AUSTRALIAN NUFFIELD FARMING SCHOLARS ASSOCIATION

REPORT OF VISIT TO THE UNITED KINGDOM AND ISRAEL

By
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(Northern Territory 1987 Award

A Study of Embryo Transplant in the United Kingdom and Saline Irrigation for Arid Land Farming in Israel.

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INDEX

		Page
1.	Introduction	38
2.	Embryo Transplants	38
	Frozen Embryos	39
	Fresh Embryos	39
	Flushing	39
	Scorching and Recovery	39
	Grading	39
	Implantation	40
	Other points of Interest	40
	Chart	41
3.	Saline Irrigation	42
4.	Irrigation Systems	43
	Flood irrigation	43
	Sprinkler irrigation	43
	Drip irrigation	43
5.	Use of Computers in Irrigation	44
6.	Crops — Vegetables	44
	Grains	44
	Field crops	44
	Forage crops	44
	Date palms	44
	Citrus	44
7.	Points of Interest	45
8.	Findings & Interpretations for Central Australia	45

INTRODUCTION

For the past 19 years I have been involved with cattle stations, both in management and practical aspects, incorporation of new ideas and methods in arid areas, and also tourism. Our area is referred to as DESERT although we prefer to call it ARID.

— LOCATION:
360kms S.W. of Alice Springs and 80kms East of Ayres Rock.

— AVERAGE RAINFALL:
170mms (occasionally) at any time of the year, no actual wet season.

— TYPE OF COUNTRY:
Varies from Sandhill and Spinifex to Mulga and Saltbush flats.

— INDUSTRY:
Beef Cattle, both breeding and rearing.

— AREA:
1,028,480 acres or 416,200 hectares.

— BEEF NUMBERS:
5500—6000 head in good seasons, 300—1000 head in drought seasons.

Water is a major and precious commodity to us and is often taken for granted by others in the less extreme areas of Australia and the world. There are no permanent rivers, lakes, or surface water in our area and "run off" from rain is not a reliable source. Underground water is scarce and hard to find, and when found, is often un-usable (saline) or in limited quantities. (Both in litres per hour and life expectancy of bore.)

As our area contains "salty" water overall, irrigation has never been attempted in the past due to salinity problems, limited amounts of "fresh" water and lack of confidence in the feasibility of saline irrigation and knowledge of techniques.

The standard of beef cattle has been "average" in the past due to the extreme conditions found in our area. To restock with stud quality cattle has been impossible due to limited numbers of cattle available at the time and limited "cash" available after years of nil income due to drought. Therefore we took what we could get and relied on numbers to help offset the lack in quality.

In recent years the technology in various fields has increased considerably and rapidly, but has been hard to put into use due to lack of information on how best to use it in our extreme conditions.

The Nuffield Farming Scholarship gave me the opportunity to study and gain knowledge in two areas which I feel may greatly influence and upgrade the Central Australian cattle industry in the future.

One of the great "hardships" I encountered whilst in the United Kingdom and Europe was the closeness and intensiveness compared with our isolated way of life. Our nearest town is 360kms away and our nearest neighbour 80kms.

This report consists of information regarding:—

— Embryo Transplant

— Saline Irrigation

— Findings and Interpretations of uses in Central Australia

The report that follows represents my own experiences and findings. These are not necessrily those of the Nuffield Farming Scholarship Trust.

Embryo Transplants

Years ago, Artificial Insemination (A.I.) was a wonderful "new" way of improving your herd without having to outlay thousands of dollars on one bull. A.I. gave the farmer the opportunity to use semen from top quality bulls from all over the world at a fraction of the cost of the bull's actual value and thereby gaining genetic improvement from a vast sire range, hitherto unobtainable. In years past the vet did all the work as it was considered "High Tech" and that the average farmer was not able to carry this out. Over the years it was found that the technique was not impossible for the farmer to perform and the more advanced thinking farmer soon learnt to do A.I. himself. Today, A.I. is accepted as a normal husbandry practice by the majority of stud breeders.

Embryo Transplant (E.T.), although complex, is not as mystical or magical as it seems, if one has a good understanding of the workings and goes about it in a logical manner.

Today E.T. is much the same as A.I. was years ago. The thought that only the vet could do the job is normal thinking. There are a few advanced farmers who have learnt how to do E.T. as such, but few have gone all the way and learnt to do actual "Flushing", "Searching", and "Grading" of embryos.

E.T. is actually transplanttion of an embryo (Fertilized Egg) from a superior female animal (Donor) to a lesser quality female animal (Recipient). E.T. is the method used to try and achieve the greatest number of offspring of superior genetic potential in the shortest period of time.

ANIMAL MANAGEMENT

Animal Management prior to E.T. is a very important factor. A cow or heifer that is in poor condition is as bad as a cow that is fat or over fat. Both conditions lead to a decline in fertility and conception rates. Ideally, a cow should be in a good forward store condition and gaining steadily (rising plane of nutrition) for at least 8 weeks before starting a programme.

During all stages of pregnancy the cow should, preferably, be in good condition at all times. Particular care should also be taken prior to calving as a fat cow can have calving problems. It is not a good practice with a fat cow to cut her feed back and reduce weight in the last 6 weeks of pregnancy, hoping to make calving easier. Studies have shown that when this is done the birth weight of the calf is lower and not as healthy. The reasons

being that during the last 6 weeks of pregnancy the calf requires more nutrition than at any other stage of development. Many farmers make this mistake today, particularly when using the popular European breeds which tend to have bigger and heavier calves. A birth weight of 65 to 70kg is not uncommon with these breeds. The bigger the calf, the greater the chance of problems at calving time. Therefore nutrition management is of great importance from before conception, during pregnancy, and to just after birth. This applies to both Donor and Recipient cows and heifers.

All cattle, Donor and Recipients, should be quiet and well handled in yards for both safety and stress factors to obtain optimum results from any programme embarked upon.

FROZEN EMBRYOS

Frozen embryos are packaged into ampules and straws very similar to semen, except the straws are longer. The "strawed" embryo is then stored in the same way as semen straws in cannisters filled with liquid nitrogen. But while semen can be thawed in water at 37°C and used immediately, the embryo has to be thawed, washed, and "Rehydrated" before use. The Thawing/ Rehydration process is reasonably complicated and normally done by a vet.

Having studied and experienced this process, I feel that the farmer could do this himself, provided he has all the equipment necessary and he has studied and fully understands the steps and reasons for them.

The great thing with Frozen embryos is that you can store them indefinitely (as with semen) and also get the wider genetic improvement that specialized stud breeders have worked for years to obtain. The one drawback with Frozen embryos is that the pregnancy percentage is down by 10% (average) on fresh embryos and the money outlayed in buying Frozen embryos has 10% less chance of being realized. All in all, Frozen embryos are the best way to go in the future, once your basic herd has reached an acceptable standard or you are starting a new stud herd line. By this I mean you use the Recipient cows you have and implant a Frozen embryo from, say the U.S.A. or U.K. without having to import a live animal and you have the new breed on line in your first calf. Only A grade embryos are used in freezing.

FRESH EMBRYOS

Fresh embryos are obtained by flushing the Donor cow on farm. They can then be transplanted to the Recipients immediately and the amount of calves per year can be substantially increased to prove or realize the genetic improvements. The use of Fresh embryos can utilize all grades of embryos i.e. A, B and C, without the cost factor of Frozen embryos using only A grade.

FLUSHING

Hygiene and carefulness are two important factors for a successful flushing. There are many variations and techniques but the methods are basically the same. I will briefly describe two methods that I studied in the U.K.

1. GRAVITY METHOD

   With the cow in the crush or bail, a 3-way Catheter is inserted and positioned. The flushing medium (generally Ovum Culture Medium) is held in position approximately 500mms higher than the cow and fed into the 3-way via one line. The outlet runs into a container approximately 500mms lower than the vagina. The outlet line can have an embryo filter installed which greatly shortens the amount of time spent in searching later on.

   The bail or crush is usually raised 200—250mms higher at the front to facilitate the gravity recovery method.

   While the medium is running through the uterine horn you rectally palpate the horn to help loosen embryos that may be "stuck" to the wall. Approximately 500mls of medium is required per horn. This method was one of the first used and gives good results.

2. SURGE METHOD:

   Again the cow must be in the crush or bail. A 2-way Catheter is inserted and positioned. Using a 50ml syringe, the medium is forced gently in and out of the horn several times before finally being deposited in a container. This is done 4 or 5 times per horn. While doing this the operator must rectally feel the amount of distention in the horn and palpate it at the same time. The medium is allowed to settle in the container for 25 to 30 minutes before the excess medium is drained off leaving embryos in approximately 20mls of medium. Approximately 200—250mls of medium is used per horn. A filter may be used with this method but I never saw one used as the operator didn't think them necessary.

   This method is gaining popularity as it is quicker than the gravity method and the results are comparable.

SEARCHING AND RECOVERY

With either method used above the searching remains the same. The remaining 20-25mls of medium containing the embryos left in the container is then divided into four petri dishes of approximately 4-5mls. These are then placed one at a time under the microscope where the actual searching begins. One tip I found very useful was to scribe grid lines into the bottom of the petri dish. This helps by using a square grid search pattern instead of trying to search in a featureless abyss. (Anyone using a microscope knows what I mean.)

A great deal of patience is helpful when first learning. As each embryo is found, it is picked up using a micro dispenser and placing it into another petri dish containing fresh medium. When all live embryos are found and have been transferred to fresh medium, the grading then begins.

GRADING

There are 4 categories of embryos:— A: Best Quality; B: Good; C: Dubious; D: Deformed or Dead. Again the embryos are picked up and placed into the respective dish with fresh medium. It helps to have each

dish marked i.e. A, B, C, or D. This helps in case of forgetfulness or mixing dishes up when moving. This step is repeated 3 times, each time using clean medium. There are 2 reasons for this. It helps to check that each embryo is graded correctly, and it cleans any foreign matter off or away from the embryo ensuring the best results can be obtained when transplaning begins.

Heat or high temperatures affect and kill embryos quickly. Therefore the best temperature to work in is 20°C or less. The embryos may be stored in a refrigerator at O° to 1°C for up to 24 hours before they die. Storing them overnight in a petri dish on ice with a little water (which keeps them 0-1°C) is often done if the Recipient cows are not tighly synchronized and they are up to 24 hours apart in Oestrus.

IMPLANTATION

There are 2 methods used. Surgical or Non-surgical. The Surgical method was the first method used and also gives the best results, although it is more expensive than the Non-surgical.

The Recipient cow is brought into the bail or crush and checked for ovulation, time, and side of ovulation. The side of ovulation is important as an embryo placed in the wrong horn has very little chance of attaching and survival. Another reason for this with the Surgical method is you don't want to incise the cow on the opposite side making the operation difficult. Once the incision is made (after the appropriate anaesthetics are given) you can visually check the ovary much better than by the rectal feeling of it. This is to make 100% sure. The actual implanting of the embryo into the uterine horn is a reasonably easy procedure but gentleness and care in handling the horn is of great importance. The embryo is deposited into the horn by use of a micro dispenser. The horn is replaced in its normal position and then the incision is stitched and treated with antibiotics, either liquid or powder, or both are used.

The Surgical method is still used in favour of the Non-surgical method when dealing with the "top" stud embryo transplants as the percentage factor of 5-10% is of importance along with the cost factor of the embryos whether Fresh or Frozen.

The pressure from animal liberation groups particularly in the U.K., are forcing many vets and studs into the Non-surgical method, as the Surgical method is classed as an "unwarranted operation." I feel this pressure is not warranted. It is practical in this situation as neither the farmer nor the vet want practices which waste money, time, and valuable cattle. This is even more pronounced when looking at U.K. farmers in the E.E.C. context, where many are being forced into cutting costs to survive as the E.E.C. gets further and further into financial difficulties.

The second method is Non-surgical implantation. This method is very similar to A.I. techniques except you are going a step further and deeper into the reproductive tract. The actual pistollette is longer than the A.I. pistollette by 200mm.

The Non-surgical method is a much simpler method than the Surgical one. No anaesthetics are necessary; there is no cutting or stitching, etc. and it is normally quicker than the Surgical method. The success factor is up to 10% less than Surgical but this may improve as more and more vets and studs move into this method and more is learned from experience.

One major drawback is that at all times the operator is working "blind" and by feel alone. A vast amount of experience is required by the operator in this method to keep the percentage factor within sight of the Surgical method.

While studying with the vets in the U.K. I found that the Non-surgical method was often preferred as they are mainly on their own while doing the E.T. Surgery necessitates at least one helping hand from the farmer while the Non-surgical doesn't need him at all.

OTHER POINTS OF INTEREST

Some other interesting points learnt while studying in the U.K. come to mind:

The success rate of Fresh versus Frozen embryos has come much closer in the last few years. In the past, all usable grades of embryos were being used in Fresh transfers, resulting in high success rates. Now that most A grade embryos are being used for freezing, whether for sale or storage, this has resulted in a lower success rate in Fresh transfers. I think that in all fairness this should be taken into account, when looking at the difference in success rates (%'s) between Fresh and Frozen.

At Cambridge University Animal Research Centre, research is being done in surgical recovery of ovum, invitro fertilizing and nurturing. The ovum are surgically recovered from cows at the abattoir and taken back to the lab to be fertilized. The fertilized ovum are then surgically placed into the fallopian tubes of a ewe. The fallopian tubes are tied just before opening into the uterine horn so the embryos cannot continue their journey and are held there for 4-5 days. The ewe is killed and the entire reproduction tract is taken out and into the lab where the embryos are again surgically recovered and the live embryos are then transplanted into the Recipient cows.

There is much to be learnt from this before it will ever become a commercial venture in everyday farming, as at present surgical recovery of ovum destroys the ovary. The idea behind this research is to bring the cost of embryos down and increase the amount of embryos to be stored for own use or sale. This research is still very much in its infancy and will be many years before a major breakthrough is achieved.

Also at Cambridge University Animal Research Centre, Dr. "Twink" Allan is doing E.T. of donkey embryos into horses. The embryo is surgically implanted into the mare and then carefully watched for 5-6 days. The mare more often than not aborts at this stage and studies from this have found the reaction to be very similar to women who abort their pregnancies. The reasons why he is studying this (much too complex and complicated for me to have taken many notes on this subject) is to gain insight into the complexities concerned and thereby benefit human medicine.

The average cost of E.T. in the U.K. at the time I was studying was $1,920.00. (Based on an exchange rate of $2.40 Australian to the English Pound.) The number of E.T.'s in the U.K. is approximately 5500 to 6000 per year. This is a very similar number to Germany and France. The U.S.A. and Canada combined number 200,000 per year but this may come down

PROGRAMME

CLIENT		DONOR	
DAY	DATE	TIME	TREATMENT
		ALL DAY	DONOR HEAT
		A.M.	Recipients: 5cc Lutalyse OR 2cc Estrumate
		A.M. P.M.	Donor 2 cc inj. Intramuscular Donor 2 cc inj. Intramuscular
		A.M. P.M.	Donor 2 cc inj. Intramuscular Donor 2 cc inj. Intramuscular
		A.M. P.M. P.M.	Donor 2 cc inj. Intramuscular Donor 2 cc inj. Intramuscular Recipients: 5cc Lutalyse OR 2cc Estrumate
		A.M. P.M.	Donor 2 cc inj. Intramuscular AND 3cc Estrumate OR 7cc Lutalyse. Intramuscular Donor 2 cc inj. Intramuscular
		A.M. P.M. 6.00 P.M.	Donor 2 cc inj. Intramuscular Donor 2 cc inj. Intramuscular Donor 1st A.I. (1 straw)
		8.00 A.M. 6.00 P.M.	Donor 2nd A.I. (2 straws) Donor 3rd A.I. (2 straws)
		8.00 A.M.	Donor 4th A.I. (1 straw)
		9.00 A.M.	Donor Collection

RECORD OF RECIPIENT HEATS

YOUR RECIPIENT IDENTIFICATION	DATE OF PG1	DATE OF HEAT AFTER PG1	DATE OF PG2	DATE OF HEAT AFTER PG2	A.M. AND/OR P.M.
HEAT = STANDING WHEN RIDDEN					

Note: PG1 and PG2 = PROSTAGLANDIN = 5cc Lutalyse or 2cc Estrumate at each injection.

drastically (up to 50%) due to Federal Tax laws instigated this year. Australia does approximately 3000 per year, but this could rise with the amount of embryos being imported to Australia in the near future: Israel, 500-600 as they have only started E.T. in the last 2 years.

The number of transplants from embryos collected from a heifer is limited to 10 until the heifer has a natural pregnancy. U.K. Breed Societies state that blood typing of E.T. calves must be done to prove sire before the calf can be registered. The blood typing of E.T. calves is not done in Australia, Canada, or the U.S.A. before registering a calf. I think this should be mandatory to keep stud breeders honest, to protect the buyer, and ensure pure bloodlines.

Splitting of embryos is still not a commercial proposition. Because of the cost of the equipment, time required, and success rates, it still proves too expensive for the average stud breeder. Most vets are still trying to perfect a way of splitting the embryos and get good results, percentage wise. So far the splitting of embryos is giving an average of 40% result. Thus the cost involved so far doesn't warrant the stud breeder going into this in depth. For example 10 embryos collected and fresh Surgical transplant gives 70% i.e. 7 pregnancies. 10 embryos collected and split and fresh Surgical transplant gives 40% i.e. 8 pregnancies.

There were a few breeders and vets working on this and some results were up to 50-55% which is promising. I know that there are results with E.T. splittings that are up to 85-90% but there are more than that below 40%. All percentages quoted are taken over total numbers per year, as a mean average, which I think is fairer and more truthful.

Some of the vets I studied with use two seperate sheets for the programmes for Donors and Recipients. The one I found easiest and simplest to use was the combined programme which was given to me by Alex Morton, shown on the following page.

SALINE IRRIGATION

No matter where you go in the world, (except Israel), saline water is regarded as being "evil" and only in the most extreme cases to be used with trepidation and as a last resort. World wide, Israel is accepted and acknowledged as being the originator and leader in saline irrigation techniques and plant biology where salt tolerance and yield are optimum requirements.

The trip to Israel to study saline irrigation techniques unfortunately was too short but it was an eye opener for me. One thing that sticks so clearly in my mind was their attitude to farming. Being a nation entirely dependent upon exporting (similar to New Zealand) to survive, their approach to anything they do is: It must be 100% minimum or they don't want it. In other words, Quality — Not Quantity. (Which is refreshing having seen some of the E.E.C. countries.) Also they make use of what the have and find ways around the obstacles that make life difficult, i.e. saline water, poor soils, extremes of climate, etc. Israel in many ways is very similar to Australia; small areas of fertile country and reliable rain, vast areas of arid and desert regions. Israel today is a developing country for agriculture that makes Central Australia look like the Garden of Eden in comparison.

In Israel, the main source of fresh water is the Sea of Galilee (Lake Kinneret). Giant networks of pipes take fresh water all over the country, to farmers and all urban areas. Rainfall in the Golan Heights replenishes Lake Kinneret, and the levels are carefully and strictly maintained all year. Great importance is placed on the amount of water taken out and a minimum level is strictly adhered to. If the water drops below way, say, O metres, the weight of the remaining water is not enough to keep the salt water springs closed, thus permitting salty water to mix with the fresh. Much money has been spent trying to seal the springs off or divert them into the Jordon River, allowing the salty water to run into the Dead Sea.

In the early 1940's Lake Kinneret was the main source of fresh water, with a salinity level of 540ppm. Today, 40 years later, the lake is still the main supply of fresh water, with a salinity level of 300ppm. By stringent conservation and new methods of irrigation, their total crop production has risen 1200% plus meeting urban growth requirements, with no increase in the total amount of water taken from the lake.

In the ensuing years much research has gone into gaining knowledge in hydrometeorology and hydrology dealing specifically with the development of underground water. Underground supplies of saline water are in abundance and bores producing 400,000 litres per hour are not uncommon. This bore water can range from 2000 to 10,000ppm and greater in some areas. The bore water in most cases is pumped and mixed with fresh water and then used in the watering of vegetables and other crops.

While in Israel my main studies were centred at Beer-Sheva. The Boyko Institute for Agriculture and Applied Biology, part of the Ben Gurian University, devotes much of its energies into the development of viable cropping using saline waters. Prof. Dov Pasternak (Director of the Boyko Institute) has devoted 20 years of research into this area and is acknowledged world wide as a leader in this field. I feel that special acknowledgement is due to him, for providing me with his valuable time, attention, and knowledge. He presented me with a copy of his report entitled; SALINE WATER IRRIGATION IN THE NEGEV DESERT," condensing 20 years invaluable experience into a mere 41 pages. His findings are the basis of my report and all crop yields, figures, etc., are from this document.

IRRIGATION SYSTEMS

There are 3 main types of irrigation which I will briefly describe. They are Flood, Sprinkler, and Drip irrigation.

FLOOD IRRIGATION

This method is used where the land is flat or has been

laser levelled with a slight down hill grade. Tremendous amounts of water are necessary for this method along with the added installation cost of irrigation channels to carry the water. Flood irrigation over a period of time will increase the salt levels in the soil and eventually ruin the land as has and is happening along the Murray River in Victoria and South Australia. This method is useless in areas such as Central Australia, Israel, etc., as there is not the amount of water available and also evaporation rates are too high and salt build up would take considerably less time.

SPRINKLER IRRIGATION

This method is the most common used throughout the world today. Areas that have large amounts of underground water usually are equipped with the central pivot type. The outlet is nearly always in the centre of the field, the central pivot spray booms are connected to this and revolve around the outlet.

Central pivot booms can be anywhere from 100 metres long to 800 metres long with sprays near the bore being fine and getting larger as they go towards the end due to the amount of distance travelled at the end of the radius compared to the centre area. Good quality water (900ppm and under) is required for this method.

Pipes and "reel in types" can also be used but have the "labour" problems of continual shifting of sprinklers and booms. Large amounts of water are necessary for sprinkler irrigation as all the soil is wetted although only the actual plant root area is necessarv.

In areas where the evaporation rate is not high, the salt build up is no problem, hot arid regions have high evaporation rates which cause various problems, e.g., salt build up, leaf burn, scalding of foliage, and when extremely hot can only be used at night. (Refer diagram 1a)

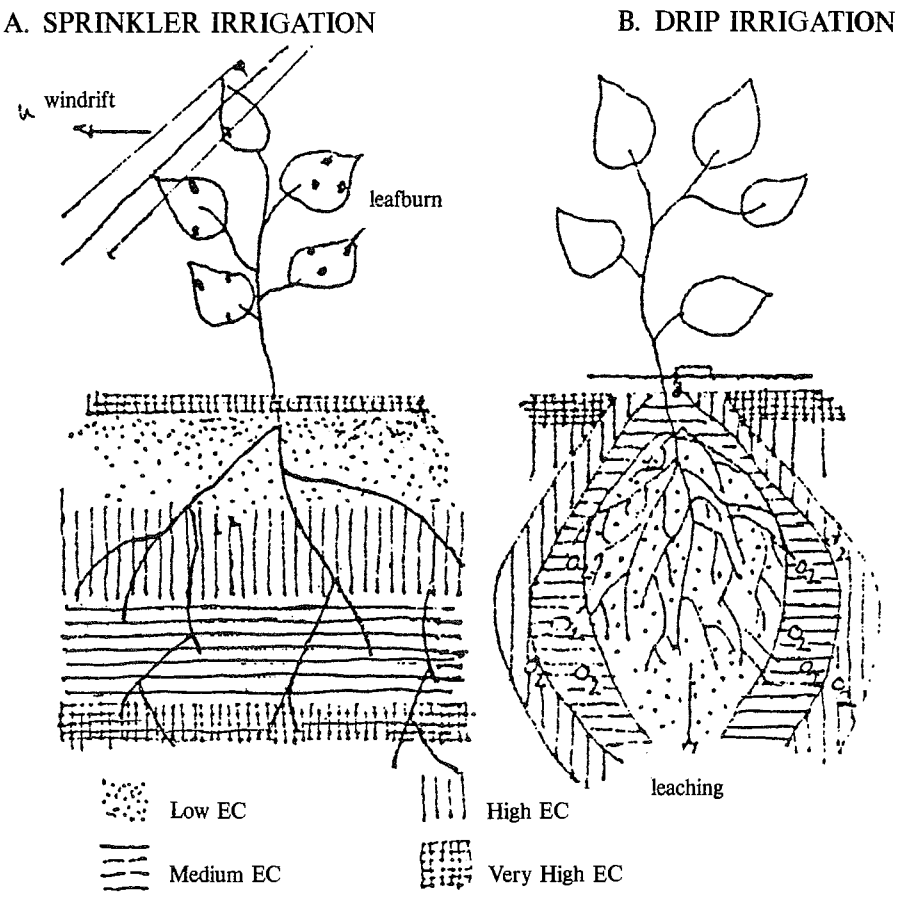
DRIP IRRIGATION

Development of a method of irrigation that could be used in hot arid areas with high salinity water was started in Israel many years ago. The drip system was the eventual method discovered, with it many advantageous points. Some of these being:—

— Exact control of amount of water per hour
— No wastage of water on areas where no roots are growing
— More water per plant with the same amount of water used in sprinkler methods
— Can be used even on the hottest days
— No leaf burn or leaf salt toxicity problems
— Salt build up in soil more controlled
— Cheaper than any other method to install
— The added factor of using small amounts of fertilizer over the whole crop life by the method call fertigation where fertilizer is dissolved and pumped into the water at a controlled rate at each irrigation
— Better aeration of the soil

There are also disadvantages with drip systems. Forage crops such as Bermuda grass, Lucerne, Sugar beet, Cotton, etc., still required the sprinkler methods due to root systems. (Refer Diagram 1b)

DIAGRAM 1



E.C. (Electrical Conductivity) of water is used world wide to determine the amount of salt in solution. It is also used to determine the amount of salt in the soil when wet. Water which has an E.C. of 1.2 is considered fresh water; it can also be quoted as 768ppm (parts per million). An E.C. 5.5 is saline water with 3520ppm. An E.C. 15.0 is salt water with 9600ppm.

USE OF COMPUTERS IN IRRIGATION

Israel is a land where computers are an integeral part of any farming programme. This is even more noticeable in the irrigation areas whether sprinkler or drip systems are used. The cost of labour is extremely high and any method of cutting this cost down is used. Where irrigation necessitates opening and closing of valves, controlling mixtures of fertilizer for fertigation, and amounts of water, it is now being done by computer. Where the salt content is too high and fresh water must be mixed with the saline water to bring it down to an acceptable level, computers show their usefulness again, through constant monitoring and making adjustments when necessary.

At the Ramat Negev Regional Experimental Station, studies were being conducted on various crops using different salt contents in the water. For example one crop had 5 different levels of salinity:— 900ppm, 1400ppm, 2000ppm, 3400ppm, and 4600ppm. On each plot salt and fresh water were mixed to these levels. The computer controls the amount of salt water added to give the exact readings and also control the amount of water per hour, stopping and starting the water when necessary. One interesting point was that nearly all the computers are solar powered. Development in this field and the reliability of the computers is outstanding.

Farmers are using computers in their offices to record crop, livestock, money, etc., to a degree that almost makes the pencil and paper obsolete.

VEGETABLES

As stated earlier, Israel is an exporting nation. Vegetables play an important part in export earnings. Saline irrigation in some instances has proven beneficial through increased yields and dry matter, and cosmetic appearances. Tomatoes and melons are two that come into this category. Saline water has been proven to increase firmness, colour, reduce the occurence of green shoulder and increase dry matter in both the salad tomato and processing tomatoes. The farmers in Israel have taken advantage of this and now airfreight tomatoes to E.E.C. countries and the U.S.A. where they command top prices. Melons have been found to have improved taste and firmness. The taste property takes two weeks to disappear in storage. So the farmers again have taken advantage of this and export these melons in late summer and autumn, again commanding top prices.

GRAINS

Studies done on wheat, sorghum and maize with water salinity up to 3500ppm have shown good results. In some instances the crops have shown improved yields with salinity up to 5000ppm. Maize in particular, yields as well on 5000ppm as on fresh water of 760ppm. Sorghum has a slight decrease in yield compared to wheat which has a slight increase on 3000ppm. The wheat and sorghum are sprinkler irrigated and the maize drip irrigated. Maize and sorghum are being used in the lot feeding and dairy industry in Israel and all were attaining good results.

FIELD CROPS

There have been studies in various field crops and many are now being used by Israeli farmers. In most cases, the yields from saline water were marginally below fresh, whereas cotton had an impressive increase.

Sugar beet, cotton, processing tomatoes, and sweet corn are the most impressive and popular with farmers. Again the tomato canning industry in Israel is paying significant bonuses for saline tomatoes, due to an increase in amounts of tomatoes suitable for canning. Some of these may even be suitable for Central Australia.

FORAGE CROPS

There are a few grasses that grow particularly well on saline water up to 3500ppm and give good yields as well as being nutritious. Bermuda grass and Rhodes grass are giving yields of up 330 tons/ha and can be used for hay or silage.

Roger Benjamin of the Gilat Regional Development Farm in the Negev Desert is using Cettarria and Pencillaria on water with 4000ppm and the growth was impressive and both are usable for hay. He has also done studies on using cotton as a feed for cattle and sheep. The cotton is left to grow until just before the seed splits. The crop is then sprayed to kill the growth and animals are left to graze this in the field. Also the trash from the gin mills is being used and good weight gains are being attained.

From what I can gather, all these grasses have the same or better food value when compared to Lucerne, which is not salt tolerant.

DATE PALMS

While in Israel I had the opportunity to study and talk with Dr. Zwi Bernstein at the Laboratory District Agricultural Centre, Jordon Valley District, near Zeemach. His specialty is date palms and the setting up of date farms and processing plants. The problems with dates are numerous and the processing plants expensive. The government backs all date farms and processing plants.

Fresh dates are a big market but there are many problems with freight, refrigeration and shelf life once in the supermarkets. Average price per ton in Israel is U.S.$4000 but when sold in Europe they only get U.S.$700/ton. One area where they are making good is in the ornamental tree sales to big hotels and business houses in Europe. For date palms in the 4 to 7 years old bracket they are receiving an average of U.S.$500 in Israel. The purchaser pays the freight from there themselves.

CITRUS TREES

As we all know from experiences here in Australia, citrus trees are nôt very salt tolerant. An average chlorine ceiling limit for irrigating citrus is 180-200mg/lt. Israeli geneticists have been developing a plant that will resist salinity contents of chlorine up to 1500-2000mg/lt. They have several times successfully repeated this but a few more years are needed until

we see this tree in the commercial field. This could be very helpful to our citrus farmers along the Murray River who are having salinity problems.

POINTS OF INTEREST

When you first arrive in Israel, one thing that stands out to an Australian is the gum trees. Many types of eucalyptus trees have been brought into Israel and used extensively along road ways and in the desert in "run off" areas. The trees have been selected specifically for their ability to withstand long dry periods. The seedlings are planted in the winter months when the rainy season starts and must be able to establish themselves during that wet time. Reafforestation in many areas use eucalypts and acacia exclusively. Acacia Silensia in particular is being used as a wind break for paddocks as it is quick growing, heavy crowned and drought tolerant.

The Israel Holstein breed of dairy cow was developed from the local breed and crossing with the Dutch black and white and later with the Holstein-Friesian.

Over the years of crossing, the Israel Holstein developed and has a number of qualities:— high milk production; good meat production; resistant to diseases; adaptable to varying climates. The latter is proven through the use of the Israel Holstein from the Golan Heights, to the Negev Desert, to the Aravan Valley. The Israel Holstein has been exported to countries such as Zambia, Egypt, Italy, Yugoslavia, and Iran. Semen has been used extensively in India, Thailand, The Philippines, South Africa, Brazil, France, Poland, Germany, and Spain.

The milk production in these cattle is consistently in the 7000kg/year and range through to 11,000kg/year. The use of citrus pulp and poultry litter to replace high cost imported concentrates is proving successful. This applies also to the beef units. Whole cotton seed including lint is being used as a supplement because of its high energy concentration and high fibre content.

Saltbush from all over the world has been collected and studied at the Migda Arid Land Experimental Station by Mr. Meir Forti. The saltbush has been planted and tested on natural rainfall, saline water and sea water (40,000ppm). Experiments are continuing but the most adaptable and high yielding is the Australian variety "Old Man Saltbush". This variety has good BIO mass, good palatability, and good recovery from intensive grazing and cutting. Saltbush is being developed for use mainly by the Bedouin people in an attempt to get them to settle and raise their sheep without continually destroying fragile country in the desert areas.

One impressive and important water resources management that has been implemented is the treatment of sewerage water. This has helped farmers by increasing the amount of water available for agriculture. Not only is treated sewerage water used in watering ovals, etc. in urban areas but is treated sufficiently to be used in growing of crops in the areas surrounding urban centres without health problems. Every possible amount of water is used to help lessen the burden of the limited fresh waters available.

From all available literature I have, nowhere have I seen an actual monetary value on water in Australia. Water in Israel is a valuable commodity. Farmers repeatedly told me that water was worth 80c in the dollar (US) of all actual input costs involved. So it seems fair to assume the remaining 20c in the dollar covers costs such as seed, fertilizer, labour, machinery, etc.

FINDINGS AND INTERPRETATIONS FOR CENTRAL AUSTRALIA

The Central Australian beef industry has always depended on extensive land and large numbers of cattle due to climatic conditions. Because of the extensive areas, animal husbandry practices were developed to suit these conditions; which differ greatly from the intensive husbandry practices. The cattle raised in these extreme conditions have had to be hardy and adaptable types. "Survival of the fittest" types were soon recognised. Cows that had calving problems were sold if found. Those that weren't died. Not always did, or do, the stud type cattle survive in our extreme conditions.

Bulls are bought in and let run with cows 12 months of the year and calvings are subsequently spread over this period. The numbers of bulls required for good calving percentages in our area is far above what is required for more normal conditions and farming areas.

The standard of cattle, through droughts and economics, in Central Australia can be described as average. Because of this, large numbers of cattle were run to maintain a viable proposition.

Over the last 15 years, management practices have changed considerably. The main reasons being the economics and disease eradication. Prices for cattle received today are almost the same as those received 12 years ago, but labour and operating costs have risen dramatically in this time. Disease eradication in Central Australia has added costs drastically to normal operations. To control diseases more easily, fencing has played a major role and new methods of controlling watering points introduced. These added costs are forcing the beef industry in Central Australia to change management practices to remain viable.

To keep up with the changes in recent years, pastoralists are trying to increase the standard of cattle to attain better prices. Natural breeding with stud bulls and Artificial Insemination are being done, but results are slow to be realized and appreciated. I feel this is where E.T. can help play a vital role in a commercial situation.

Stud bulls that are introduced to this area need 6 to 12 months to acclimatize, in reasonable seasons.

As stated earlier in this report, the average cost for E.T. was $1920. The major portion of this cost was the purchasing of Recipient heifers or cows and vet charges. I feel that for me, that one cost is eliminated as we already have heifers on the station that could fulfill this role. It is from these heifers and cows, that are survivors, that the resulting E.T. calf would learn to also survive. The "stud" calf would grow and learn from its Recipient mother the finer points of survival in harsh conditions and climates. This would be passed on in future to the E.T. and A.I. calves being born. I feel this is a major factor for E.T. when compared to importing cattle from areas outside Central Australia.

Improved fencing and facilities are required before any E.T. programme can be started as a more intensive animal management practice is required. This is not a major obstacle to E.T. as a lot of this has already started, and few extras are required to bring the necessary management practices into service.

E.T. compared to A.I. has many advantages, as stated earlier, and the genetic improvement and actual standard of cattle will be realized and appreciated much more quickly. I feel that to keep ahead of an ever changing economic climate, speed is the essence, and time saved on improving the entire breeding nucleus is at a premium to maintain our viability.

With our large numbers of Recipient cattle always at hand, costs in E.T. can be minimized and I feel certain we can prove the value of E.T. on a commercial scale that hitherto has not been tried in our area.

As with Israel, water is a valuable resource in Central Australia. The majority of water we have, is used only for watering stock and our own needs. Much of this water is suitable for saline irrigation and knowledge of how to implement this into our land is all that is needed (assuming of course that money is available), apart from a little gambling initiative.

The cost of setting up saline irrigation and what can be grown, must of course be thoroughly explored and then compared with the cost of buying in grain, forage, etc. from other areas. The cost of irrigating must be at the minimum, the same as the imported products or better still less than the cost of importing. It's simple economics.

I feel sure they could or will be less, due to the long distances involved (freight) to import grain, forage, etc. from southern areas where they are readily available, e.g. Meadow hay bought in South Australia cost $2.00 per bale. The freight was $3.00 per bale, which makes the overall cost of the bale of hay quite high. The freight cost and amounts of produce involved, make importing forage an expensive commodity. Lot feeding has been studied in the Alice Springs district on fully imported grain, etc. and viability of this project has a very fine line.

The use of saline irrigation could help in E.T. and A.I. programmes during dry years. Benefits could also be gained by using in a feed lot situation to "top" or finish steers before sending to market.

For crops and forage that could be suitable refer to Table 1.

The use of saline water to grow vegetables could be introduced into this area as a diversification project that could help cash flow in dry years. Not being a vegetable farmer, there would have to be a lot of homework done into marketing, outlets, etc. before any venture of this sort was anticipated. There would also be a great need to change the outlook from one of pure pastoralism to the broader fields of farming. Refer to table 1 for suitable vegetables.

My overall thoughts are that:
E.T. has a place in the Central Australian beef industry on a commercial scale, but due to extremes in climate, saline irrigation and E.T. go hand in hand.

ECONOMICAL YIELDS OF FORAGE GRAIN FIELD AND VEGETABLE CROPS TESTED IN RAMAJ NEGEV EXPERIMENTAL STATION (D. PASTERNAK)

CROP	IRRIGATION SYSTEM	YIELD (TON/HA) AT ELECTRICAL CONDUCTIVITY OF IRRIGATION WATER (ds/m) 1.2	4.5-5.5	6-8	8-10	10-15	REMARKS
FORAGE CROPS (dry weight/yr)							
Bermuda Grass (Cynodon dactylon)	Sprinkler	—	330.0	—	—	—	cv Suwannee, mean of two years
Rhodes Grass (Chloris gayana)	Sprinkler	—	330.0	—	—	—	cv Kantanbura, mean of two years
GRAINS (yield of grain at 12% moisture)							
Wheat (Triticum vulgare)	Sprinkler	6.77	6.68	—	—	—	cv Mivhor 1177
Sorghum (Sorghum vulgare)	Sprinkler	10.0	8.4	—	—	—	cv RS 610
Maize (Zea mays)	Drip	7.09	4.56	3.07	1.31	—	cv KWS 752 saline irrigation throughout season
Maize (Zea mays)	Drip	6.98	6.73	6.98	5.17	—	cv KWS 752, saline irrigation from day 21 after germination
FIELD CROPS							
Sugar Beet (Beta vulgaris)	Sprinkler	18.9	17.4	—	—	—	cv Depre, sucrose yield
Cotton (Gossyplum hirsutum)	Sprinkler	4.25	5.4	—	—	—	cv Acala SJ-1, lint yield mean of two years
Processing tomatoes (Lycopersicon esculentum)	Drip	136.0	120.0	127.0	—	—	cv VFM 82-1-8, saline irrigation from leaf stage
Processing tomatoes (Lycopersicon esculentum)	Drip	136.0	123.0	55.0	—	—	cv VFM 82-1-8, saline irrigation throughout
Processing tomatoes (Lycopersicon esculentum)	Sprinkler	107.7	73.5	—	—	—	cv Napoli, saline irrigation throughout
Sweet Corn (Zea mays)	Drip	18.1	18.2	15.7	15.0	—	cv Jubilee, ear yield, saline irrigation from day 21 after germination
VEGETABLES							
Asparagus (Asparagus officinalis)	Sprinkler	6.65	6.62	—	—	—	cv VC 711, four year old plot
Broccoli (Brassica oleracea)	Drip	23.4	21.8	—	19.0	14.3	cv Green Duke, fresh weight
Beetroot (Beta vulgaris)	Sprinkler	55.5	52.7	—	—	—	cv Cylindra
Celery	Sprinkler	155.0	171.0	—	—	—	cv Early Bell, fresh weight
Chinese Cabbage (Brassica pekinensis)	Drip	135.0	118.0	108.0	109.0	—	cv Michili, fresh weight
Chinese Cabbage (Brassica pekinensis)	Sprinkler	135.0	109.0	—	—	—	cv Michili, fresh weight
Melons (Cucumis melo)	Drip	27.0	24.0	24.0	22.0	—	cv G6-8, a salt tolerant cultivar autumn grown
Lettuce (Lacura sativa)	Drip	67.7	64.5*	52.8	58.3	—	Romaine lettuce cv Roman-9 fresh weight heads *water EC = 3.5 ds/m
Tomatoes (Lycopersicon esculentum)	Drip	86.5	72.9	—	62.7	53.0	cv Faculty 19, summer grown