is that the amount of feed used by the sheep flock and the timing of this feed usage obviously affects the amount and quality of pasture required by the flock. This directly affects the number of sheep which can be run on any given area of land and therefore the economics of livestock enterprises on the farm. A measure of gross margin per DSE for each sheep enterprise is vital to accurately assess the economic merit of alternative sheep enterprises because the amount of feed required by the enterprise then provides a common base on which to compare alternative net returns.

The ability of the Sheep Cents model to calculate the feed requirements of the operator specified sheep enterprise means that there is no longer a need to rely on assessing the relative merit of a particular sheep enterprise based solely on the gross margin per ewe (or sheep) or gross margin per enterprise. Most economists have assumed the DSE rating of various enterprise types are fixed or variable only at the extreme. For instance, a merino wether producing 20 micron wool had an assumed DSE rating of 1 (Fraser, 1991). Whereas one producing 22 micron wool had a rating of 1.1 DSE, a merino ewe and follower producing 22 micron wool had a rating of 2.1 DSE and a first cross spring lamb producing ewe also had a 2.1 DSE rating.

These assumptions provide no flexibility for calculating any variations in the assumed enterprise structure, the so-called "what-if" analysis. For example the merino ewe enterprise assumed to use 2.1 DSE sells all lambs at 2 months of age. If the lambs were held to 1.5 years of

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[11] A "Dialog Box" is the name given by the Excel program for information input prompts or "windows".

age, as is often the case, what would happen to the DSE rating? Until now it has usually been assumed to still be the same, or if any variation was considered it was some pro-rata increase. The reluctance to determine the actual feed demand from different sheep enterprises arose from the time consuming calculations needed to determine the new DSE rating. When you calculate the actual feed requirements of such a sheep enterprise, the DSE rating is almost 4.5, or 214 percent higher.

If this were applied to the gross margin per DSE which is the net return per unit of feed required, it represents over a 50 percent inaccuracy. Given the fact that most sheep enterprise budgets are used by farmers and/or their advisers in enterprise selection, this could lead to an inappropriate level of resource allocation.

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Sheep Cents - Sheep and Wool Financial Analysis.

Enterprise Name: Prime Lamb - Elite 120 % Lambing **Region:** Northwest NSW
Average No. of Adult Ewes: 968 **Date:** 4-Feb-93

A. Annual Income:

1. Shearing

	Class	Month	Kg/head	Net $/kg	Budget
990	BLM - 1st Cross ewes	January	4.50	3.59	$15,993.45
15	Dorset - Blue Dot rams	January	1	4.08	$61.20
15	Dorset - Blue Dot rams	July	1	4.08	$61.20
0	hoggets	not shorn	0.00	4.36	$0.00
0	lambs	not shorn	0.00	0.00	$0.00

2. Crutching

1005	BLM - 1st Cross ewes	July	0.45	1.20	$542.70
0	hoggets	not crutched	0	0.00	$0.00
1363	lambs	January	0.25	1.20	$408.90

3. Sheep Sales

595	wether lambs / hoggets	@ average price	$15.70	/lamb	$10,689.26
595	ewe lambs / hoggets	@ average price	$15.59	/lamb	$10,613.51
185	CFA ewes	@ average price	$13.26	/ewe	$2,452.23
4	CFA rams	@ average price	$6.63	/ram	$26.51
		A. Total Income			$40,848.96

B. Annual Operation Expenses:

1. Replacement stock

4	replacement rams @	$331.38	$1,325.53
215	replacement ewes @	$33.14	$7,124.73

2. Shearing / Crutching / Mulesing

Number	Class	Shorn/(Crutched)	1st Month	2nd Month	
990	BLM - 1st Cross ewes	$3.30 /head	January		$3,267.00
30	Dorset - Blue Dot rams	$5.00 /head	January, 1st shearing	July, 2nd shearing	$150.00
0	hoggets	$3.30 /head	not shorn		$0.00
0	lambs	$0.00 /head	not shorn		$0.00
1005	BLM - 1st Cross ewes	($1.00 /head)	July		$1,005.00
1363	Lambs	($1.00 /head)		January	$1,363.00
Number	**Class**	**Mulesed/(Marked)**	**1st Month**	**2nd Month**	
0	lambs	$0.35 /head	May	May	$0.00
1383	lambs	($0.21 /head)	September	Not Marked	$290.50

3. Husbandry Operations (total cost of operation - see Calendar of Operations for details)

Number of Operations	Operation	Product Used**	Ave. Cost/ Dose	Total Cost	
5352 Sheep	Drench	Ivomec	$0.25	$1,327.40	$1,327.40
2379 Sheep	Jetting	Topclip Blue	$0.06	$137.99	$137.99
1005 Sheep	Lice Control	Grenade - Dipping	$0.11	$113.34	$113.34
3763 Sheep	Vaccine	Glanvac 6 in 1	$0.14	$511.79	$511.79

4. Sale costs

a. slaughter levies	50.8 c for sheep &	100.8 c for lambs		$1,468.91
b. sale commission	4.50%	Stock and Station Agent's commission charged on sale sheep		$1,070.17
c. saleyard costs	1551 sale sheep @	$0.23 /head	saleyard charge	$356.73

5. Transport Costs: (Note that minimum transport costs often apply over short distances)

a. Wool	Wool is transported by	rail to market in:	Sydney - Yennora	
25 bales	$10.00	per bale		$250.00
b. Sale Sheep	4 decks/truck	@ 100 sheep per deck	4 truck/s	
40 kilometres	to market at	Tamworth	$2.30 /km/truck	$368.00

6. Miscellaneous Costs:

a. Shearing Sundries (wool packs etc):	$200.00 p.a.			$200.00
b. Supplementary Feed:	4797 kgs	Oats & Hay	$0.08 /kg	$383.75
	B. Total Operation Expenses:			$20,713.85

Gross Margin (A - B)	$20,135.11
Gross Margin/Sheep	$20.14
Gross Margin/Dry Sheep Equivalent	$7.63
Annual Return per DSE on Capital Invested in Livestock	48.41%
Gross Margin/Operator Labour Hour	$80.27

Notes:

The sheep flock's feed requirement in DSE's is 2671 (or 2.64 DSE/head*)
The sheep flock's capital investment is $42,105 (or $15.76 per DSE)
Sheep flock's total operator labour time is 251 hours
* DSE per head is calculated based on the number of ewes joined. 1 DSE = 3052 MJ of metabolisable energy
** Use of a particular brand name is not intended to indicate the recommendation of that brand.

Sheep Gross Margin Budgets - Production Information

Enterprise Name: Prime Lamb - Bills 120 % Lambing **Region:** Northwest NSW
Average No. of Adult Ewes: 968 **Date:** 4 Feb 93

1. Livestock Trading:

a: Sale Livestock

Number	Class	Month Sold	Weight (kg)	Price ($/kg)	Price ($/head)	Age (weeks) or years
397	S. male lambs 1	January	35	$0.40	$14.16	(16)
198	T. male lambs 1	February	35	$0.49	$16.99	(24)
0	S. male lambs 2	December	0	$0.00	$0.00	(0)
0	T. male lambs 2	December	0	$0.00	$0.00	(0)
397	S. ewe lambs 1	January	35	$0.49	$16.99	(20)
198	T. ewe lambs 1	March	35	$0.41	$14.41	(28)
0	S. ewe lambs 2	December	0	$0.00	$0.00	(0)
0	T. ewe lambs 2	December	0	$0.00	$0.00	(0)
185	cfa ewes	January	60	NA	$13.26	6
4	cfa rams	January	80	NA	$6.63	5

b: Purchase Livestock

Number	Replacement Class	Month Purchased	Weight (kg)	Price ($/kg)	Price ($/head)	Age (months) or years
4	Dorest - Blue Dot	August	80	NA	$331.38	1.3
215	BLM - 1st Cross		45	NA	$33.14	(16)

2. Flock Production Information:

Target flock size (number of adult sheep +- 2%)		1000
Average body weight of mature sheep (kgs)		60
Average lambing rate		137%
Average weaning weight	- male lambs (kgs)	28.7 kgs
	- female lambs (kgs)	23.8 kgs
Average weaning age	- lambs (in weeks)	14
Mortality rate	- adult sheep (per annum)	3.00%
	- hoggets (per annum)	0.00%
	- lambs	2.00%
Rams	- as a percentage of ewes	2%
Ewe hoggets	- age first joined (months)	16
Ewes	- month first joined	April
Ewes	- age when culled (years)	6
Replacement Strategy	- purchase replacements	

3. Flock Structure:

Sheep Age (years)	Sheep No.s at Main Joining	Lambs	Weaners	Flock Output	Sold at ave. Age
1.3	215				
2	209		681 ewe lambs	215 replacement	ewes purchased
3	202				
4	196	1390 lambs		681 ewe lambs	@ 24 weeks old
5	190				
6	185		681 male lambs	681 male lambs	@ 20 weeks old
				185 cfa sheep	@ 6 years old
				4 Sale Rams	@ 5 years old

Sheep Enterprise Budgets - Calendar of Operations:

Month	Drenching	Jetting	Lice Control	Vaccination	Crutching	Shearing	Mulesing	Marking
January	all sheep		adult sheep	lambs	lambs	adult sheep		
February	lambs							
March								
April								
May							lambs	
June								
July					adult sheep			
August	adult sheep			all sheep				
September				lambs				lambs
October	adult sheep							
November		all sheep						
December								

1. Veterinary Products Information:

Operation	Product Name	50 kgs $/sheep	Dosage Base per
Drench	Ivomec	$0.2656	45
Jetting	Topclip Blue	$0.0580	head
Lice Control	Grenade - Dipping	$0.1128	head
Vaccine	Glanvac 6 in 1	$0.1360	head

2. Shearing

Number	Class	Month	Kg/head	$/kg
990	BLM - 1st Cross ewes	January	4.5	$3.59
15	Dorset - Blue Dot	January	1	$4.08
15	Dorset - Blue Dot	July	1	$4.08
0	Hoggets	January	0	$4.36
0	Lambs		0	$0.00

3. Crutching

Number	Class	Month	Kg/head	$/kg
1005	BLM - 1st Cross ewes	July	0.45	$1.20
0	Hoggets	July	0	$0.00
1363	Lambs	January	0.25	$1.20

4. Mulesing

Number	Class	Mulesed
0	Lambs	May
0	Lambs	May

5. Marking

Number	Class	Marking	Cost per lamb	Cost
1383	Lambs	September	$0.21	$290.50
0	Lambs	Not Marked	$0.21	$0.00
			Total Cost	$290.50

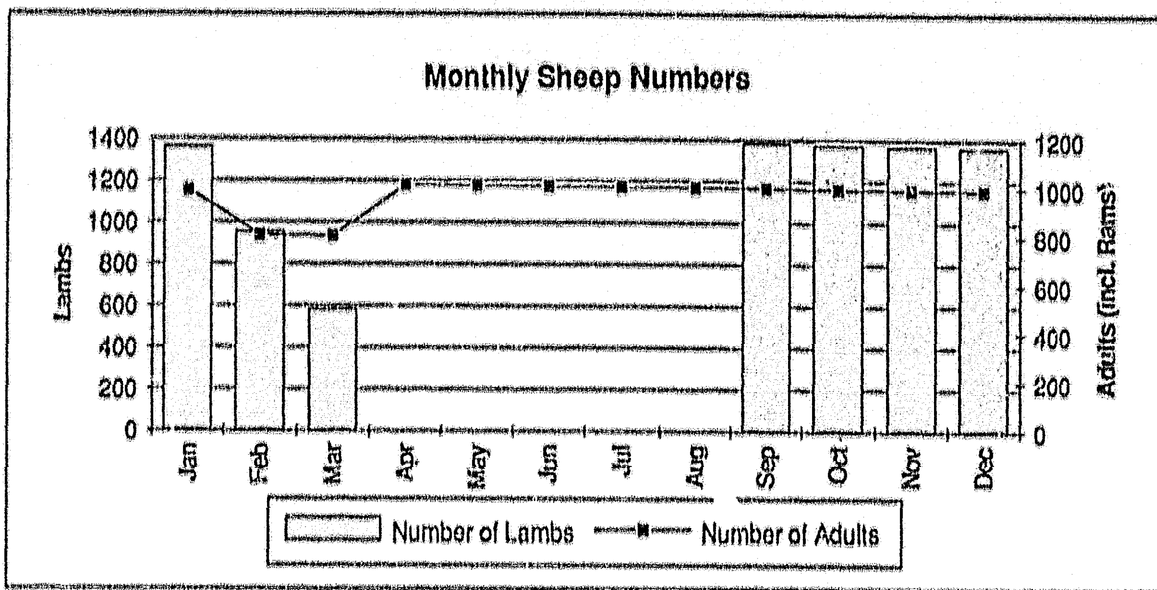
6. Labour Times

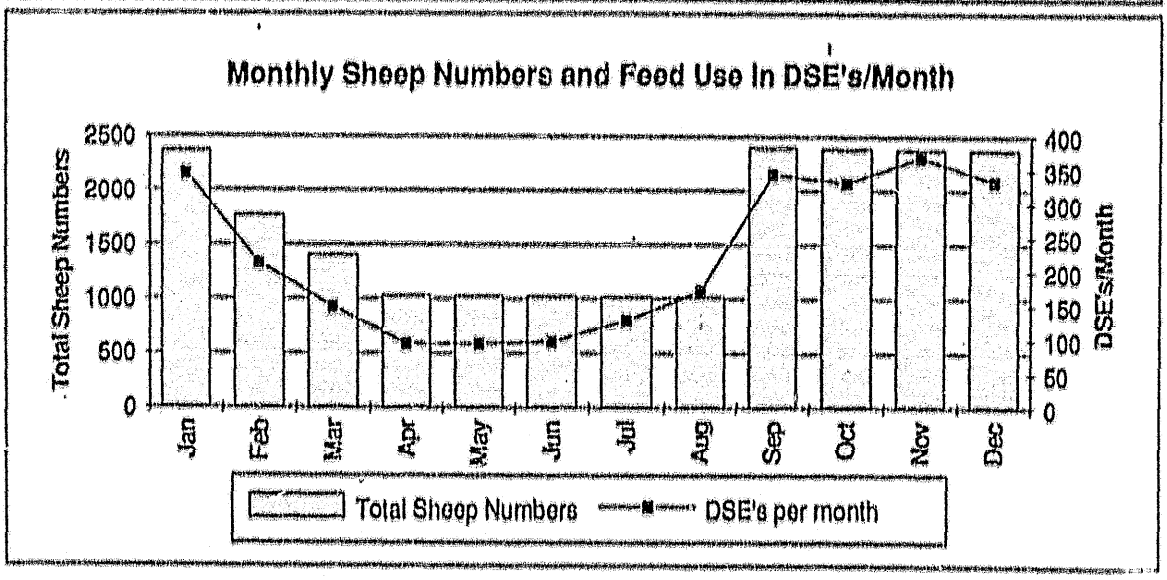
Operation	Labour Times (hrs/1000)	Sheep No.s	Op. Labour (Hr/Operation)
Drench	6	5352	32
Jetting	8	2379	19
Lice Control	6	1005	6
Vaccine	7.3	3763	27
Shearing	16	1005	16
Crutching	8	2382	19
Mulesing	8	0	0
Marking	8	1383	11
Supervision	Hours/Year		
Joining	10	1000	10
Lambing	10	1000	10
Water	50	1000	50
Pasture	50	1000	50
0	0	1000	0
		Total Hours	250.84

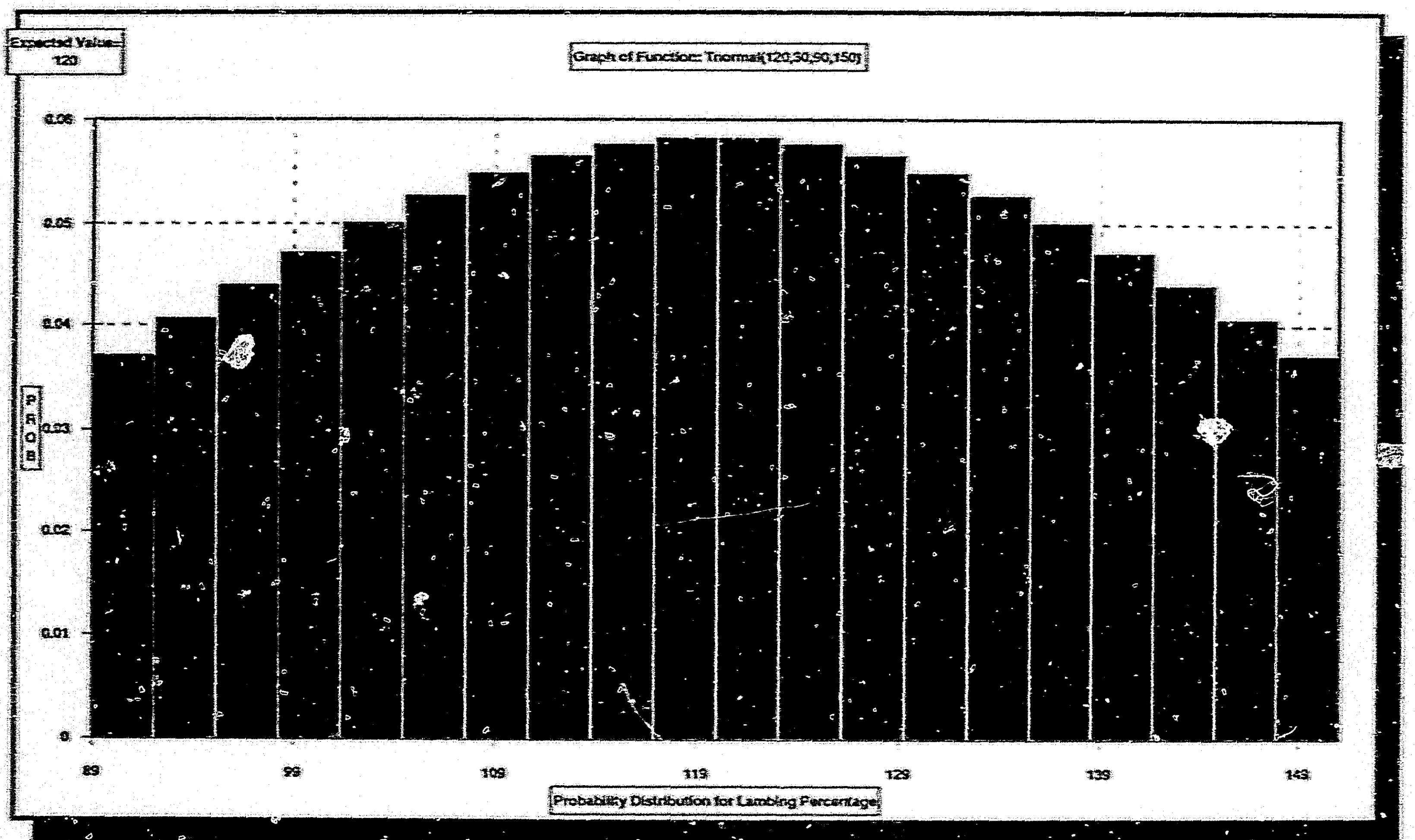
4. Capital Inventory:

Valuation made in: December

Number	Sheep Class	Sheep Age	$/Head	Total
211	repl. ewes	1.5 yrs old	$20.00	$4,220
204	ewes	2 yrs old	$15.00	$3,060
198	ewes	3 yrs old	$15.00	$2,970
192	ewes	4 yrs old	$10.00	$1,920
187	ewes	5 yrs old	$8.00	$1,496
185	ewes	6 yrs old	$5.00	$923
			$0.00	
			$0.00	
			$0.00	
15	rams	2 to 5 years	$200.00	$3,000
681	male lambs	from 0 to 24 weeks	$16.00	$10,896
681	female lambs	from 0 to 28 weeks	$20.00	$13,620
Total Capital Value invested in enterprise				$42,105



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PROB
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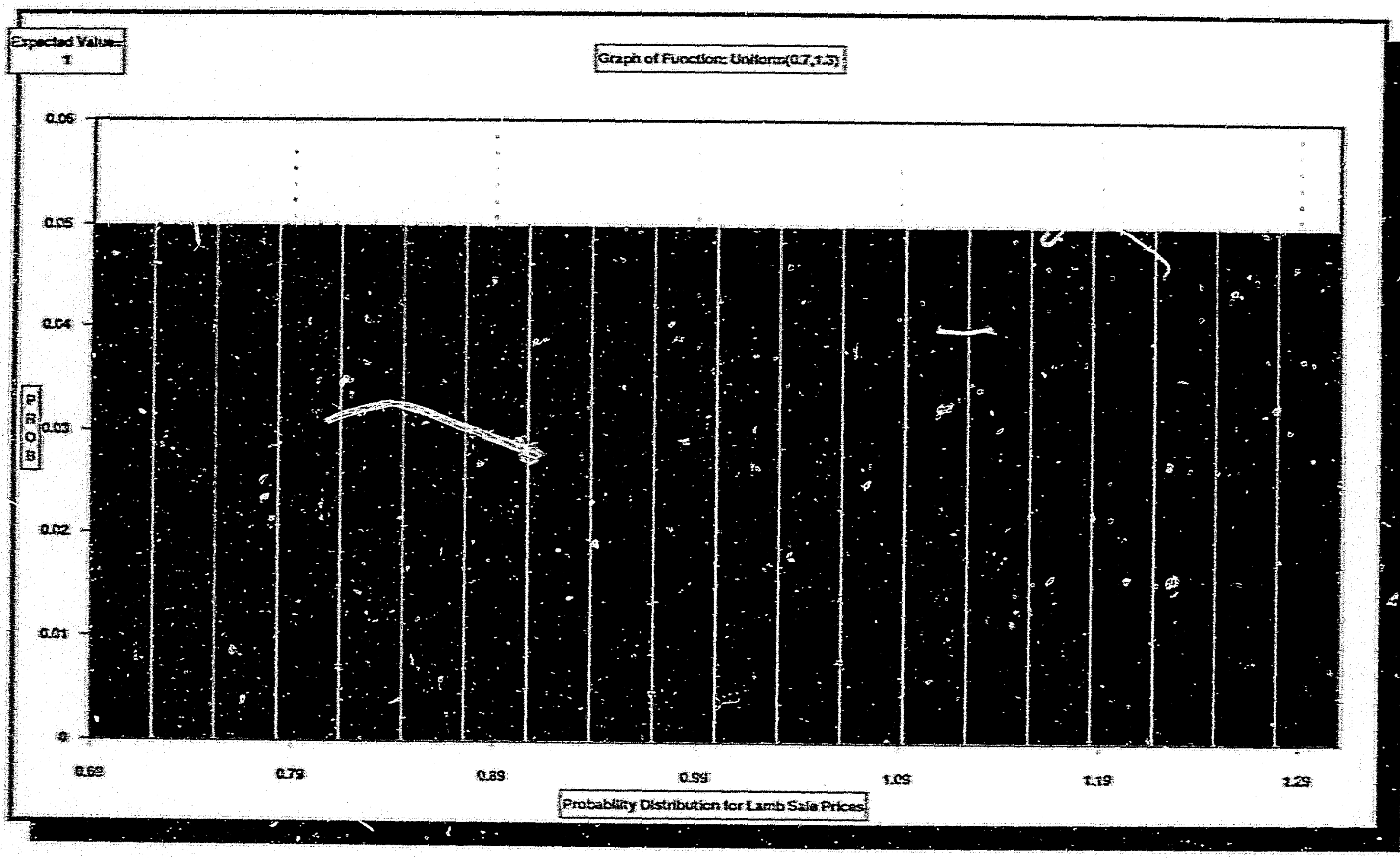
0.05
0.04
0.03
0.02
0.01
0
89
99
109
119
129
139
143
Probability Distribution for Lambing Percentage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Graph of Function: Uniform(0.7,1.3)
P R O B
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0.05
0.04
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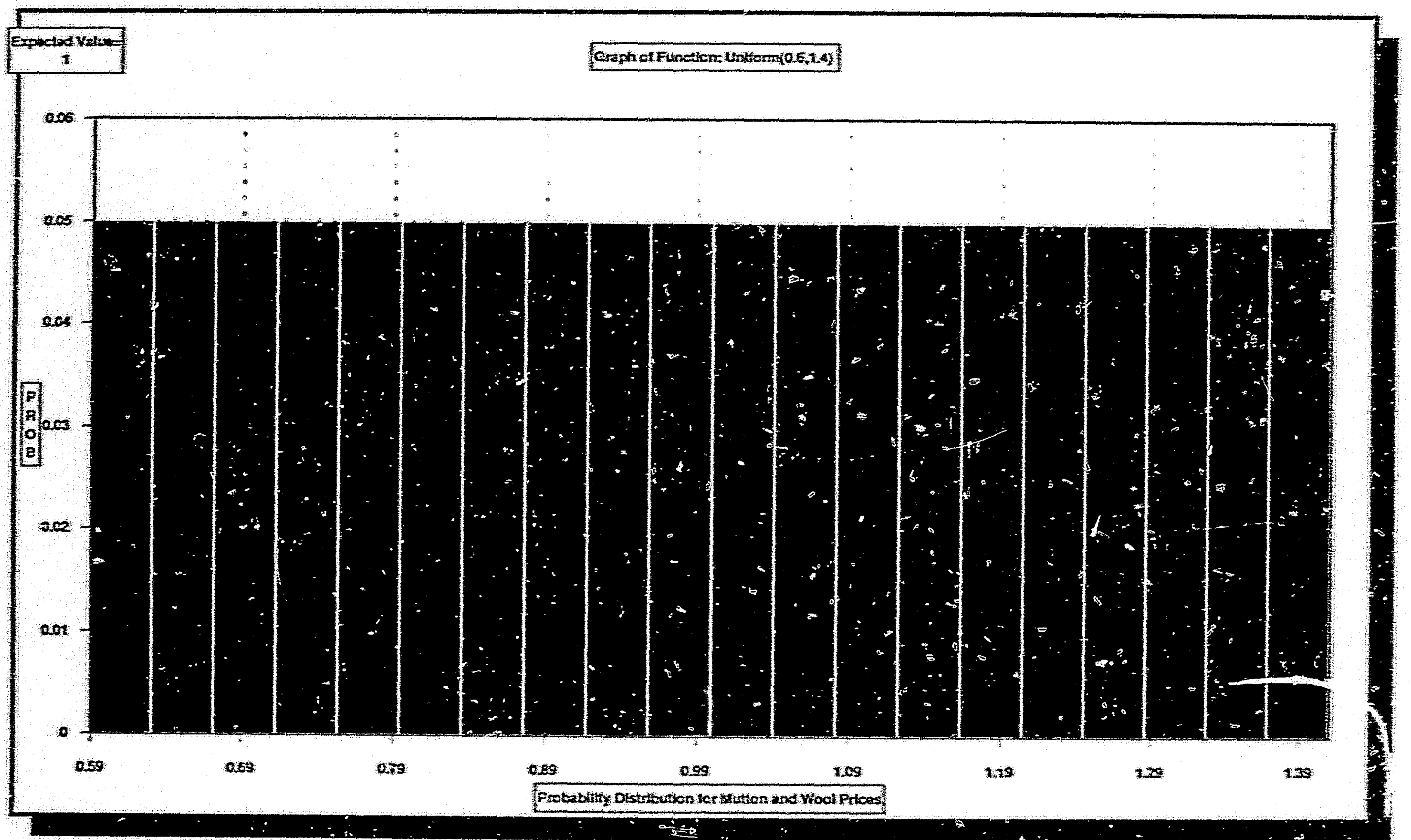
0.99
1.09
1.19
1.29
Probability Distribution for Lamb Sale Prices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0.05
0.04
0.03
0.02
0.01
0
PROB
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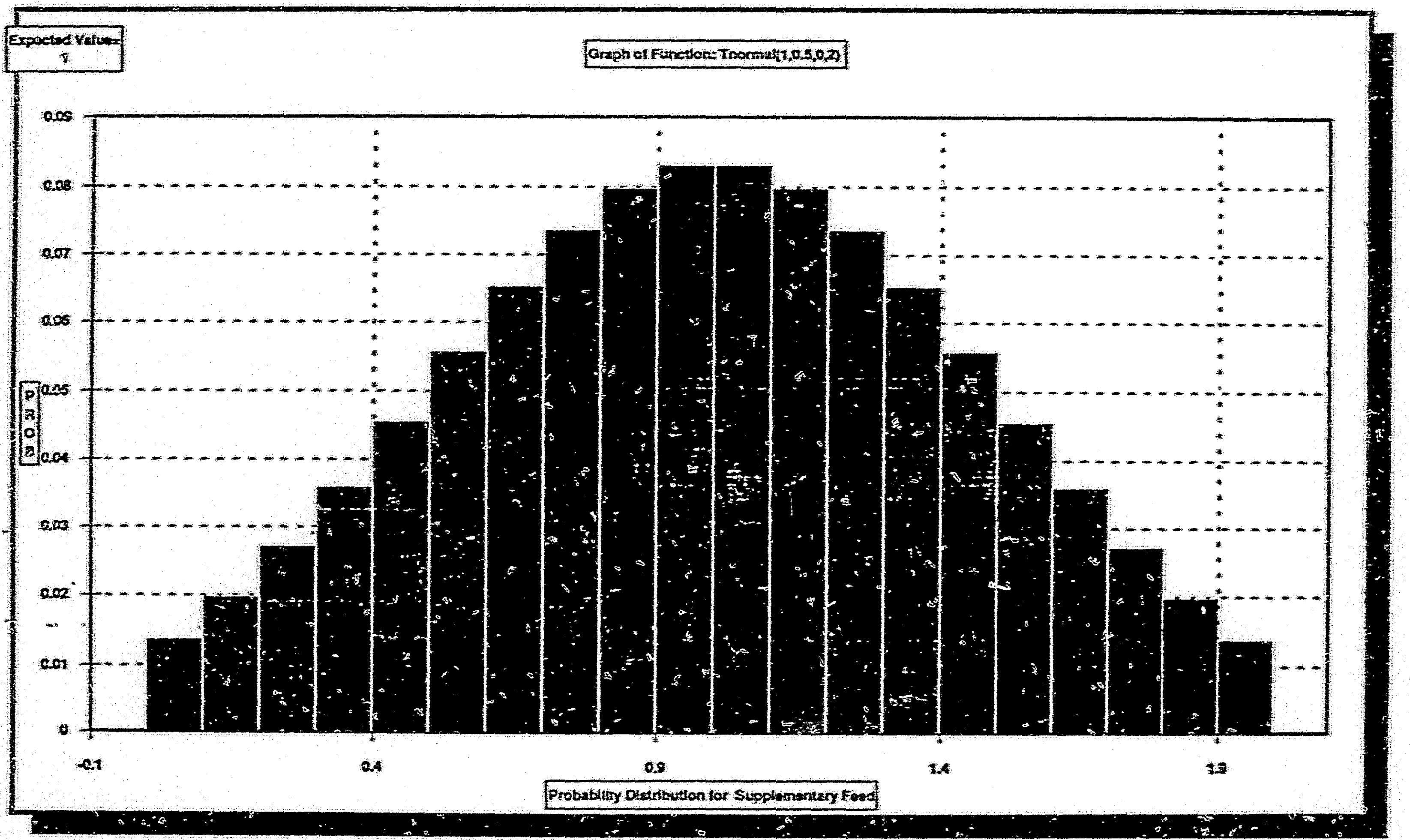
1.09
1.19
1.29
1.39
Probability Distribution for Mutton and Wool Prices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0.07
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0.05
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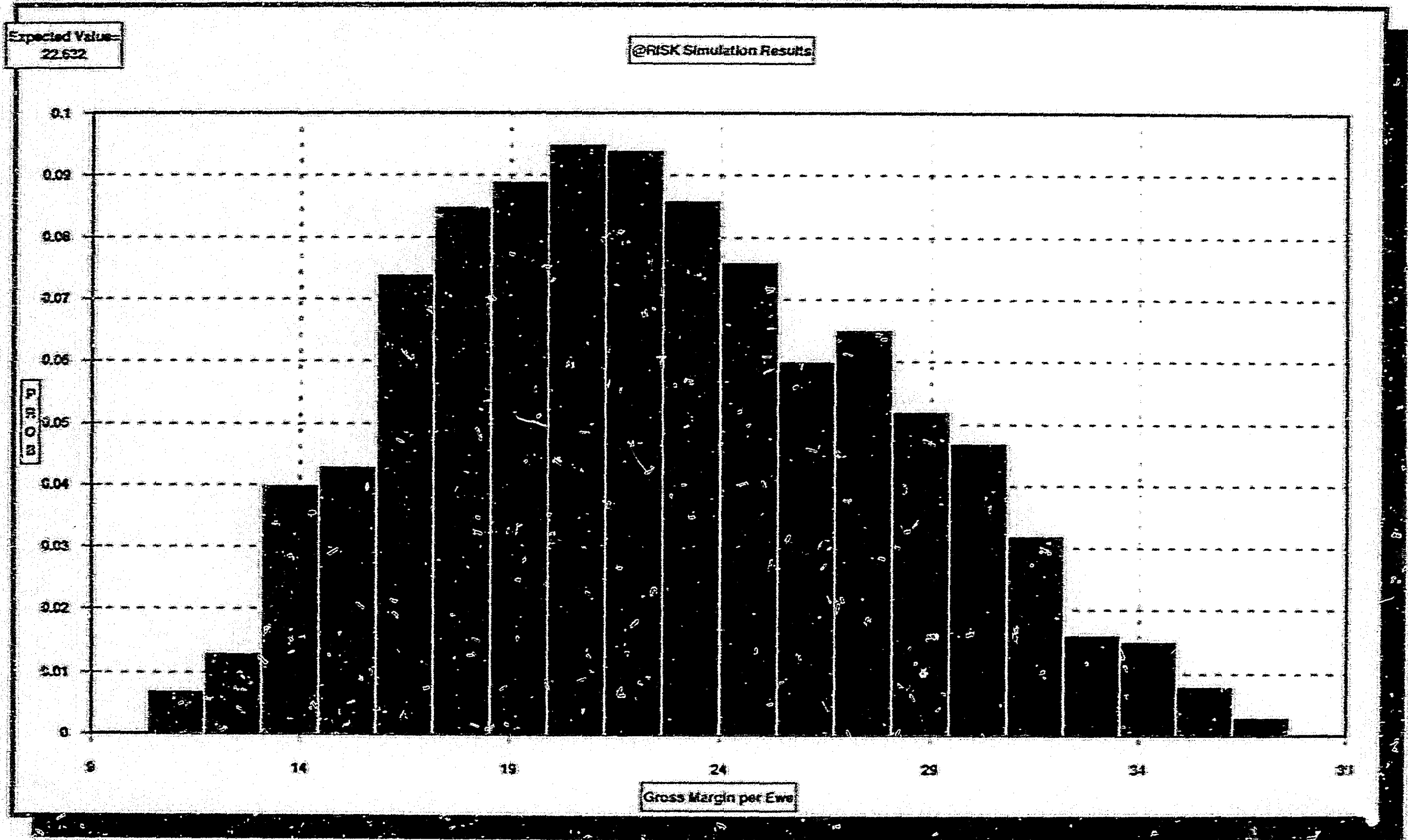
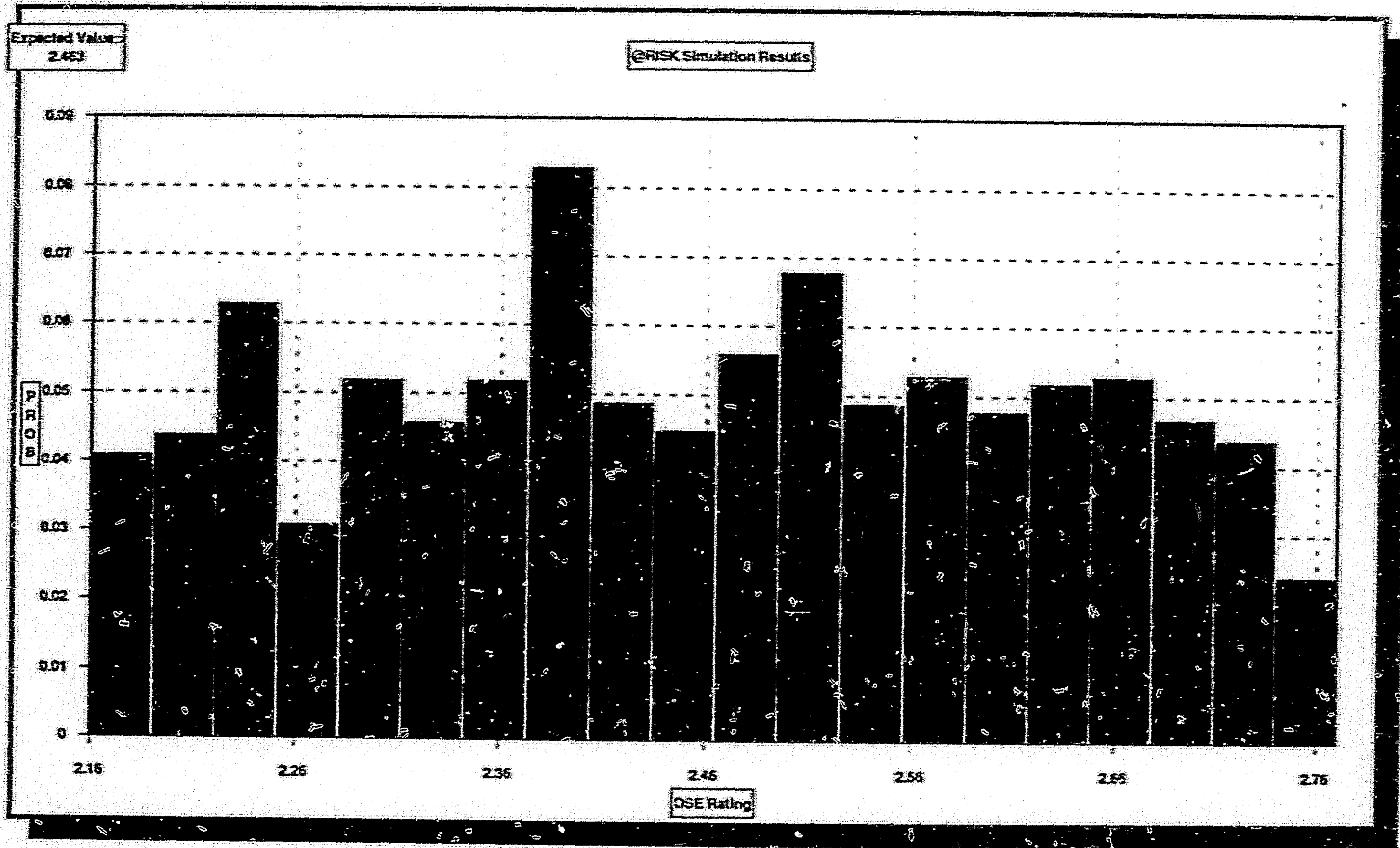
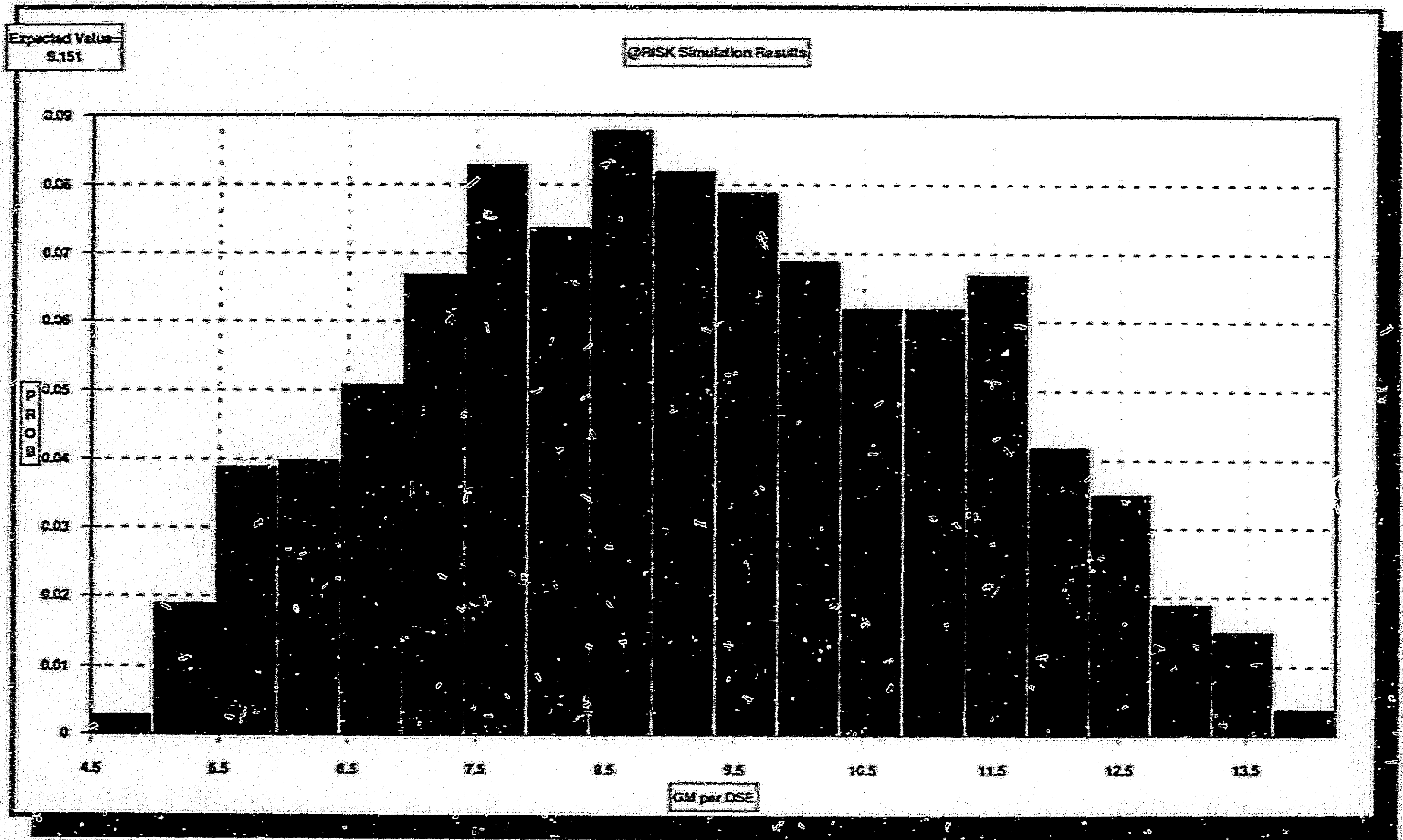
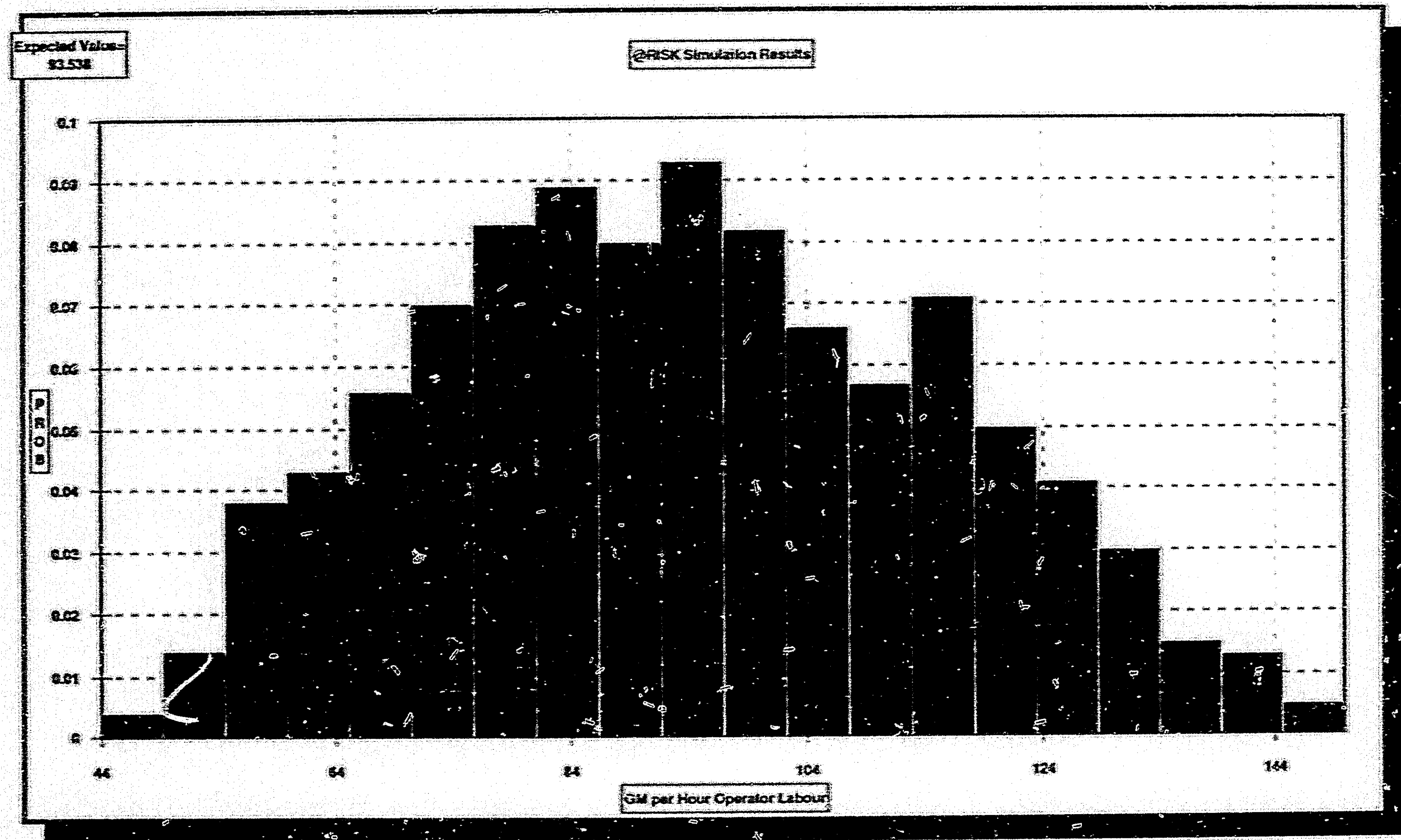
0.02
0.01
0
PROB
-0.1
0.4
0.9
1.4
1.9
Probability Distribution for Supplementary Feed

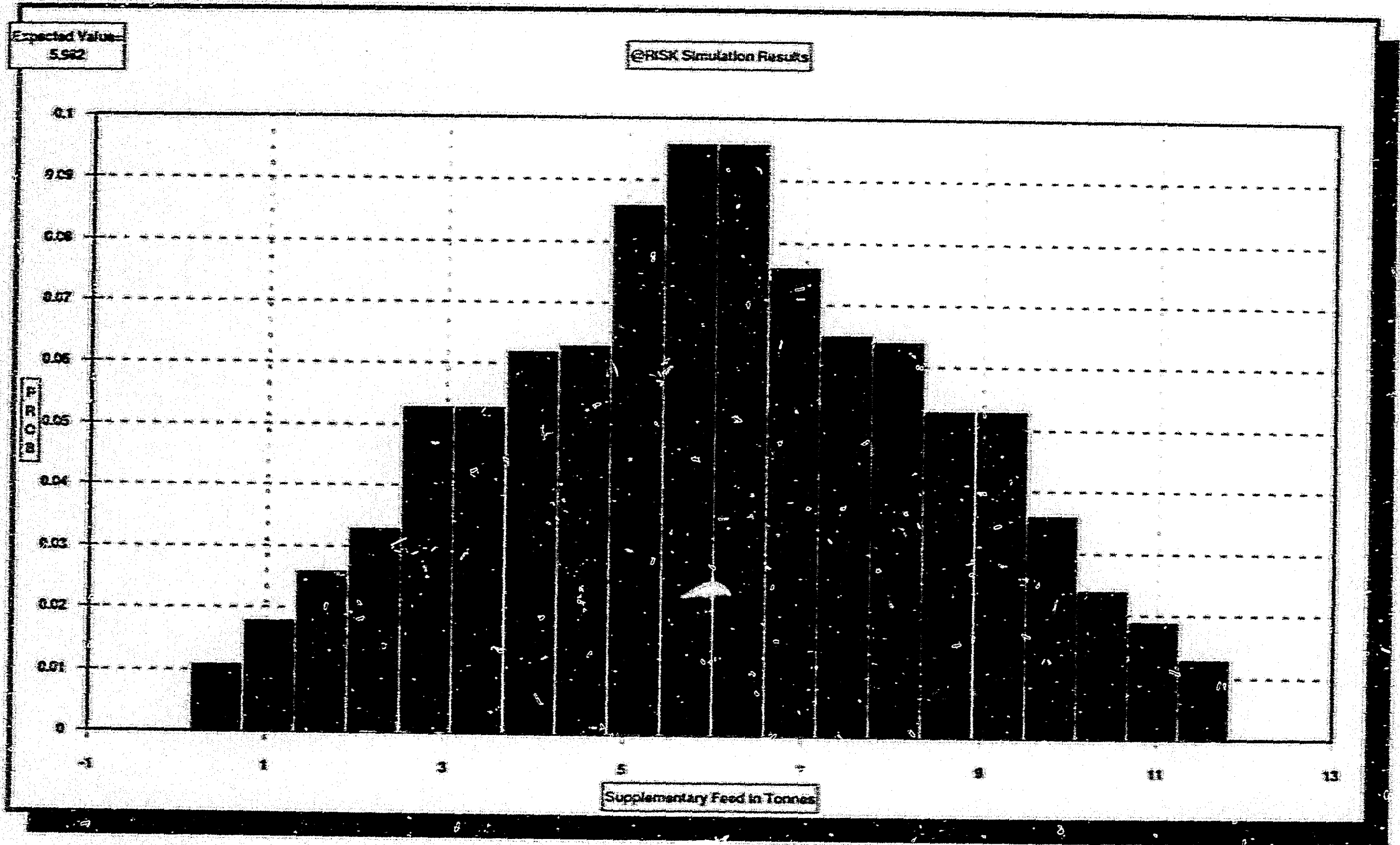

Expected Value=
22.632
@RISK Simulation Results
P
R
O
B
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
9
14
19
24
29
34
39
Gross Margin per Ewe

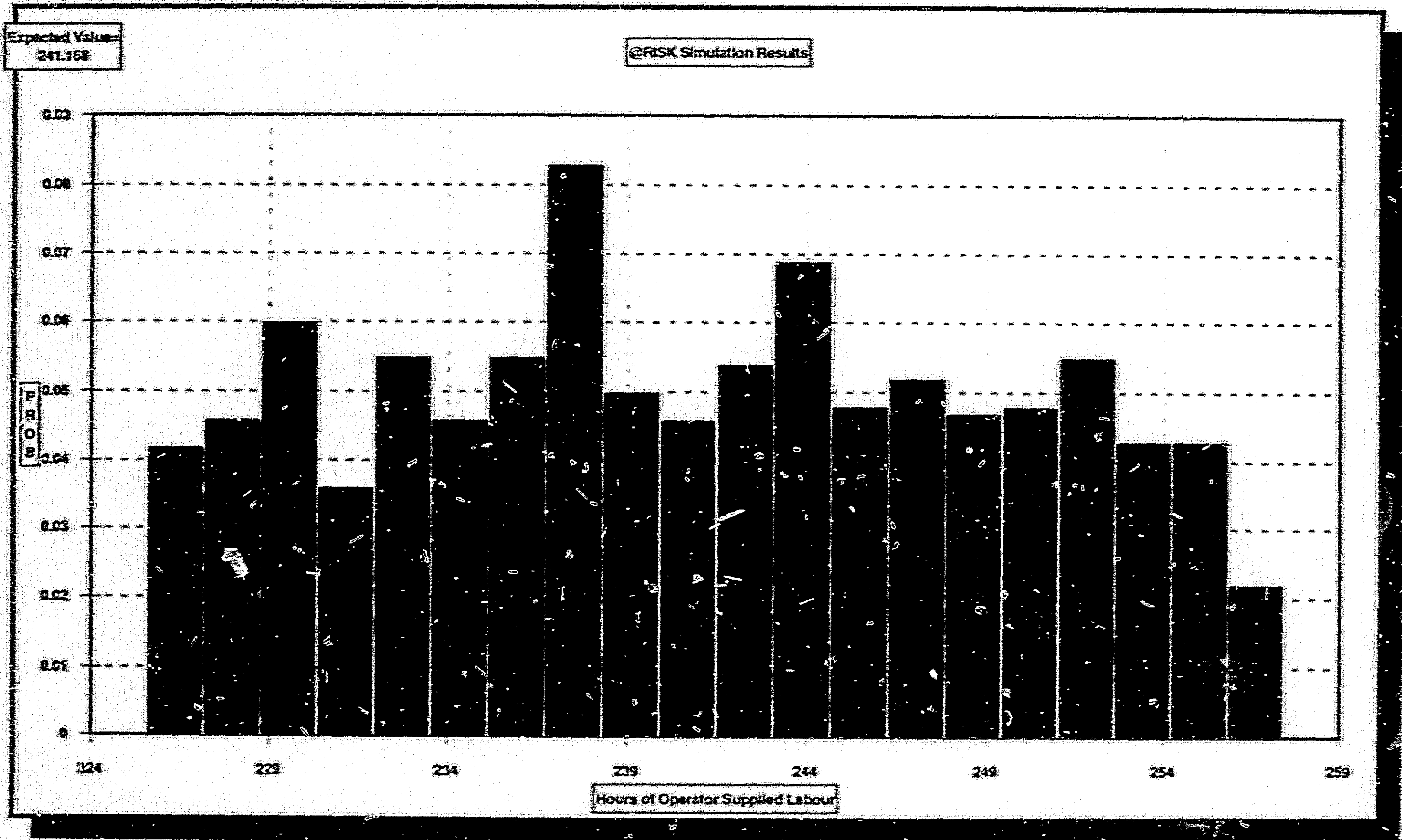


Expected Value= 2.463
@RISK Simulation Results
P R O B
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
2.16
2.26
2.36
2.46
2.56
2.66
2.76
DSE Rating


Expected Value=
9.151
@RISK Simulation Results
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
PROB
4.5
5.5
6.5
7.5
8.5
9.5
10.5
11.5
12.5
13.5
GM per DSE


Expected Value=
93.538
@RISK Simulation Results
P
R
O
B
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
44
64
84
104
124
144
GM per Hour Operator Labour


Expected Value= 5.982
@RISK Simulation Results
P R O B
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-1
1
3
5
7
9
11
13
Supplementary Feed in Tonnes



Expected Value=
241.158
@RISK Simulation Results
PROB
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
229
234
239
244
249
254
259
Hours of Operator Supplied Labour