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DOUBLE SUCKLING IN
BEEF x DAIRY ONCE-BRED HEIFERS

A thesis presented in partial fulfilment of the requirements for the degree
of
Master of Agricultural Science in Animal Science
at
Massey University, Palmerston North, New Zealand

JORGE LUIS NORICUMBO-SAENZ
1995
Double suckling beef production systems are a strategy to increase annual output of suckled beef cows. This study compared the effect of single and double suckling on the performance of dams and their calves on pasture with an average sward surface height of 11.5 cm.

Thirty eight spring-calving, 2-year old Hereford x Friesian (H x F) and Hereford x Jersey (H x J) heifers mated to Angus sires were randomly allocated to either single or twin rearing treatments as they were calving. Nineteen Friesian male calves were used as foster calves for the twin rearing treatment. Individual calf 90-day weaning liveweight gain (adjusted) and liveweight gain from weaning to 11 months of age were recorded. Individual heifer liveweight changes from calving to weaning, and weaning to slaughter were recorded. Heifer productivity was estimated as kilograms of weaner calf produced per heifer present at weaning. Heifer efficiency was estimated as the ratio of heifer productivity to average liveweight of the heifer from calving to weaning. Results are presented as least square means ± standard error (LSM ± SE).

Calf daily liveweight gains were 1.00 ± 0.02, 0.90 ± 0.03, 0.70 ± 0.03 kg/hd \((P < 0.05)\) for single calves, heifers' own twin reared calves and twin reared foster calves respectively. At weaning, heifers' own twin reared calves were 8.1 kg lighter than single reared calves \((P < 0.05)\). From weaning to 11 months of age, heifers' own twin reared calves had greater daily liveweight gains \((0.50 ± 0.02 \text{ kg/hd}, P < 0.01)\) than single reared calves \((0.44 ± 0.02 \text{ kg/hd}, P < 0.01)\) and tended to be heavier \((244.12 ± 4.8 \text{ versus } 236 ± 5.3 \text{ kg})\).

Double suckling did not affect heifer daily liveweight gain from calving to weaning \((0.7 ± 0.05 \text{ and } 0.6 ± 0.04 \text{ kg/hd} \text{ for single and double suckled } H \times F \text{ heifers respectively, and } 0.3 ± 0.06 \text{ and } 0.3 ± 0.06 \text{ kg/hd} \text{ for single and double suckled } H \times J \text{ heifers, respectively})\) or from weaning to slaughter \((0.3 ± 0.05 \text{ and } 0.3 ± 0.05 \text{ kg/hd})\).
0.3 ± 0.04 kg/hd for single and double suckled H x F heifers respectively, and 0.2 ± 0.06 and 0.3 ± 0.06 kg/hd for single and double suckled H x J heifers, respectively).

Double suckled H x F and H x J heifers were 44.7 and 55.5 % more productive (P < 0.05) than single suckled H x F and H x J heifers respectively. Double suckled H x F heifers were 45.1 % more efficient than single suckled H x F heifers (P < 0.05) and double suckled H x J heifers were 58.1 % more efficient than single suckled H x J heifers.

It was concluded that although twin reared calves were 8.1 kg lighter than single reared calves at weaning, twin reared calves were able to surpass these liveweight differences through compensatory liveweight gain after weaning. Therefore, heifer productivity and efficiency can be significantly enhanced through the use of foster calves in double suckling beef production systems.

**Keywords** once-bred heifers; double suckling; foster calves; liveweight gain; cow productivity.
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<tr>
<td>BCS</td>
<td>body condition score</td>
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<tr>
<td>CL</td>
<td>corpus luteum</td>
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<tr>
<td>FSH</td>
<td>follicle stimulating hormone</td>
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<tr>
<td>hd</td>
<td>head</td>
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<tr>
<td>LSM</td>
<td>least square means</td>
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<tr>
<td>OBH</td>
<td>once-bred heifers</td>
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<tr>
<td>OM</td>
<td>organic matter</td>
</tr>
<tr>
<td>PPAI</td>
<td>postpartum anoestrus interval</td>
</tr>
<tr>
<td>R1 yr</td>
<td>rising one year</td>
</tr>
<tr>
<td>R2 yr</td>
<td>rising two years</td>
</tr>
<tr>
<td>SE</td>
<td>standard error</td>
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<tr>
<td>su</td>
<td>stock unit</td>
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CHAPTER ONE

INTRODUCTION

PREAMBLE AND BACKGROUND TO THE STUDY

In New Zealand approximately 300,000 heifers are slaughtered annually for beef production. These heifers could potentially rear a calf before slaughter (Morris et al. 1992b). Furthermore, in traditional breeding cow systems 70% of the food consumed goes towards the maintenance of the cow, her calf and her replacement (Morris et al. 1991). Hence, there is an opportunity to make pastoral beef cow systems more efficient.

Once-bred heifer (OBH) beef production systems involve mating heifers at 15 months of age to calve at two years of age. The system can be operated in different ways ranging from the simplest, whereby heifers produce a calf and are slaughtered at or soon after calving, to more complex systems involving suckling periods of up to six months. In all the systems, to meet New Zealand carcass classification requirements, the once-bred heifer must be slaughtered before no more than six permanent incisors teeth have erupted (usually at 30 - 36 months of age).

Although it has been shown that the meat quality and taste of calved and non calved heifers is similar (Keane 1988; Sreenan and Diskin 1988), in the European Union the main reason for farmer reluctance to adopt the OBH systems is the price differential between maiden and calved heifer beef (Keane 1988; Sreenan and Diskin 1988). In New Zealand, however, the OBH meat will grade as heifer beef in both the export and the local New Zealand grading systems (Morris et al. 1991), which is favourable from the farmers' viewpoint.

If the objective is to develop a highly profitable OBH beef production system, alternative options to the traditional system have to be evaluated. By utilising the genetic potential of the Beef-Dairy cross heifers, which are commonly used in OBH systems, it is possible to foster an extra calf to such heifers and
hence profits would increase and approach those of the more profitable bull beef production systems. In New Zealand a typical OBH system was calculated as the second most profitable beef system after bull beef systems (Parker 1994). Furthermore, in a OBH system, early weaning offers the advantage of increased flexibility for grazing management and selling times for calves and heifers (Khadem 1994).

There are however, some unresolved issues that must be considered within OBH systems. Compared to other beef production systems (e.g. maiden heifers and steer systems) OBH systems usually require more area for grazing (Keane 1988). Lactating OBH’s consume more herbage organic matter (OM) than unbred heifers (11.36 vs 9.19 kg OM/hd/day $P < 0.05$) (Khadem et al. 1993). Thus a careful assessment of management skills and feed availability are required to make a OBH system succeed, especially if double suckling is going to be established.

This chapter reviews the literature on these subjects and develops a rationale for the research chapter that follows.

WAYS OF OBTAINING COWS REARING TWO CALVES

The suckled beef cow has a low reproductive performance in comparison with other farmed meat producing species. The natural fertility of a suckled cow is the production of one calf per year. If annual cow output can be increased by rearing an additional calf the productivity of this cow can be markedly increased. Both fostering of alien calves onto beef or Dairy-Beef crossbred cows (multiple suckling) and twin calving have been studied as means of increasing beef cow productivity. Twinning offers the opportunity to increase the number of calves weaned and thereby increase the total weight of calf weaned per cow. Furthermore, some results have suggested that costs per unit of beef output could be reduced 20 to 30% for that proportion of a herd producing twins instead of single calves (Dickerson et al. 1988). There are, however, other methods of obtaining cows rearing more than one calf during a productive cycle. These
methods range from the principles of genetic selection to the sophisticated embryo transfer technology.

**Genetic selection**

Genetic selection is an option to induce twinning in cattle. Twin ovulation rates tend to increase as cow age increases up to approximately 8 years (Morris et al. 1992a). The use of ovulation rates should permit effective indirect selection for twinning rate among yearling heifers based on individual performance, and among young sires based on ovulation rates of siblings and daughters (Echternkamp et al. 1990). In New Zealand, from a herd of cows selected for a history of at least two sets of twin calves, only 9.7% calved twins again within a four year period (1983 - 1987). The figures were even lower (3.3%) for the daughters of these cows (Morris and Day 1990b).

Reports from New Zealand have shown that when cows have been selected for a history of twinning, less than 45% of cows with more than one set of twins double ovulate each year and from those only 41 - 44% actually calved twins (Morris et al. 1992a). Three private dairy herds with a reputation of having a considerably higher average twinning frequency than normal for New Zealand dairy herds, recorded a proportion of double ovulations of 0.08, 0.27 and 0.50 for three groups that had previously produced 0, 1 or > 1 sets of twins, respectively. Nevertheless, the proportion of cows that actually calved twins ranged from 0.10 to 0.23 for cows from dams calving no twins or calving at least two sets of twins (Morris and Day 1990a). These results and research results from other countries indicate that twinning in cattle is a trait with low repeatability and heritability (Echternkamp et al. 1990; Gregory et al. 1990a; Morris and Day 1990b; Piper and Bindon 1990; de Rose and Wilton 1991), which makes genetic selection rather infeasible for farmers primarily because it is not feasible for beef producers to retain all females for several parities to observe differences in twinning rates (Davis and Bishop 1992).
Induced twinning

A method that can be used to increase the production of weaned calves from beef herds is induced twinning (Bellows et al. 1974; Kay et al. 1976; McMillan et al. 1993b). However, to actually produce twins, techniques such as super ovulation together with artificial insemination, or embryo transfer are required. For induced twinning to have a major impact on the beef industry, the frequency of twinning must be greater than naturally occurring twinning levels. Moreover, successful application of twinning technology would require improved management and a clear demonstration of the profitability of twinning under local conditions (Cummins, 1992).

Hormonal induction of twinning

The most common method to induce multiple ovulations in cattle is through the use of follicle stimulating hormone (FSH) followed by prostaglandin injection (Calder and Rajamahendran 1992; Rajamahendran and Calder 1993). Recent studies have concentrated on testing methods that are less expensive than earlier endeavours to induce twinning in cattle. The method with the most potential consists of the use of a vaccine against the protein hormone Inhibin, which is a natural peptide produced by the ovary and which acts on the pituitary to keep FSH secretion under control (Morris et al. 1993b). The interesting characteristic of this method is that ovulation rates remain elevated for more than one oestrus cycle (Piper and Bindon 1990). Furthermore, there are reports in which 60% (3 out of 5) heifers calved twins after immunization against inhibin (Morris et al. 1993b).

Although it has been shown that pregnancy rates may be higher in multiple than in single ovulating cows, not all the cows that ovulate more than one egg give birth to more than one calf (Echtemkamp et al. 1990). Furthermore, when attempting to transfer twinning techniques to the commercial farm level, there are
some aspects that need to be taken into account. For example, when using superovulation to induce twin births, a high success rate (more than 30% of multiple births) is required to offset the costs of synchronisation, FSH injections and the additional management costs of rearing calves arising from multiple births (Bindon and Hillard 1992). However, with hormonal treatments intending to produce multiple ovulation, individual variation in response to treatment remains a problem with many cows producing only one calf and others producing three or four rather than the desired two calves (Davis and Bishop 1992).

Furthermore, there are several reports highlighting the negative effects of twin calvings such as reduced calf size at birth, longer postpartum anoestrus interval (PPAI), increased mortality, higher percentage of dystocia and more retained placentas. These problems are accentuated when twin bearing cows are managed as single bearing cows (Bellows et al. 1974; Kay et al. 1976; Reid et al. 1986; Diskin et al. 1987; Dickerson et al. 1988; de Rose and Wilton 1988; Davis et al. 1989; Gregory et al. 1990b; Guerra-Martinez et al. 1990; Davis and Bishop 1992). Problems such as lower birth weight of the calves, due to shorter gestation length, placental retention and delayed re-breeding, may be overcome by improved nutritional management of the twinning cow during pregnancy and lactation (Kay et al. 1976; de Rose and Wilton 1988; Gregory et al. 1990b).

**Embryo transfer**

Embryo transfer can be carried out either surgically or non-surgically (Diskin and Sreenan 1984; McCutcheon et al. 1991; Hafez 1993; McMillan et al. 1993b; Patterson et al. 1993). Embryo transfer has been reported to be more effective at producing twin births than mild superovulation in cattle (Rowson et al. 1971; Anderson 1978).

Two main methods exist for the production of twins in cattle through the use of embryo transfer. One embraces the transfer of a pair of embryos whereby both embryos are placed simultaneously into the reproductive tract of an unmated cow. The two embryos can be placed either in one uterine horn or one embryo in each uterine horn (Rowson et al. 1971; Anderson 1978; Patterson et al. 1993).
The second method involves the placement of one embryo into one uterine horn (either ipsilateral or contralateral to the CL) of a recipient cow that conceived a few days earlier (usually seven days earlier) (Rowson et al. 1971; Anderson 1978; Diskin and Sreenan 1984; Diskin et al. 1991; McCutcheon et al. 1991; McMillan et al. 1993b; Patterson et al. 1993). Placement of embryos into the uterine horn either contralateral or ipsilateral to the ovary with the CL has not made any significant difference to twin calving rates (McMillan et al. 1993b; Patterson et al. 1993).

The proportion of a herd that produces twins following embryo transfer largely depends on the inherent level of fertility within the herd (Diskin and Sreenan 1984). Cows used in embryo transfer (ET) experiments, have widely variable twinning rates (Dickerson et al. 1988; Davis et al. 1989; Cummins et al. 1992; McMillan et al. 1993b). Furthermore, it is suggested that large numbers of embryos may need to be transferred in order to obtain sizeable numbers of twin sets (Davis et al. 1989). The low twinning percentage has sometimes been blamed on the fact that recipient cows were lactating (Davis et al. 1989). Nevertheless, if the optimum average herd postpartum anoestrus period lies between 60 and 70 days (Pleasants et al. 1991), then lactation must not be a restriction to achieving high pregnancy rates under commercial farming systems.

Successful embryo transfer depends on several factors including superovulation, oestrus detection in the donor and recipients, insemination of the donor, recovery of embryos, short- and long-term storage of embryos, embryo transfer, proper management of the recipient through parturition and successful rearing progeny until sale (Diskin and Sreenan 1984; Hafez 1993). Success rates of the embryos surviving to term following embryo transfer into recipient cows have seldom been as high as 80% (Hafez 1993). Moreover, although the highest pregnancy rates in cattle through the use of embryo transfer have been obtained when one embryo is transplanted into each uterine horn of the recipient cow (Hafez 1993), the outcome of those pregnancies do not always result in twin births (Rowson et al. 1971; McCutcheon et al. 1991; Hafez 1993; Patterson et al. 1993).
Although a wide variety of breeds have been used in embryo transfer experiments, the most common causes of dystocia have been presentation of both calves at the same time and inappropriate position of one or both calves (Reid et al. 1986; Gregory et al. 1990b; Guerra-Martinez et al. 1990). However, when one embryo is being transferred to a pregnant cow to induce a twin birth, combination of calf breeds that are widely variable in gestation length is not recommended (Diskin and Sreenan 1984). Otherwise calving time is likely to be controlled by the breed of calf with the shortest gestation length, which will result in the birth of one of the calves being premature (Diskin and Sreenan 1984).

Embryo transfer under research conditions has achieved a success of 52% in Ireland (Sreenan and Diskin 1988). However, it has been estimated that the overall efficiency of non-surgical embryo transfer techniques at farm level would be 25% (Sreenan and Diskin 1988). Hence, to make embryo transfer more applicable for farmers, the cost of implanting the recipient cows must not exceed the cost of artificial insemination (AI) and pregnancy rates from embryo transfer should approach conception rates similar to AI (de Rose and Wilton 1988).

**Use of foster calves**

The use of foster calves is an option that permits the rearing of two calves per cow at a reasonable cost (e.g. the cost of a foster dairy bull calf) and a high success rate (90%) (McMillan et al. 1993a; Morris et al. 1994b). As the degree of acceptance of the foster calf by the cow does affect calf performance, difficulties encountered in fostering calves limit the development of the double suckling system (Wyatt et al. 1977; Le Neindre et al. 1978; Nicoll 1982a). Hence, it is necessary to utilise a fostering method which leads to a high rate of success.

**Fostering techniques**

Maternal bonding between a calf and a cow is not an all-or-nothing phenomenon, but the possible interaction between a cow and her foster calf can be represented as a continuum, with complete rejection of the calf at one extreme.
and complete adoption at the other extreme (Rosecrans et al. 1982). The critical period for the establishment of the mother-offspring bond in domestic ruminants occurs soon after parturition (Rosecrans and Hohenboken 1982). Hence, the techniques used to foster calves on to cows all follow the same principles and the aim is to confuse the cow during this critical period. Satisfactory fostering of calves on to nurse cows may be achieved as early as 24 h post-partum (Kent 1984).

One method of fostering includes the use of foster calves exclusively whereby once the cow calves, her calf is taken away and is replaced by foster calves. The foster calves are separated from their foster dam, in order to make the calves hungry. Then the calves and their foster dam are confined into a small area and the calves are expected to suckle. After suckling, the calves and their foster dam are separated once again. This procedure is repeated daily for 2-3 days until the cow permits the calves to suckle without having negative reactions. Before joining the main nurse-cow herd, each cow and her calves are run in a small "imprinting" paddock for approximately ten days and are then shifted to a mob of three to four cows and their respective calves. The use of this method, has given widely variable outcomes (Hudson 1977).

A different fostering technique includes the close observation of cows in calf. Hence, when calving is imminent, the cows are allocated into a small pen and as soon as a cow calves, the amniotic fluid is collected and the calf is removed from its dam. The foster calf is wiped with the amniotic fluid and put together with the cow within few minutes after removal of the cow’s own calf. The disadvantage with this method is the problem of having to be present when the cow calves (Hudson 1977; Petit et al. 1978).

A technique that is simpler than either of the above involves the removal of the calf from its dam, soon after birth, for a period of approximately 8 h. The cow’s own calf and the foster calf are linked together with swivel connections to two neck bands. The pair is then given access to the cow and kept under observation until the cow allows the foster calf to suckle without reacting (Rowan and Wall 1970). A modification to this technique is known as the "Dog-collar method" in which the cow’s own calf and the foster calf are joined by a 40 cm of
rope attached via a swivel to a dog collar on each calf. Each cow and her two calves are then placed in a small pen with access to feed and water for 24 hours. They are then shifted to a small paddock in order to observe their behaviour for up to 7 days before the collars are removed. Once the collars are removed cow and calves join the main herd (McMillan 1993a).

Foster calves can be obtained from different sources. In some double suckling experiments the foster calves have been obtained from within the same herd in which the foster cows already are. Thus the cows that are calf donors do not suckle any calves and therefore have to be taken out of the herd (Rowan and Wall 1970; Wyatt et al. 1977; Rosecrans et al. 1982; McMillan et al. 1993a), which is not likely to happen under commercial farming situations. Other researchers have used calves from the dairy industry as foster calves. These have usually been Friesian calves (Everitt and Phillips 1971; Hudson 1977; Nicoll 1982a; McMillan et al. 1993a). This latter source of fosters calves is an option which is more likely to be used under commercial farming situations. Furthermore, dairy farms usually sell young calves soon after they are born.

Although some authors have reported that calf liveweights of the dam's own calf and the foster calf should be similar (McMillan et al. 1993a), under most practical situations it is not possible to chose the liveweight of the foster calf (Rowan and Wall 1970; Everitt and Phillips 1971; Hudson 1977; Wyatt et al. 1977; Nicoll 1982a; Rosecrans and Hohenboken 1982; Rosecrans et al. 1982). Hence, the only alternative has been to chose the age of the foster calf, with the hope that at similar ages liveweight differences between the foster and the dam's own calf are not great. The age at which the foster calves are usually acquired ranges from one to ten days, regardless of whether the foster calves are from within the herd or from outside (Rowan and Wall 1970; Everitt and Phillips 1971; Hudson 1977; Wyatt et al. 1977; Nicoll 1982a; Rosecrans and Hohenboken 1982; Rosecrans et al. 1982; McMillan et al. 1993a).

Not all researchers that have used foster calves have reported management practices that have been applied to the foster calves. However, most researchers have reported that potential foster calves should have had colostrum either by feeding with nipple bottles (Rosecrans and Hohenboken
1982; Rosecrans et al. 1982) or by delaying separation of the foster calf from its own mother earlier than 4 days after birth (Hudson 1977). Thus, if foster calves are going to be used it is always advisable that colostrum is fed to them just after birth. Furthermore, it has been pointed out that one disadvantage of bringing foster calves from outside the farm is the risk of introducing diseases to the farm (Diskin and Sreenan 1984). Thus, another security measure when obtaining foster calves, apart from making sure that they have received colostrum at the appropriate time, is to make sure that they do not come from a place where there are any diseases that are not present on the new farm.

A high percentage of cross suckling has been reported in double suckling systems regardless of whether both calves are foster, both the cow's own twins, or one foster and the other the cow's own calf (Hudson 1977; Le Neindre et al. 1978; Petit et al. 1978; Rosecrans and Hohenboken 1982; Davis et al. 1989; Davis and Bishop 1992). Furthermore, it has been reported that when single and double suckled cows graze together, cross suckling occurs even with single suckled cows (Nicoll 1982b; Rosecrans et al. 1982). Foster calves tend to suckle from alien cows more frequently than will a cow's own calf (Nicoll 1982b).

Under double-suckling conditions it has been observed that dairy-bred cows allow alien calves to suckle more frequently than straight beef-bred cows (Le Neindre et al. 1978). It is thought that one of the reasons for dairy cows to be more flexible in respect to suckling alien calves is that dairy cattle have been strongly selected for less rigid maternal behaviour, whereas the beef cow has been strongly selected for early calf recognition and strong bonding between the cow and calf (Le Neindre 1989).

The use of foster calves seems an option readily available to increase beef cow productivity. However, to implement a double suckling system, relative price values of cattle, availability of foster calves, supplementary feeding and labour within each environment and constraining resources must be considered (Rosecrans et al. 1982; Armstrong et al. 1990b).
ANIMAL PERFORMANCE IN DOUBLE SUCKLING SYSTEMS

Calf liveweight gains have been variable within double suckling trials. Generally the cow’s own calf grows faster than the foster calf. However, there have been cases where growth rate does not differ significantly between the foster calf and the cow’s own calf (Nicoll 1982b). When double suckled calves have been compared with single reared calves, single reared calves tend to gain liveweight faster. However, total kg of calf weaned per cow is generally greater in double suckled cows than in single suckled cows.

Calf liveweight gain from birth to weaning

It has been observed that double suckled calves grow at a slower rate from birth to weaning than single suckled calves (Kay et al. 1976; Nicoll 1982b; Rosecrans et al. 1982; Smith et al. 1982; Diskin and Sreenan 1984; Diskin et al. 1987; Diskin et al. 1991; McCutcheon et al. 1991). Weaning weight of calves is influenced more by their dam’s milk production than any other single factor (Barton 1970; Huw and Morgan 1991). When foster calves have been weaned and the dam’s own calves remained on their dams, the liveweight gains of these latter calves have been similar to those of calves that have been single suckled from birth to weaning (Rowan and Wall 1970). In grazing systems, cow milk yield is affected by stocking rate, which affects cow feeding level. Therefore under grazing conditions, daily liveweight gains of double suckled calves are expected to be lower than those of single suckled cows at the same stocking rate.

While single suckled calves usually consume more milk per day, double suckled calves usually spend more time grazing to compensate for their lower milk intake. Nevertheless, as milk organic matter (OM) has a higher metabolic energy (ME) concentration than herbage OM (Wright and Russell 1987), increased herbage intake is unable to compensate the effect of reduced milk intake in young calves (Rowan and Wall 1970; Nicoll 1982a; Nicoll 1982b; Wright and Russell 1987; Wright et al. 1987).
As calves age, herbage becomes an increasingly important part of their diet (Drennan 1971b; Wright and Russell 1987). Although the relationship between milk yield of the cow and growth rate of the calf declines slightly as lactation progresses, milk still remains important throughout the suckling period (Drennan 1971a; Barton 1970).

When multiple suckled calves suckle simultaneously they consume milk in equal quantities and hence their growth rates are more uniform (Rowan and Wall 1970; Hudson 1977), whereas when calves suckle at different times the calf that suckles first consumes the most (Hudson 1977). Thus liveweight gains of both the cow's own calf and foster calf are more likely to be similar when the calves remain linked together by a neck chain. Once the neck chain is removed, the cow's own calf tends to gain weight faster than its foster mate (Rowan and Wall 1970). Nevertheless, there are reports in which both the foster and the cow's own calf have had similar growth rates from birth to weaning even if they are not linked together (Nicoll 1982b).

Calf weaning ages in double suckling systems using foster calves have varied from 60 to 291 days in different experiments depending on what the objective of the experiment was (Rowan and Wall 1970; Everitt and Phillips 1971; Hudson 1977; Wyatt et al. 1977; Nicoll 1982b; Rosecrans et al. 1982; McMillan et al. 1993a). However, when the primary objective has been weaner calf production, the weaning ages have varied between 150 and 291 days (Rowan and Wall 1970; Wyatt et al. 1977; Nicoll 1982b; Rosecrans et al. 1982; McMillan et al. 1993a). Furthermore, when weaner calf production is the objective of the double suckling system, twin born calves are usually double suckled until they reach 5 to 7 months of age (Smith et al. 1982; Diskin and Sreenan 1984; Diskin et al. 1987; Gregory et al. 1990b; Guerra-Martinez et al. 1990; McCutcheon et al. 1991).

The methods by which the foster calves have been weaned have also varied. Some authors have weaned the foster calves first and left the dams' own calves suckling until the desired weaning age (Rowan and Wall 1970), whereas the majority have weaned both double suckled calves at the same time regardless of whether both calves are foster or whether one is the dam's own calf.
and the other a foster (Rowan and Wall 1970; Everitt and Phillips 1971; Wyatt et al. 1977; Nicoll 1982b; McMillan et al. 1993a). Double suckled twin born calves are usually both weaned at the same time (Smith et al. 1982; Diskin and Sreenan 1984; Diskin et al. 1987; Gregory et al. 1990b; Guerra-Martinez et al. 1990; McCutcheon et al. 1991).

**Calf liveweight gain after weaning**

After weaning, liveweight gain of double suckled and single suckled calves are usually similar (Rosecrans et al. 1982; Diskin et al. 1987; Diskin et al. 1991). Furthermore, double suckled calves usually show compensatory liveweight gain after weaning. However, these liveweight gains are usually not enough to compensate for the increased weaning weight of single calves and hence liveweight of double suckled calves at slaughter is lower (Dickerson et al. 1988; Wright et al. 1987; de Rose and Wilton 1988; Davis et al. 1989; Gregory et al. 1990b; Guerra-Martinez et al. 1990; de Rose and Wilton 1991). Nevertheless, in some cases when these calves have become one year old, the difference in liveweight has disappeared (Kay et al. 1976).

Although animals have the ability to compensate for restricted feed intake, this is only so when restriction occurs at a stage in life when the level of nutrition can influence fat deposition (Drennan 1971b; Wright and Russell 1987; Wright et al. 1987). During the first 3 - 4 months of a calf’s life, little fat is deposited in the body. Hence, nutritional penalty within the first 3 - 4 months of a calf’s life cannot be compensated in later life. Thus the scope for manipulation of body fatness through nutrition is rather limited in early stages of a calf’s life (Wright et al. 1987). Once this critical age has passed, both weaning age and weight are widely flexible in double suckled calves without adversely affecting later calf performance (Everitt and Phillips 1971).
Cow milk production

Total liveweight of calves reared per cow is largely determined by the dam's milk production (Everitt and Phillips 1971; Armstrong et al. 1990a; Huw and Morgan 1991). A common procedure used for estimating milk production of suckled beef cows, is the "weigh-nurse-weigh" method (W-N-W) (Barton 1970; Huw and Morgan 1991). However, it is incorrect to regard the data obtained by this method as providing unequivocal evidence of a cow's milk production as these procedures are essentially an estimate of the calf's appetite for milk (Barton 1970).

Potential milk yield in early lactation is usually above the needs of the calf, as the one month old calf is unlikely to consume more than 9 kg of milk daily (Barton 1970). Thus double suckled cows seem to produce significantly more milk (27 - 63% depending on the cow's genotype) than their single suckled contemporaries, especially in early lactation (Le Neindre et al. 1978; Petit et al. 1978; Nicoll 1982a; Smith et al. 1982; Chestnut 1988; Graham et al. 1990; de Rose and Wilton 1991).

Milk production in early lactation is stimulated by the suckling process (Everitt and Phillips 1971; Smith et al. 1982; Chestnut 1988). Moreover the quantity of milk removed in early lactation may be an important factor influencing subsequent milk yield of suckler cows (Drennan 1971a; Smith et al. 1982). High milk potential beef cows of the so called dual purpose breeds such as Salers, Simmental, Brown-Swiss or Beef-dairy crosses can greatly increase cow productivity without sacrificing calf performance excessively. Nevertheless, an increase in milk production will invariably lead to an increase in nutrient requirements of the cow (Petit et al. 1978). Thus cows under high planes of nutrition will be able to produce more milk than cows with limited feed available (Somerville et al. 1983; Wright and Russell 1987; Armstrong et al. 1990a).
Cow liveweight gain and post-partum anoestrus interval

Efficient female cattle reproduction implies that cows resume regular cyclic activity with overt oestrus sufficiently early to become pregnant 75 to 85 days after calving (Lang et al. 1970). To achieve a short post-partum anoestrus interval (PPAI) under farm conditions sound feeding management skills are highly desirable, as energy deficient suckling cows will attempt to maintain milk production at the expense of body reserves (Somerville et al. 1983).

Cow body condition score (BCS) and liveweight gain during the lactation period are paramount aspects that must be considered to achieve short PPAI (Doornbos et al. 1984; Mossman 1984; Nicholson and Sayers 1987; Short et al. 1990; Pedron et al. 1993). Thus, any factors affecting either cow liveweight gain or BCS are likely to affect PPAI. For example, a combination of the increased suckling frequency and persistence of suckling contributes to increases in cow milk yield (Nicol 1976), which will be reflected in greater calf liveweight gains. However, calf liveweight gain attributable to milk production, has been negatively correlated with cow liveweight gain (Huw and Morgan 1991). Therefore, when increased cow milk production is stimulated it is necessary that the extra energy required for that increase in milk yield is supplied through extra feed and not through cow body reserves. Furthermore, increases in either cow milk yield or suckling stimulus have been reported to affect reproductive performance by suppressing oestrus and delaying ovulation (Everitt and Phillips 1971).

Some researchers have reported that multiple suckled cows have had longer PPAI than single suckled cows (Everitt and Phillips 1971; Bellows et al. 1974; Wyatt et al. 1977; Wetterman et al. 1978). Others have reported that cow liveweight gain and/or the interval from calving to conception have not been influenced by the number of calves reared (Rowan and Wall 1970; Petit et al. 1978; Rosecrans et al. 1982; Reid et al. 1986; Wheeler et al. 1982). Prolonged PPAI in cows nursing more than one calf may be due to either milk production and/or the suckling stimulus associated with nursing more than one calf (Bellows et al. 1974; Wyatt et al. 1977). Nevertheless, when feeding management has been related to milk production levels, with the objective of maintaining cow
liveweight or a specific BCS, PPAI between single and double suckled cows has not been different (Rowan and Wall 1970; Petit et al. 1978; Rosecrans et al. 1982; Wheeler et al. 1982; Reid et al. 1986; Day et al. 1987).

Double suckling cows generally require more feed than cows rearing single calves (Freking and Marshal 1992). Moreover, specific studies have reported that twin bearing cows should be fed more energy (up to 30% more) than single bearing cows during the last third of gestation in order to achieve similar PPAI (Guerra-Martinez et al. 1990). However, when supplementary feed has been offered throughout the year to both single and double suckling cows, double suckled cows have consumed only 12.9% more energy than single suckled cows (Wyatt et al. 1977). Nevertheless, although PPAI may not be prolonged when feed management is appropriate, cows rearing two calves tend to lose more weight during the lactation period than cows rearing single calves (Petit et al. 1978; McCutcheon et al. 1991; McMillan et al. 1993a).

**Cow productivity and efficiency**

Calves individually suckled generally have greater liveweight gains than double suckled calves. Nevertheless, double suckled cows usually produce more kg of calf per cow present at weaning than single suckled cows (Smith et al. 1982). Twin rearing cows have produced from 57 to 73% more kg of calf at weaning than single rearing cows (Rowan and Wall 1970; Wyatt et al. 1977; Petit et al. 1978; Nicoll 1982a; Diskin and Sreenan 1984; Diskin et al. 1987; de Rose and Wilton 1988; Guerra-Martinez et al. 1990; Diskin et al. 1991; de Rose and Wilton 1991; McCutcheon et al. 1991; Davis and Bishop 1992; McMillan et al. 1993a). Productivity, however, does not reflect how efficient a cow is in converting feed into the final product.

A commonly used measure of biological efficiency in the beef breeding cow herd is obtained through dividing the average weight of calves weaned by the average cow liveweight at joining (Morris et al. 1988). However, a more direct method is obtained through dividing the weight of carcass product by unit of feed intake. (Taylor et al. 1985; Herd et al. 1993; Morris et al. 1994a). Furthermore,
to increase efficiency in any beef system, the degree of maturity of the animals slaughtered has to be 40 to 70% the mature weight of an adult animal (Taylor et al. 1985; Herd et al. 1993). Hence, the sooner a replacement female can be obtained and the dam slaughtered, the greater the efficiency of the system. Furthermore, as weaning rate increases cow efficiency will also increase, and as maintenance requirements of the dam decrease, efficiency of feed utilization increases (Taylor et al. 1985). Cow efficiency would be much higher than it currently is if herds had a weaning rate of 100%, a scenario only possible if up to one third of the births were twins (Taylor et al. 1985).

Studies analysing the overall efficiency of feed conversion into lean meat in traditional, twinning and sex-controlled beef production systems, have shown that the most efficient have been either twinning or once-bred heifer systems (Taylor et al. 1985; Herd et al. 1993; Morris et al. 1994a). However, some of the techniques utilised to induce twin births in these systems are either very expensive (e.g. sex-controlled embryos) or not yet commercially available (immunization against inhibin) (Taylor et al. 1985; Herd et al. 1993). One study comparing 26 different beef producing systems, calculated that a system utilising cross-bred cows together with induction of twin births (through the use of anti-inhibin immunisation) and selling offspring as yearlings rather than weaners was the most productive, most efficient and most profitable (Herd et al. 1993). However, a system that is biologically the most efficient may not be the best economically. Using readily available technologies (foster calves), it has been calculated that although a OBH system was biologically the most efficient among four beef producing systems (traditional, OBH and Beef x Dairy cows rearing one or two calves), economically the most efficient was the system using Beef x Dairy cows rearing two calves (Morris et al. 1994a). Nevertheless, if the Beef x Dairy dam rearing two calves was a OBH herself, such a system would be biologically the most efficient and economic efficiency would also increase.
SCOPE OF THE STUDY

Once bred heifers (OBH) are a profitable beef producing enterprise. Furthermore, as a great proportion of the OBH are Beef x Dairy heifers, they have the genetic potential to produce milk in sufficient quantities to rear more than one calf. If the extra calf is reared as a foster calf, the major costs involved in rearing that extra calf are those of buying a new born calf plus the extra feed consumed by the heifer during lactation. Through this procedure, heifer productivity, efficiency and profitability can be increased to be almost as profitable as pastoral bull-beef producing system.

A double suckling system that uses foster calves from the dairy industry is able to utilise a proportion of the large number of bobby calves that are destined for slaughter at approximately 3 days of age in New Zealand. Furthermore, it eliminates both the calving risks of twin births in cattle (plus the costs involved in induced twinning programs) and the extra feed requirements of cows bearing twins.

The objectives of this study were: firstly to show that Beef-Dairy cross OBH are able to rear more than one calf at once, without affecting heifer performance; secondly, to show that post-weaning calf liveweight gain is not affected by double suckling when foster calves are utilised; thirdly to compare the productivity and the efficiency of double suckled Hereford x Friesian (H x F) and Hereford x Jersey (H x J) once-bred heifers with single suckled H x F and H x J once-bred heifers.
CHAPTER TWO

DOUBLE SUCKLING IN
BEEF x DAIRY ONCE-BRED HEIFERS

ABSTRACT

Double suckling beef production systems are a strategy to increase annual output of suckled beef cows. This study compared the effect of single and double suckling on the performance of dams and their calves on pasture with an average sward surface height of 11.5 cm.

Thirty eight spring-calving, 2-year old Hereford x Friesian (H x F) and Hereford x Jersey (H x J) heifers mated to Angus sires were randomly allocated to either single or twin rearing treatments as they were calving. Nineteen Friesian male calves were used as foster calves for the twin rearing treatment. Individual calf 90-day weaning liveweight gain (adjusted) and liveweight gain from weaning to 11 months of age were recorded. Individual heifer liveweight changes from calving to weaning, and weaning to slaughter were recorded. Heifer productivity was estimated as kilograms of weaner calf produced per heifer present at weaning. Heifer efficiency was estimated as the ratio of heifer productivity to average liveweight of the heifer from calving to weaning. Results are presented as least square means ± standard error (LSM ± SE).

Calf daily liveweight gains were 1.00 ± 0.02, 0.90 ± 0.03, 0.70 ± 0.03 kg/hd (P < 0.05) for single calves, heifers’ own twin reared calves and twin reared foster calves respectively. At weaning, heifers’ own twin reared calves were 8.1 kg lighter than single reared calves (P < 0.05). From weaning to 11 months of age, heifers’ own twin reared calves had greater daily liveweight gains (0.50 ± 0.02 kg/hd) than single reared calves (0.44 ± 0.02 kg/hd, P < 0.01) and tended to be heavier (244.12 ± 4.8 versus 236 ± 5.3 kg).

Double suckling did not affect heifer daily liveweight gain from calving to weaning (0.7 ± 0.05 and 0.6 ± 0.04 kg/hd for single and double suckled H x F...
heifers respectively, and 0.3 ± 0.06 and 0.3 ± 0.06 kg/hd for single and double suckled H x J heifers, respectively) or from weaning to slaughter (0.3 ± 0.05 and 0.3 ± 0.04 kg/hd for single and double suckled H x F heifers respectively, and 0.2 ± 0.06 and 0.3 ± 0.06 kg/hd for single and double suckled H x J heifers, respectively).

Double suckled H x F and H x J heifers were 44.7 and 55.5 % more productive (P < 0.05) than single suckled H x F and H x J heifers respectively. Double suckled H x F heifers were 45.1 % more efficient than single suckled H x F heifers (P < 0.05) and double suckled H x J heifers were 58.1 % more efficient than single suckled H x J heifers.

It was concluded that although twin reared calves were 8.1 kg lighter than single reared calves at weaning, twin reared calves were able to surpass these liveweight differences through compensatory liveweight gain after weaning. Therefore, heifer productivity and efficiency can be significantly enhanced through the use of foster calves in double suckling beef production systems.

**Keywords** once-bred heifers; double suckling; foster calves; liveweight gain; cow productivity.

**INTRODUCTION**

The annual output from a suckled beef cow is low in comparison with other farmed meat producing species. If maximum annual cow output of one calf per year is increased by either a once-bred heifer (OBH) system or by rearing an additional calf, productivity can be markedly enhanced. Once-bred heifer beef production systems involve mating heifers at 15 months of age to calve at two years of age. To grade as heifer beef, heifers must be slaughtered before no more than six permanent incisor teeth have erupted (usually 30 - 36 months of age), while the calves can be sold as weaner calves or kept for finishing (Morris et al. 1992b). Under New Zealand pastoral conditions, a typical OBH system was calculated to be the second most profitable system after bull beef production
systems (Parker 1994). Nevertheless, there is scope to enhance such profitability even further through the use of double suckling in OBH systems.

Twin births can be achieved by hormonal induction (Piper and Bindon 1990; Davis and Bishop 1992), genetic selection (Echternkamp et al. 1990; Gregory et al. 1990a; Morris and Day 1990a; Morris et al. 1992a) embryo transfer (Dickerson et al. 1988; McMillan et al. 1993b), or foster calves can be used to simulate twin births (McMillan et al. 1993a; Morris et al. 1994b) Hormonal induction and embryo transfer have been more successful in obtaining twin births than has genetic selection (Dickerson et al. 1988; Davis et al. 1989; Bindon and Hillard 1992; Davis and Bishop 1992). Genetic selection for twins seems by far the cheapest way of inducing twin births. However, herd twinning rates reported in New Zealand literature range from 10 to 20% (Morris and Day 1990a; Morris and Day 1990b; Morris et al. 1992a). Furthermore, twinning in cattle is a trait with low repeatability and heritability (Echternkamp et al. 1990; Gregory et al. 1990a; Morris and Day 1990b; Piper and Bindon 1990; de Rose and Wilton 1991). The use of foster calves is an option that permits the rearing of two calves per cow at a reasonable cost (e.g. the cost the extra 4 day old calf) and high success rate (90%) (McMillan et al. 1993a), which, in the present study, is defined as the percentage of foster calves that were accepted by the herd of suckled heifers.

Calf liveweight gains have been variable within double suckling trials. There are reports in which the cow's own calf grows faster than the foster calf (Rowan and Wall 1970) and reports in which there is no significant difference between the foster calf and the cow's own calf (0.70 vs 0.72 kg/day respectively) (Nicoll 1982b). Nevertheless, when the double suckled cows' own calves have been compared with single reared calves, the single reared calves tend to gain weight faster (Drennan 1971b; Nicoll 1982b; Dickerson et al. 1988; Davis et al. 1989; de Rose and Wilton 1991). However, total kg of calf weaned per cow is significantly higher in double suckled cows than in single suckled cows (de Rose and Wilton 1988; Graham et al. 1990; Farquharson 1991).

The objectives of this trial were firstly to compare the performance (productivity, efficiency and liveweight gain) of Beef x Dairy once-bred heifers rearing one calf with the performance of Beef x Dairy once-bred heifers rearing
two calves, and secondly to compare the effect of heifer genotype on heifer performance within a double suckling once-bred heifer system.

**MATERIALS AND METHODS**

Thirty eight spring-calving, 2-year old Hereford x Friesian (H x F) (mean ± standard error of mean post-calving liveweight 382.86 ± 7.36 kg) and Hereford x Jersey (H x J) (mean post-calving liveweight 334.29 ± 10.16 kg) heifers mated to Angus sires were used for the experiment and calved to two cycles of mating with a mean calving date of 6 September. After calving, heifers were randomly allocated to either single or twin rearing groups. All the heifers were grazed on a sward containing mainly ryegrass and white clover with an average sward surface height of 11.5 cm. On 15 December 1993 the calves were weaned and grazed on a separate area. The dams, continued grazing on 11.5 cm height swards. A dry summer resulted in the average sward surface height decreasing to 7 cm through February and March.

**Fostering technique**

Nineteen straightbred Friesian male calves of approximately four days of age (41.66 ± 0.97 kg of liveweight) were obtained from a nearby dairy farm and used as foster calves in order to make pairs formed by the heifer's own calf (35.01 ± 0.76 kg of liveweight) and a foster calf. Hence, there were three calf rearing treatments (single calves, heifers' own twin reared calves and twin foster calves). The fostering process used was the "dog-collar technique", in which the heifer's own calf and the foster calf are joined by 40 cm of chain attached via a swivel to a dog collar on each calf (McMillan et al. 1993a).

Fostering occurred within the first 24 hours after the heifer's own calf was born. Both the heifer's own calf and the foster calf were weighed before joining with the dog collar. Once joined, the two calves (called from now on twins) were separated from the dam for a period of 8 hours. Subsequently the dam and her
twin calves were shifted to a small paddock with access to pasture and water for 24 hours. They were then confined to a three hectare paddock, where they were observed several times a day in order to detect any antagonistic behaviour from the dam. Seven days later, the dog collars were removed from the calves and the heifer and her calves joined the rest of the mob.

Single suckled male calves were castrated by using rubber rings soon after birth and double suckled calves were castrated when the dog collars were removed (Ensminger 1987). Two single suckled Hereford x Friesian heifers were diagnosed as having spring eczema (Bruce et al. 1992) and were removed from the experiment. Data for these heifers were not taken into account for any of the analyses, therefore the number of heifers in the experiment was reduced to thirty six. Table 1 indicates the allocation of heifers to suckling status.

Table 1. Heifer distribution according to suckling status and genotype.

<table>
<thead>
<tr>
<th>Heifer genotype</th>
<th>Suckling status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>H x F(^1)</td>
<td>11</td>
</tr>
<tr>
<td>H x J</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

\(^1\) H x F = Hereford x Friesian; H x J = Hereford x Jersey.

Liveweight measurements

Unfasted-heifer liveweights were recorded one month prior to the mean calving date, one month after the mean calving date and then monthly until weaning. The heifers' own calves were weighed at birth and the foster calves were weighed prior to the fostering process. Calves were then weighed monthly. At weaning (mean age 100 ± 1.3 days) the foster calves and the heifers' own calves were divided into two separate mobs and liveweights recorded monthly until eleven months of age.
Heifer efficiency and productivity

Heifer productivity was estimated as kilograms of weaner calf produced per heifer present at weaning (Morris et al. 1988), and heifer efficiency was estimated as the ratio of productivity to average heifer liveweight from calving to weaning (Morris et al. 1988).

Milk production

Milk production from heifers was estimated by the "weigh-nurse-weigh" method (Huw and Morgan 1991) on days 31, 64 and 92 after the mean calving date. Calves were fasted for a 17 hour period and then weighed. They were allowed to suckle until their appetite was satisfied or there was no milk left in the heifer's udder, and then immediately weighed. Differences between calf liveweights before and after suckling were adjusted to a 24 hour basis to obtain an estimate of the heifer daily milk production of the cow (Huw and Morgan 1991; Jenkins and Ferrell 1992).

Suckling behaviour

Three heifers of each genotype (H x F and H x J) and suckling status (single and twin) were randomly selected to observe suckling behaviour of the calves during a 24 hour period on days 34, 67 and 94 after the mean calving date. To allow long range identification, the heifers and the calves were identified with coloured neck collars. During the observation period, the selected group of animals were allocated to a separate paddock of 0.4 hectares. Observations started at 0600 hrs and finished at 0600 hrs the following day. At night the observations were made with the help of a nightscope (Day et al. 1987). The aim was to count the number of daily suckling bouts for each group of calves. A suckling bout was defined as the time spent by a calf sucking milk from the udder of any cow after the teat had been received into the calf's mouth. This period was not restricted to a minimal duration (Day et al. 1987). The proportion of cross
suckling for the calves was computed as the number of times a calf suckled an alien cow divided by the total number of suckling bouts recorded for that calf (Rosecrans and Hohenboken 1982).

Carcass traits

The heifers were slaughtered in two different groups according to liveweight. Four heifers had missing data and therefore were not included. The heaviest group (n = 16) was slaughtered on 18 March, while the lightest group (n = 16) was slaughtered on 7 July 1994. Final heifer liveweight, carcass weight, dressing out percentage, number of teeth erupted, muscularity, yellowness, fat depth, carcass length, femur weight and femur length were measured.

Statistical analysis

Data analyses were performed using the general linear models procedures to test the effects of calf rearing group, heifer genotype and suckling status. Differences between group means were tested using t-test. Results are expressed in terms of least square means (LSM) ± standard error (SE). All analyses were performed using the statistical analysis system computer package (SAS 1985).

RESULTS

Calf performance

Preliminary analyses showed that the sex of calf effect was not significant from birth to weaning or from weaning to 11 months of age and the results are therefore not presented. Calf liveweight and liveweight gain from birth to weaning were significantly greater for the single reared group than for any of the other two groups (P < 0.05) (Table 2). From weaning to 11 months of age, the heifers' own
twin reared calves had greater liveweight gains than single calves (P < 0.01). These greater liveweight gains and the marginally small difference in weaning weights between these two groups of calves, resulted in twin heifers' own calves being heavier at 11 months of age. However, this difference in liveweight at 11 months of age was not significant. Heifer genotype had no effect on either calf liveweight gain from birth to weaning or from weaning to 11 months of age. Although calf liveweight at 11 months of age was not significantly different between the single and the twin heifer's own calves, the twin heifer's own calves tended to be heavier than the single calves (Table 3).

Table 2 Effect of calf rearing group on calf weaning weight and liveweight gain from birth to weaning at 90 days of age (LSM ± SE).

<table>
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<tr>
<th></th>
<th>Single</th>
<th>Twin</th>
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<tr>
<td></td>
<td>Weaning weight¹ (kg)</td>
<td>Heifer's own calf</td>
</tr>
<tr>
<td>127.4 ± 2.60</td>
<td>119.3 ± 2.4</td>
<td>97.40 ± 2.7</td>
</tr>
<tr>
<td>Liveweight gain (kg/day)</td>
<td>1.00 ± 0.02</td>
<td>0.90 ± 0.03</td>
</tr>
</tbody>
</table>

¹Age adjusted weaning weight (Nicoll and Rae 1977).

a,b,c Means with different superscripts within rows are significantly different (P < 0.05)

Table 3 Effect of calf rearing group on calf liveweight and liveweight gain from weaning (approximately 100 days of age) to 11 months of age (LSM ± SE).

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Twin heifer's own calf</th>
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<tr>
<td>Live weight (kg)</td>
<td>236.20 ± 5.30</td>
<td>244.12 ± 4.80</td>
</tr>
<tr>
<td>Liveweight gain (kg/day)</td>
<td>0.44 ± 0.02</td>
<td>0.50 ± 0.02</td>
</tr>
</tbody>
</table>

a,b Means with different superscripts within rows are significantly different (P < 0.01)
The foster calves (Friesian steers) were grazed separately from their twin mates and from weaning to 320.10 ± 2.41 days of age achieved a liveweight of 218.63 ± 6.32 kg reflecting a liveweight gain of 0.46 ± 0.01 kg/day.

**Heifer performance**

H x F heifers had greater liveweight gains from calving to weaning and greater carcass weights (P < 0.05) than H x J heifers. However, neither heifer liveweight gain from birth to weaning nor carcass weight were affected by suckling status. Liveweight gain from weaning to slaughter was not affected by suckling status or by heifer genotype. Dressing out percentage was similar for all the heifers except from the single suckled H x J, which had a significantly greater dressing out percentage than both groups of H x F heifers (P < 0.05) (Table 4). Neither breed nor suckling status had any effect on any other carcass characteristics. Only one heifer (H x F) was graded within the K category for fatness and six heifers had poor muscularity (n = 4 and n = 2 for H x F and H x J respectively). The rest of the heifers were graded as P2. As none of the heifers had more than four permanent incisor teeth at the time of slaughter, all heifers classified as heifer meat within the New Zealand meat carcass classification system.

Double suckled heifers were both more productive and efficient than single suckled heifers (P < 0.01) (Table 5). Within each suckling status the H X F heifers were more productive than the H x J heifers (P < 0.05). There was no difference in efficiency between single suckled H x F and H x J. However, within the double suckling status the H x J heifers were more efficient than the H x F heifers (P < 0.05).

Throughout the lactation period double suckled heifers consistently produced more milk than single suckled heifers (P < 0.01). Milk production was not affected by heifer genotype (Table 6).
Table 4  Effect of suckling status and heifer genotype on heifer liveweight gain and carcass weight (LSM ± SE).

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H x F&lt;sup&gt;1&lt;/sup&gt;</td>
<td>H x J</td>
</tr>
<tr>
<td>Liveweight gain (kg/day)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>calving to weaning</td>
<td>0.7 ± 0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.3 ± 0.06&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>weaning to slaughter</td>
<td>0.3 ± 0.05</td>
<td>0.2 ± 0.06</td>
</tr>
<tr>
<td>Carcass weight (kg)</td>
<td>226.1 ± 2.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>202.9 ± 4.7&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dressing out (%)</td>
<td>48.6 ± 0.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50.3 ± 0.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> H x F = Hereford x Friesian; H x J = Hereford x Jersey.

<sup>a,b</sup> Means with different superscripts within rows are significantly different (P < 0.05)
Table 5  The effect of suckling status and heifer genotype on heifer productivity and efficiency from calving to weaning at 90 days of lactation (LSM ± SE).

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H x F¹</td>
<td>H x J</td>
</tr>
<tr>
<td>Productivity²</td>
<td>128.3 ± 4.1b</td>
<td>111.2 ± 4.9ª</td>
</tr>
<tr>
<td>Efficiency³</td>
<td>0.31 ± 0.01ª</td>
<td>0.31 ± 0.01ª</td>
</tr>
</tbody>
</table>

¹H x F = Hereford x Friesian; H x J = Hereford x Jersey.

²Productivity = kg of calf weaned / heifer present at weaning

³Efficiency = \( \frac{\text{Productivity}}{\text{Heifer liveweight}} \)

a,b,c,d Means with different superscripts within rows are significantly different (P < 0.05)
Table 6  Effect of suckling status and heifer genotype on kilograms of milk produced per heifer per day (LSM ± SE).

<table>
<thead>
<tr>
<th>Month of lactation</th>
<th>Single</th>
<th>Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H x F</td>
<td>H x J</td>
</tr>
<tr>
<td>1</td>
<td>8.6 ± 1.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.5 ± 1.3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>8.3 ± 0.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.1 ± 0.9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>8.3 ± 0.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.5 ± 0.9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> H x F = Hereford x Friesian; H x J = Hereford x Jersey.

<sup>a,b</sup>Means with different superscripts within rows are significantly different (P < 0.01)
Calf behaviour

The total number of suckling bouts did not differ among calves and likewise the proportion of suckling bouts by the single and the heifers' own twin reared calves with their own dam did not differ. Twin foster calves sucked their own dams for 60\% of the time (P <0.01) with the remaining 40\% spent cross suckling other heifers, which happened regardless of their dam's genotype (Table 7).

Table 7 Effect of calf rearing group on the total number of calf suckling bouts (TSB), the proportion of calf suckling bouts with its own dam (SBOD) and the proportion of calf cross suckling bouts (CSB) (LSM ± SE).

<table>
<thead>
<tr>
<th></th>
<th>Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>TSB</td>
<td>6.1 ± 0.4</td>
</tr>
<tr>
<td>SBOD</td>
<td>1.0 ± 0.1a</td>
</tr>
<tr>
<td>CSB</td>
<td>0</td>
</tr>
</tbody>
</table>

abMeans with different superscripts within rows are significantly different (P < 0.01)

Heifer behaviour

Single suckled heifers nursed their own calves for most of the suckling bouts (98 and 80\% for H x F and H x J respectively). Double suckled heifers allowed alien calves to suckle more often than single suckled heifers. However, double suckled heifers did spend a greater proportion of the total suckling bouts nursing only their own calves rather than nursing their foster calves (e.g. 50\% of the total nursing bouts H x F heifers were nursing their own natural calves, for the other 50\% of the suckling bouts, they were nursing either their twin calves or alien calves). Within each genotype, H x J heifers tended to allow more alien suckling than H x F heifers (Table 8).
Table 8 Effect of heifer suckling status and genotype on the proportion of suckling bouts, in which the heifers nursed their own calves (NOC), and cross suckling bouts, in which the heifers nursed alien calves, including their foster calves (NAC) (LSM ± SE).

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HxF</td>
<td>HxJ</td>
</tr>
<tr>
<td>NOC</td>
<td>0.98 ± 0.1c</td>
<td>0.80 ± 0.1bc</td>
</tr>
<tr>
<td>NAC</td>
<td>0.02 ± 0.1a</td>
<td>0.20 ± 0.1ab</td>
</tr>
</tbody>
</table>

1 HxF = Hereford x Friesian; HxJ = Hereford x Jersey.

Means with different superscripts within rows are significantly different (P < 0.05)

DISCUSSION

Calf performance from birth to weaning

The objectives of the present study were: firstly to compare productivity, efficiency and liveweight gain of Beef x Dairy once-bred heifers rearing one calf with similar heifers rearing two calves; and secondly to compare the effect of heifer genotype (Hereford x Friesian or Hereford x Jersey) on heifer performance within a double suckling once-bred heifer system.

Single reared calves had the greatest liveweight gains (1.00 kg/day) followed by the heifers’ own twin reared calves (0.90 kg/day) and twin foster calves having the lowest liveweight gains (0.70 kg/day). These results are similar to those of Wyatt et al. (1977) where Angus x (Hereford x Holstein) single, cows’ own twin reared calves and foster calves had liveweight gains of 0.91, 0.79 and 0.62 kg/day respectively, from birth to weaning at 240 days of age. Comparatively, Nicoll (1982b) using Hereford x Friesian and straight Friesian cows mated to either Charolais, Hereford or Friesian bulls and using Friesian...
calves as foster calves, reported calf daily liveweight gains of 0.94 kg/day for single calves and no difference between cows' own twin reared calves (0.72 kg/day) and twin foster calves (0.70 kg/day).

There are reports, however, in which calf liveweight gain between single and cows' own twin reared calves have not been significantly different when foster calves have been used in double suckling experiments. McMillan et al. (1993a) using Hereford x Friesian cows mated to either Hereford or Friesian bulls reported that calf liveweight gains between single and the cows' own twin reared calves (while double suckled) were not different (1.12 and 1.10 kg/day for single and cows' own twin reared calves respectively). The foster calves in this experiment, which were straight Friesian, were significantly lighter at weaning and had a daily liveweight gain of 0.77 kg.

Friesian male foster calves achieving daily liveweight gains of 0.70 kg may not be heavy enough to be sold as weaner calves for finishing systems in New Zealand. However, McRae and Morris (1984) stated that in bull beef systems in New Zealand, Friesian bulls are usually bought as weaner calves at three months of age with a liveweight of 80 kg. These calves are artificially reared and if a birth weight of 35 kg is assumed for such calves, then to reach 80 kg at three months of age a daily liveweight gain of 0.5 kg is required. Hence, situations in which double suckled cows' own calves are as heavy as single suckled calves at birth and double suckled foster calves can achieve daily liveweight gains of 0.70 kg, allow the foster calves to achieve industry target weaning liveweights similar to those of artificially reared Friesian bull calves.

**Suckling behaviour**

Calf liveweight gain is primarily determined by the amount of milk that each calf drinks (Barton 1970; Huw and Morgan 1991). Therefore, the number of calf suckling bouts per day could be an important factor in determining why a double suckled foster calf does not usually grow as fast as a double suckled dam's own
calf (Rowan and Wall 1970; Wyatt et al. 1977; Nicoll 1982b; McMillan et al. 1993a).

Suckling bout observation periods have been carried out in several different ways. Some researchers have made observations during daylight (Kilgour 1972; Nicol and Sharafeldin 1975), while others have carried out observations for 24 hour periods (Reinhardt and Reinhardt 1981; Lewandrowski and Hurnik 1983; Day et al. 1987; Stewart et al. 1993).

In the present study, where 24 hour observation periods were carried out, average daily suckling bouts for the three groups of calves (6.1, 5.6 and 5.5 for single, heifers' own twin reared calves and twin foster calves respectively) is within the range of 4.3 to 6.3 reported by other authors who recorded suckling bouts in 24 hour observation periods (Reinhardt and Reinhardt 1981; Lewandrowski and Hurnik 1983; Day et al. 1987; Stewart et al. 1993). The total number of suckling bouts did not differ among the three groups of calves, a result consistent with Wyatt et al. (1977) and Nicoll (1982b).

Previous studies where suckling behaviour has been recorded indicate that twin foster calves perform more cross suckling bouts than the cows' own twin reared calves (Nicoll 1982b). In the present study twin foster calves cross suckled 40% of the total suckling bouts. Furthermore, it was observed that almost none of the foster calves were nursed if they were not accompanied by the heifer's own calf. It was common to see alien calves approach a heifer once one or both of her calves were suckling. Alien calves, and in some cases foster calves, usually approached and suckled from the rear of the heifer or alongside the other calf already suckling.

Although nursing bout duration was not measured, it is clear that when the foster calf arrived at the udder of any heifer (usually a double suckled heifer), the heifer's own calf had been suckling for a while and therefore the foster calf had less milk available to consume. Therefore, when multiple suckled calves suckle at different times, the calf that suckles first consumes the most milk (Hudson 1977), which is reflected in the lower performance of the foster calves.

Cross suckling was also observed within the single suckled group of heifers; however, double suckled heifers nursed significantly more alien calves
than single suckled heifers. Although suckling bouts per day were similar among the three groups of calves, double suckled heifers spent a greater percentage of the total suckling bouts nursing only their own calves without any other calf suckling at the same time (Table 7). This is in agreement with Wyatt et al. (1977) who reported that although the number of suckling bouts did not differ between twin foster calves and dams' own twin reared calves, the actual time that the twin dams' own calves spent suckling with their dams was significantly higher than it was for twin foster calves.

**Post-weaning calf performance**

The heifers' own twin reared calves were able to regain the liveweight differences at weaning (8.1 kg) through faster liveweight gain during the post-weaning period. This compensatory gain actually resulted in the twin heifers' own calves being heavier at 11 months of age than single reared calves.

Guerra-Martinez et al. (1990) reported that when both twin and single reared calves were put to pasture during the post-weaning period (from 180 to 350 days of age), liveweight gains were in favour of twin reared calves (0.30 vs 0.37). However, single calves were heavier at weaning and remained heavier than twin reared calves at 350 days of age. Diskin and Sreenan (1984) reported differences in weaning weight of 23 kg between single and twin born-twin reared calves and although liveweight differences decreased with time, at 650 days of age, twin reared calves were still lighter than single reared calves (436 vs 444 kg respectively). These reports suggest that unless single born-single suckled calves are restrictively fed during certain stage of the post weaning period (Wright et al. 1987), it is not possible for twin born-twin reared calves to recover, after weaning, from liveweight differences of 30-40 kg at weaning. However, as suggested by the results in the present study, when the liveweight difference between single and double suckled calves is 8.1 kg, it is possible for double suckled calves to recover this difference in liveweight through compensatory liveweight gain after weaning.
Heifer liveweight changes

Lactation liveweight gains of 0.6 kg/day for double suckled H x F heifers in the present study, are well above the targets recommended by Morris et al. (1992b) of 0.33 kg/day for single suckled OBH, and similar to those reported by Khadem et al. (1993) (0.61 kg/day) for single suckled H x F OBH. However, double suckled H x J heifers did not perform as well as double suckled H x F heifers (0.3 kg/day). Comparatively, single suckled heifers did achieve liveweight gains superior to those recommended by Morris et al. (1992b) (0.7 and 0.4 kg/day for H x F and H x J respectively).

Results of dam performance from double suckling experiments have been variable depending on the nutritional regime of the dam. When double suckled dams have been fed ad libitum, liveweight gains from calving to weaning have been similar between single and double suckled dams (Rowan and Wall 1970; Guerra-Martinez et al. 1990; McCutcheon et al. 1991). When feed consumption has been measured, double suckled dams have consumed more feed than single suckled dams (Guerra-Martinez et al. 1990; McCutcheon et al. 1991). Similarly, in double suckling experiments where supplementary feed has been used, it has been reported that double suckled dams have needed more supplementary feed than single suckled dams in order to maintain either similar body weight or similar body condition score (BCS) to that of single suckled dams (Wyatt et al. 1977; Rosecrans et al. 1982; de Rose and Wilton 1991). Therefore, in double suckling experiments where feed allowance has been limited by either fixed amounts of supplementary feed or fixed stocking rates, double suckling dams have had lower liveweight gains than single suckled dams (Drennan 1971a; Nicoll 1982a). Although feed intake was not measured in the present study, the results obtained agree with those from experiments in which double and single suckled dams have been fed ad libitum (Rowan and Wall 1970; Guerra-Martinez et al. 1990; McCutcheon et al. 1991; Khadem et al. 1993). However, in the present study, Hereford x Jersey heifers had constantly lower liveweight gains than the Hereford x Friesian heifers.
Heifer milk production

Results from double suckling experiments have shown that double suckled dams have produced between 27% and 63% more milk than single suckled dams (Le Neindre et al. 1978; Petit et al. 1978; Nicoll 1982a; Smith et al. 1982; Chestnut 1988; Graham et al. 1990; de Rose and Wilton 1991). Furthermore, Reid et al. (1986) reported a daily milk production difference of 5.4 litres between single and double suckled cows of different beef and dual purpose crosses. In the present experiment, double suckled heifers were estimated to produce more milk than single suckled heifers (4.4 and 5 litres more for Hereford x Friesian and Hereford x Jersey respectively). Although double suckling did increase milk production, heifer genotype did not influence milk production significantly in either suckling group, which indicates that under the ad libitum pasture allowances in this experiment, Hereford x Jersey heifers were able to produce as much milk as Hereford x Friesian heifers.

Heifer productivity

In double suckled experiments, dam productivity defined as kg of calf weaned per dam present at weaning (approximately 200 days after calving), has been estimated between 57% and 73% greater for double suckled than for single suckled dams (Rowan and Wall 1970; Wyatt et al. 1977; Petit et al. 1978; Nicoll 1982a; Diskin and Sreenan 1984; Diskin et al. 1987; de Rose and Wilton 1988; Guerra-Martinez et al. 1990; Diskin et al. 1991; de Rose and Wilton 1991; McCutcheon et al. 1991; Davis and Bishop 1992; McMillan et al. 1993a). However, in one experiment in which weaning was done 100 days after calving, it was reported that double suckled cows had a 40% greater productivity than single suckled cows (Davis and Bishop 1992). In the present study weaning occurred at 90 days after calving and resulted in double suckled heifers being more productive (44.7% and 55.5% for Hereford x Friesian and Hereford x Jersey respectively) than single suckled heifers. These results suggest that as
calf weaning weights increase, productivity of double suckled dams also increases in comparison with single suckled dams.

**Heifer efficiency**

Heifer efficiency was calculated as kg of calf produced per heifer divided by the average heifer liveweight from calving to weaning. Double suckled heifers were more efficient than single suckled heifers (45.1 % and 58.1 % for Hereford x Friesian and Hereford x Jersey respectively). Although a more direct method to estimate cow efficiency in beef cattle can be obtained through dividing the weight of carcass product by unit of feed intake (Taylor et al. 1985; Herd et al. 1993; Morris et al. 1994a), this method could not be used in the present study because neither animal intake was measured nor were the calves slaughtered.

Within single suckling status, Hereford x Friesian heifers were as efficient as Hereford x Jersey heifers. However, double suckled Hereford x Jersey were 8.9 % more efficient than double suckled Hereford x Friesian heifers. Using a procedure similar to the procedure used in this study to estimate heifer efficiency, Morris et al. (1993a) reported that single suckled Jersey x Hereford cows were 2.7 % less efficient than Hereford x Friesian cows at producing kg of calf at weaning under harsh conditions. However, single suckled Angus x Jersey cows were 8.3 % more efficient than Angus x Friesian cows under the same harsh conditions (Morris et al. 1993a).

Several authors (Jenkins and Ferrell 1992; Morris et al. 1993a; Jenkins and Ferrell 1994) have reported that there is no single breed that is the best for all important beef production traits and for all environments. When feed availability and quality are not limiting factors higher production efficiency can be achieved using breed crosses with high genetic potential for milk production (Jenkins and Ferrell 1994). Furthermore, as maintenance requirements of the dam decrease, efficiency of feed utilization will increase (Taylor et al. 1985). However, this was not the case for single suckled H x J heifers in the present
experiment. It might have been that milk production was limited by the inability of single reared calves to consume all the milk in early lactation.

Experiments comparing Jersey and Friesian cows in New Zealand have shown that Jersey cows have been approximately 8% more efficient than Friesian cows in converting feed energy into milk energy when both groups of cows produce similar quantities of milk (L’Huillier et al. 1988; Sharma 1993). This is consistent with the 8.9% increased efficiency of double suckled Hereford x Jersey heifers compared with double suckled H x F in the present study, when presumably milk production of the heifer was not limited by the inability of the single reared calves to consume all the milk.

CONCLUSIONS

In summary within double suckled systems, using foster calves as simulated twins, liveweight gains from birth to weaning are usually highest for single suckled calves followed by twin dams’ own calves and lowest for twin foster calves.

If the milk production potential of double suckled dams is adequate to rear two calves, then it is possible that the dams’ own twin reared calves can achieve weaning liveweights marginally lighter (8.1 kg) than single suckled calves. Subsequent liveweight gains allow this liveweight difference to be regained through compensatory liveweight gain after weaning. Furthermore, double suckled foster Friesian calves are able to achieve industry target weaning liveweights at three months of age.

When feed is not a limiting factor, double suckled dams have similar liveweight gains to those of single suckled dams. Furthermore, dam productivity and efficiency is significantly enhanced through the use of foster calves.

The use of foster calves from the dairy industry is an option that is readily available for commercial farmers and is flexible, to the point that allows farmers to go back to traditional single-suckled systems at any stage.
CHAPTER THREE

GENERAL DISCUSSION

The objectives of the present study were: firstly to show that Beef x Dairy once-bred heifers (OBH) are able to rear two calves without affecting heifer performance; secondly, to show that post-weaning calf liveweight gain is not affected by double suckling when foster calves are utilised; and thirdly to compare the productivity and the efficiency of double suckled Hereford x Friesian (H x F) and Hereford x Jersey (H x J) once-bred heifers. This chapter reviews the experimental approach used in chapter two and examines the likely uses of double suckling in the New Zealand beef industry.

Calf liveweight gain

In suckling beef herds calf liveweight gain from birth to weaning strongly depends on the dam’s milk production. Thus, when foster calves are used in double suckling systems their performance depends on two main factors. Firstly on the genetic ability of the foster dam to produce enough milk for the two calves, and secondly on the success of the fostering procedure used. When double suckled pairs of calves consist of the dam’s own calf and one foster calf, the foster calf usually has lower liveweight gains.

If weaning liveweight differences between double suckled and single suckled calves of the same breed cross are not greater than 8.1 kg, double suckled calves have the opportunity to recuperate from lighter weaning weights through compensatory liveweight gain after weaning. Differences in weaning weight are accentuated if there are large differences in birth weights between single and double suckled calves, a situation that is encountered when twin births occur but not when a foster calf is used as a twin calf.

In the present study, a pre-weaning daily liveweight gain of 0.7 kg for foster calves is considered adequate, as double suckled twin-born calves have achieved much lower performances than that (Smith et al. 1982; Guerra-Martinez
et al. 1990). Furthermore, as was observed in the present study, when a double suckled foster calf is achieving a daily liveweight gain of approximately 0.7 kg the dam's own twin reared calf is achieving a greater liveweight gain, which is in agreement with Rowan and Wall (1970) and McMillan et al. (1993a).

Suckling behaviour observations from the present study indicated that twin foster calves were not able to suckle their foster dam if they were not accompanied by the twin heifer's own calf. Therefore, foster calves had to be alert to suckle from any cow that allowed them to suckle while she was nursing her own calf. This suggests that foster calves were not able to consume as much milk as the heifers' own calves did, which may be a reflection of foster calves' lower liveweight gains. However, to actually know how much time each calf spends suckling, it would be necessary to measure the duration of each suckling bout for each individual calf. Furthermore, if actual herd behavioral interactions were to be observed, it would be necessary to perform observations with the complete herd. It would also be useful to record calf grazing behaviour and herbage intake, which will give information on whether the double suckled calves attempt to compensate their decreased access to milk consumption through increasing grazing time and/or herbage intake.

**Heifer performance**

Adequate herbage allowance was available for the extra energy demands of double suckled heifers, resulting in similar liveweight gains between single and double suckled heifers. Furthermore, double suckled heifers were more productive and efficient than single suckled heifers. Hereford x Friesian (H x F) heifers were more productive than Hereford x Jersey (H x J) heifers regardless of suckling status. However, double suckled H x J heifers were the most efficient, probably because their maintenance requirements are smaller and because their genetic milk production potential was not limited by the quantity of milk that a single calf can consume in early lactation, as might have happened with single suckled H x J heifers. However, in OBH beef systems, the extra efficiency
generated by H x J heifers at weaning may be negated by their lighter carcass weight (16 kg in the this trial).

For beef production systems where Beef x Dairy dams comprise a major part of the breeding herd, it is necessary to accurately assess the effect of double suckling on dam reproductive traits especially if the dam is not a OBH and therefore is expected to give birth every year. Hence the effect of double suckling on reproductive traits and the interaction between milk production and different herbage allowances need to be assessed in non OBH double suckling systems. Finally as pasture is the main source of feed in New Zealand farming systems, and it is greatly affected by stocking rate, it is important to assess the effect of double suckling on stocking rate which may call for assessment of heifer herbage intake via intraruminal chromium controlled release and pasture growth rate data collection.

**Gross margins analysis**

In the present study double suckled heifers were more efficient and productive than single suckled heifers. However, it is not sensible to suggest adoption of different farming practices to farmers if economic aspects are not shown. Therefore, a gross margin comparison was made for the two suckling groups of OBH used in the present study (Appendix 1). The feed requirements of heifers and calves for the 100 day lactation period, were estimated through the use of spreadsheets constructed to estimate daily dry matter intake according to suckling treatment (Morris et al. 1994a). Thus, the estimated extra feed requirements for double suckled dams and their calves were 2.68 kg DM per day.

The gross margins per stock unit (su) estimated were $45.7/su and $61.3/su for single suckled and double suckled OBH systems respectively. This increase of $15.6/su in double suckling systems is primarily due to the sale of extra weaner calves. Gross margins, however, are sensitive to changes in prices. Hence, replacement cost of foster calves and market price (affected by time of
sale, breed and weight of the foster calf) obtained for the foster calf will have a
direct effect on gross margins variations.

CONCLUSIONS

As a large part of New Zealand beef breeding herds embrace Beef x Dairy
cows, double suckling systems using foster calves is an option for such herds
that can be easily adopted. If a feed shortage is foreseen, double suckling
systems that use foster calves have the flexibility of not buying the foster calves
and continue with a traditional single suckling system. On the contrary, if pasture
growth conditions are appropriate, the foster calves can be kept and used to
control summer pasture surpluses until weaning. Furthermore, when Friesian
calves are used as foster calves, they can be sold at 3 months of age for bull
beef systems and the cows’ own calves can be kept until commercial weaning
ages for weaner calves. These decisions will have to be based on pasture
condition and market prices at the time when early weaning at three months of
age might occur.

Other options for double suckling systems are: to rear Beef x Dairy heifers
as foster calves for replacements (as OBH or beef breeding cows); or to increase
beef weaner cattle sales by rearing Hereford x Friesian males for sale to prime
beef finishing systems. These options are suitable for the New Zealand cattle
industry, where a considerable part of the more than 800,000 odd bobby calves
that are slaughtered each year would be captured and taken through to finishing.

When sufficient feed is available to meet the extra nutritional requirements
of double suckled dams during the lactation period, liveweight gains are not
different between double suckled and single suckled dams. Furthermore, double
suckled dams are more productive and more efficient than single suckled dams.
This represents potential extra benefits at the farm level. If grazing management
skills are appropriate, and the beef breeding herd has the potential to produce
milk in enough quantities to rear two calves, double suckling systems look
attractive as a means of increasing both biological and economical efficiency of beef production.
APPENDIX 1

Gross margin calculation of single and double suckled once-bred heifer (OBH) beef production systems (After Parker 1994).

Table 1 Gross margin calculation of a OBH single suckling system.

<table>
<thead>
<tr>
<th>Assumptions</th>
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<tbody>
<tr>
<td>Replacements</td>
</tr>
<tr>
<td>- weaners 100 head</td>
</tr>
<tr>
<td>- yearling 0 head</td>
</tr>
<tr>
<td>Heifer calving (wintered) 85% pregnant</td>
</tr>
<tr>
<td>Losses</td>
</tr>
<tr>
<td>- weaners 2%</td>
</tr>
<tr>
<td>- R1 yr to R2 yr 2%</td>
</tr>
<tr>
<td>- R2 yr non pregnant 2% to sale</td>
</tr>
<tr>
<td>- R2 yr pregnant 3% to sale</td>
</tr>
<tr>
<td>- calves 5% to sale</td>
</tr>
</tbody>
</table>

Herd consists of 50% H x J and 50% H x F heifers

Stock wintered

<table>
<thead>
<tr>
<th>Number</th>
<th>Class</th>
<th>stock units (su)</th>
<th>total su</th>
<th>Value /hd</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>R1 yr</td>
<td>4.0</td>
<td>392</td>
<td>100.0</td>
<td>39,400.0</td>
</tr>
<tr>
<td>82</td>
<td>R2 yr-pregnant</td>
<td>5.5</td>
<td>451</td>
<td>500.0</td>
<td>41,000.0</td>
</tr>
<tr>
<td>14</td>
<td>R2 yr-non-pregnant</td>
<td>5.0</td>
<td>70</td>
<td>475.0</td>
<td>6,650.0</td>
</tr>
<tr>
<td>0</td>
<td>Bulls</td>
<td></td>
<td>0</td>
<td>800.0</td>
<td>0.0</td>
</tr>
<tr>
<td>194</td>
<td></td>
<td></td>
<td>913</td>
<td></td>
<td>$ 77,050.0</td>
</tr>
</tbody>
</table>

Total Revenue

<table>
<thead>
<tr>
<th>carcass weight (kg)</th>
<th>$/kg</th>
<th>$/head</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>79 R2 yr heifers-pregnant</td>
<td>217 1</td>
<td>2.63</td>
<td>571.0</td>
</tr>
<tr>
<td>14 R2 yr heifers non-pregnant</td>
<td>230</td>
<td>3.12</td>
<td>718.0</td>
</tr>
<tr>
<td>39 calves-male</td>
<td>280</td>
<td>2.09</td>
<td>585.0</td>
</tr>
<tr>
<td>39 calves-female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Bull</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTAL $ 82,243.0

1 Average carcass weight: 225 and 209 kg for H x F and H x J respectively

Variable expenses

<table>
<thead>
<tr>
<th>$/hd</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heifer replacements</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>- weaners</td>
</tr>
<tr>
<td></td>
<td>- yearlings</td>
</tr>
<tr>
<td>98</td>
<td>Breeding sire</td>
</tr>
<tr>
<td>14</td>
<td>Animal health - R1 yr</td>
</tr>
<tr>
<td>82</td>
<td>R2 yr non-pregnant</td>
</tr>
<tr>
<td>98</td>
<td>R2 yr pregnant</td>
</tr>
<tr>
<td>96</td>
<td>Synchronisation and artificial insemination</td>
</tr>
<tr>
<td>82</td>
<td>Feed (hay)</td>
</tr>
</tbody>
</table>

Interest on capital @ 5%

GM $ 41,724.0
GM/su $ 67.7

1 Average price: $330.00 and $270 for H x F and H x J respectively
Table 2  Gross margin calculation of a double suckled OBM system

<table>
<thead>
<tr>
<th>Replacements</th>
<th>100 head</th>
<th>0 head</th>
<th>67 head (assuming 85% success at fostering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heifer calving (wintered)</td>
<td>85% pregnant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Losses</td>
<td>2%</td>
<td>2%</td>
<td>2% to sale</td>
</tr>
<tr>
<td></td>
<td>3% to sale</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5% to sale</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2% to sale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herd consists of 50% H x J and 50% H x F heifers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stock wintered

<table>
<thead>
<tr>
<th>Number Class</th>
<th>stock units (su)</th>
<th>total su</th>
<th>Value $/hd</th>
<th>Total $</th>
</tr>
</thead>
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<td>4.0</td>
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<td>70</td>
<td>475.0</td>
<td>6,650.0</td>
</tr>
<tr>
<td>0 Bulls</td>
<td>5.0</td>
<td>0</td>
<td>800.0</td>
<td>0.0</td>
</tr>
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<td>194</td>
<td></td>
<td>913</td>
<td></td>
<td>$ 77,050.0</td>
</tr>
</tbody>
</table>

Total Revenue

<table>
<thead>
<tr>
<th>Carcass weight (kg)</th>
<th>$/kg</th>
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<td>79 R2 yr heifers-pregnant</td>
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<td>230</td>
<td>3.12</td>
<td>718.0</td>
</tr>
<tr>
<td>39 calves-male</td>
<td>300</td>
<td>11.00</td>
<td>330.0</td>
</tr>
<tr>
<td>39 calves-female</td>
<td>300</td>
<td>11.00</td>
<td>330.0</td>
</tr>
<tr>
<td>67 Friesian calves</td>
<td>280</td>
<td>2.09</td>
<td>585.0</td>
</tr>
<tr>
<td>1 Bull</td>
<td>280</td>
<td>2.09</td>
<td>585.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$ 104,353.0</td>
</tr>
</tbody>
</table>

1 Average carcass weight: 225 and 209 kg for H x F and H x J respectively

Variable expenses

<table>
<thead>
<tr>
<th></th>
<th>$/head</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heifer replacements</td>
<td>300.0</td>
<td>30,000.0</td>
</tr>
<tr>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1 Breeding sire</td>
<td>800.0</td>
<td>800.0</td>
</tr>
<tr>
<td>98 Animal health - R1 yr</td>
<td>10.0</td>
<td>980.0</td>
</tr>
<tr>
<td>14 R2 yr non-pregnant</td>
<td>8.0</td>
<td>112.0</td>
</tr>
<tr>
<td>82 R2 yr pregnant</td>
<td>10.0</td>
<td>820.0</td>
</tr>
<tr>
<td>98 Synchronisation and artificial insemination</td>
<td>25.0</td>
<td>2,450.0</td>
</tr>
<tr>
<td>96 Pregnancy testing</td>
<td>2.0</td>
<td>192.0</td>
</tr>
<tr>
<td>82 Feed (hay)</td>
<td>16.0</td>
<td>1,312.0</td>
</tr>
<tr>
<td>67 Double suckled heifers and calves eating 2.68 extra kg of DM/day @ 100 days</td>
<td>26.8</td>
<td>1,796.0</td>
</tr>
<tr>
<td>69 Friesian bulls</td>
<td>85.0</td>
<td>5,695.0</td>
</tr>
<tr>
<td>69 collars</td>
<td>6.6</td>
<td>442.0</td>
</tr>
<tr>
<td>Total</td>
<td>442.8</td>
<td>4,818.0</td>
</tr>
</tbody>
</table>

Interest on capital @ 5%

GM: $ 5,892.0
GM/su: $ 46.3

1 Average price: $ 330.00 and $ 270 for H x F and H x J respectively
BIBLIOGRAPHY


Diskin, M.G.; Connolly, W.; Sreenan, J.M. 1991: Growth rates of single versus twin born beef calves. *Farm and food research* 1, 1: 4-5.


