Seed Potato
Small is beautiful

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Conventional seed potato multiplication is a slow process and it takes over 6 years before seed tubers of a selected variety reach the potato grower. To ensure quality seed tuber production in the shortest possible time, a system has been developed at Kinsealy Research Centre for producing seed potato by integrating test-tube culture and conventional production. This has substantially reduced the cost and labour of multiplying potato cultures. The integrated system has the potential to produce 3 crops of mini-seed potato from March to December, as against a single crop grown in a field. Mini-tubers produce normal and healthy early potatoes true to type of the parent cultivar.

Potato crop grown from mini-potatoes under plastic.

High quality seed is essential for producing high yields of potatoes. Since potatoes are propagated vegetatively, all seed tubers are essentially clones of a single plant. Hence, a lot of care is needed in maintaining the trueness of the cultivar during multiplication. In addition, the seed tubers must be free from insect pests and fungal, bacterial and viral diseases.

Conventional multiplication

Conventional seed potato multiplication is a slow and cumbersome process, and requires high inputs of land, labour and time. The plant breeder, usually with the help of a plant pathologist, maintains a small quantity of the healthy tubers in the pure and true form of the cultivar, called the breeders' seed. In the conventional system of potato seed multiplication, breeders' seed is handed to agencies which multiply tubers through 2 to 3 cycles of propagation to build sufficient stocks of the nucleus seed. The nucleus seed is then grown and the seed crop is inspected a few times at regular intervals. This results in the production of certified seed for growing potato crop. The whole process of seed tuber multiplication can take over 6 years before seed tubers of a selected cultivar reach the potato grower.

The quality assurance of seed potato is essential not only for growing high yielding and quality crops at home, but also for the export of seed potatoes which cannot be undertaken without such an assurance. The current Irish seed potato export of 10,000 tonnes/year is valued at IR£2.5 million of which 90% is based on a single cultivar, 'Cara'. Any mishap e.g., mixing of tubers from different cultivars, outbreak of fungal and bacterial diseases, such as late blight, scab, blackleg, and infection with any of the several potato viruses at any stage during seed multiplication can delay varietal release, cause shortages of seed potato, affect exports, lead to the growing of alternative cultivars, and ultimately destroy the established markets for a specific cultivar.

Micro-culture method

To assure quality seed tuber production in the shortest possible time, a system has been developed for producing seed potato by integrating test-tube culture and conventional production at the Plant Biotechnology Department, An Foras Talúntais, Kinsealy Research Centre, Dublin.

Potato cultivars can be easily micro-propagated in test-tube cultures (micro-cultures) initiated from the apical meristems. For this purpose, 1 to 2 mm long pieces are taken from the tips of the shoots from sprouted tubers which have been checked for freedom from viral, bacterial and fungal diseases. The apices are surface sterilized, which removes all bacteria and fungi from the tissues. The tissues are then cultured under aseptic conditions on defined media which contain salts, vitamins, sugars and a gelling agent. The micro-cultures are kept under controlled conditions of light intensity, day-length and temperature. Under such optimal growth conditions, a single apical shoot-tip proliferates into several shoots within 30 days. Indeed, in some cases, it is possible to clone a single shoot into 2 within 10 days or multiply a single shoot into seven shoots within 4 weeks. Such tissue cultures, once established, can be recut and subcultured again and again, thus cloning the desired plant rapidly in a

Both Hereford × Friesian and continental × Friesian heifers were bred to continental bulls and then induced to calve on or just before Day 285, the sire breed gestation average.

Calf viability was higher for the induced groups and calving difficulty reduced even though calf birth weights were only marginally reduced.

When birthweight is close to the threshold for dystocia, a marginal reduction in calf weight will be sufficient to allow easier delivery. Using this parturition-induction regime, a once-calved heifer system could be based on the use of continental crossbred heifers, mated to continental sires. This would not only produce three-quarter bred continental calves, but the heavier and leaner carcasses suitable for the European market would improve the economic attractiveness of a once-calved heifer system.

TABLE 1: Induction of calving in once-bred heifers

Heifer breed type	Sire breed	Natural or induced calving	No. of viable calves (%)	Calf birth wt (kg)
H x F	C	Natural	16/18 (89)	41
H x F	C	Induced	20/21 (95)	39
C x F	C	Natural	15/18 (83)	42
C x F	C	Induced	16/16 (100)	40

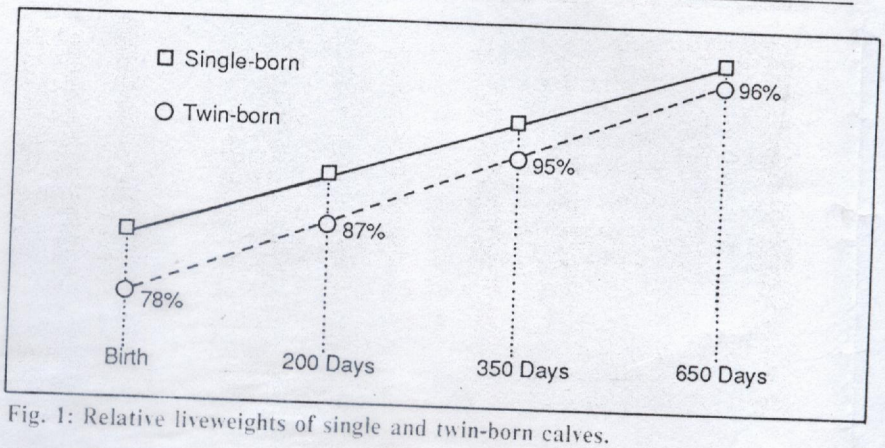

Fig. 1: Relative liveweights of single and twin-born calves.

Production of twin calves by embryo transfer

Profitability in suckler cow enterprises depends solely on high calf sales per cow. Successful twin-calving increases output as well as biological and economic efficiency (*Farm and Food Research*, October, 1987). If twinning could be extended to a portion of the national dairy herd this would have a major impact on calf numbers.

Over a number of years, research has been carried out at Belclare on the development of a twinning technique by embryo transfer and a study has also been made of the production and economic aspects of twinning. Following the research phase, a suckler herd was established at Belclare to test the efficiency of non-surgical embryo transfer to inseminated cows to induce twinning. This is summarised in Table 2.

Based on a pregnancy rate of 60% and a twin-calving rate of 50%, embryo transfers produced an extra 30 calves for every 100 embryos transferred. Farm trials carried out from Belclare suggest that the overall efficiency at farm level in beef cow herds would be 25 extra calves for every 100 embryos transferred.

The relative liveweights of single and twin calves from the Belclare herd are summarised in Figure 1.

From the production data generated by this herd the impact on beef output and financial returns were studied and recently published (*Farm and Food Research*, October, 1987). The returns computed for a 20 ha farm fully stocked and with a twin-calving rate of 50% in the mature cows, suggested an increased return of 22-38% in disadvantaged areas and of 35-64% in non-disadvantaged areas, depending on the sale date of the calves.

Production of twin calves by immunisation

If the ovulation rate in cows could be increased this would be a practical and cheaper way of producing twins. This approach is now being developed at Belclare. Following a primary injection and a booster some weeks later some 40% of the immunised or "vaccinated" cows have produced twin ovulations. These have occurred at several cycles over the breeding season. Further groups of cows are being treated and inseminated to check pregnancy and twin-calving rates.

TABLE 2: Efficiency of non-surgical embryo transfer to induce twinning

Twinning rate of cows calving	56/108 (52%)
Twin gestation length	280.5 days
Single gestation length	285.5 days
Twin birth weight	36.1 kg
Single birth weight	46.9 kg

Maintaining the beef quality of dairy calves

Friesian calves from the national dairy herd are and will be the predominant breed type for beef. In the national interest there is a need to maintain or indeed increase the beef characteristics of Friesians and Holsteins while simultaneously selecting for increased milk yield. This could be accommodated by initially selecting and then progeny- and performance-testing dairy bulls from a wide genetic base. This would help to identify bulls with good milking and beefing qualities.

Importation of calves

The very high calf prices during 1988 have given rise to some discussion on the possibility of importing calves. However, at the present time disease control regulations prohibit calf importation. Unless calf prices during 1989 exceed those of 1988, which is unlikely, calf importation is equally unlikely.

It is unlikely that any one of the above approaches will provide a significant increase in calf numbers in the short term. It is more likely that a combination of approaches, including both management and innovative technology, will be required to reduce the predicted calf deficit.

short duration, small space and on a year round basis, irrespective of the weather and season. Under special conditions of growth, it is possible to produce a million clones from a single apical shoot within 30 weeks.

Micro-tuber production

Potato meristem cultures when grown for 4 to 6 months without retransfer to fresh medium, produce micro-tubers, ranging from 2 to 12 mm in diameter. These tubers are formed on the stems or are produced in the medium-gel. By adapting disposable plastic containers with snap-on lids and multi-cavity trays, a modular system of micro-propagation has been developed which allows batch handling of containers and cultures and stacking during culture and weaning. This has substantially reduced the cost and labour involved in multiplying potato cultures. A single 150 ml container with 30 ml medium and 4 to 5 stem-cuttings after six months produces as many as 20 micro-tubers in addition to providing enough cuttings to generate 100 to 150 micro-cuttings.

The micro-tubers, ca. 5 to 10 mm in diameter, are exactly like the large seed tubers, ca. 35 to 55 mm, except for their minature size, and often have similar tuber shape, skin colour, and number, distribution and relative depth of the eyes as in the conventional seed potato tubers. Such micro-tubers can be used for multiplying and maintaining the parental cultivars in true and completely disease- and germ-free conditions, and are akin to the conventional nucleus seed. Because of their small size, as many as 500 can be packed in a 9 cm petri dish and can be shipped across the world at a very low cost.

Mini-tuber production

Four to six week-old test-tube cultured plants when grown in soil under plastic produce mini-tubers, ranging from 10 to 25 mm in diameter, within 80 days during summer and 90 days during autumn without heating in a plastic tunnel. The resulting mini-seed tubers are free from diseases and viruses and are akin to the certified seed potato tubers. The mini-seed tubers weigh 5 to 30 g each and can be packed and shipped more easily than the conventional field-grown seed potato tubers which weigh 70 to 110 g per tuber. In addition, the test-tube cultured plants when grown in soil produce a few large tubers which are comparable to the conventional table-ware potatoes. Since potato test-tube cultures can be produced in large numbers on a year-round basis, the integrated system has the potential to produce mini-seed potato on a year-round basis. It is thus possible to grow three seed crops under plastic from March to December as against a single crop grown in the field.

Comparative size of micro, mini and conventional seed potato.

Performance of mini-tubers

Mini-tubers were tested for their genetic stability and yield potential by growing them under a plastic tunnel. Mini-tubers produced normal healthy potatoes true to the type of the parental cultivar. Tuber yield/drill ranged from 1.7 kg after 80 days to 5.6 kg after 116 days from drills 2 m long and 60 cm apart with 8 plants per drill. This yield is equivalent to 12-45 t/ha (5 to 18 t/acre).

Micro-propagation of potato thus offers a number of potential advantages over the conventional method of seed potato production such as:

(1) Rapid multiplication and production of disease-free high quality seed tubers,
(2) Production on an year-round basis,
(3) Ease of packaging, shipping and handling of seed tubers,
(4) Diversification of glasshouses and plastic polytunnels for horticultural use, and
(5) Production of fresh tableware potatoes on a year-round basis and replacing imports of early potatoes.

At present, mini-tuber production is being investigated for producing seed potato tubers as a commercially viable project.

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