Irrigation is crucial to agriculture in Southern Alberta, Canada. **Mike Abram** visited to learn about the challenges farmers are facing from climate change.

Canadian farmers have invested heavily in upgrading irrigation equipment to become more efficient.

Climate change challenges Alberta's irrigation system

It is no stretch to say irrigation is vital to the farmers and overall prosperity of Southern Alberta in Canada.

Just fewer than 600,000 hectares of land is irrigated across 11 irrigation districts in the region by around 6,000 producers, contributing CA$5.4 billion (£3.2bn) to the province's GDP.

But there are warning signs, as in many parts of the world, that water resources are under threat.

Snow in the Rocky Mountains acts as the water reservoir for the river basins in the region.

This year, not only was there a below average snowpack, but it had also melted by mid-May, three weeks earlier than usual.

Most irrigation districts, using a water supply forecast provided by the Government of Alberta, set an annual on-farm irrigation limit early in spring. This is regularly reviewed during the season and can be tweaked up or down depending on conditions.

By August, allocations ranged from 13-21 inches (325-525 mm), in the four largest irrigation districts, which account for about 85 per cent of the irrigated area.

However, one of the smallest irrigation districts in western Southern Alberta, Magrath, announced that irrigation water would be shut off on August 17 because of the severe drought.

Choices

Setting the limit early allows irrigators to make cropping choices based on the limit according to Margo Jarvis Redelback, executive director, Alberta Irrigation Districts Association.

She says: "Growers are able to apply to their irrigation district to move water between parcels, giving the opportunity to ensure crops with higher water demands have adequate water supplies."

For most growers, allocations have been adequate for crop needs although those with higher demand crops such as timothy hay, potatoes, corn or alfalfa, were feeling some stress, according to sugar beet, bean, alfalfa and cereal farmer Cory Vanden Elzen.

He farms 520ha of irrigated crops in Coaldale, Alberta, which lies in the St Mary's River Irrigation District that had some of the tightest restrictions on water use this season.

The farm started with a 14in (350mm) allocation, which could have climbed to 16in (400mm) with adequate rain, but the summer drought brought a further cut to 13in (325mm).

Up to 14in (350mm) is required on his 88ha of sugar beet, a similar amount, if not slightly more, on alfalfa, with 8in (200mm) on three types of dry beans — pinto, small white and yellow. Cereals usually receive 7-10in (175-250mm).

While he had been careful, had enough allocation to see the season through and was concerned for future years, he points out this year had not been unique.

He says: "In 2001 we were rationed to around 7in, and 2002 was shaping up to be a disaster until 6in of rain fell early in the year."

Farmers have invested heavily in upgrading irrigation equipment to become more efficient, he says.

"We have upgraded from side roll wheel lines to low pressure pivot systems, which allows us to put less water on, but more often, to match crop use.

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3-6in a time on, but it would take up to two weeks to get across a quarter section.

"Now I can put 0.75in on over two days, which is especially important in the spring when we try to get crops established after seeding.

"Pivots are also more able to function on windy days, which we get lots of in spring and fall," says Mr Vanden Elzen.

About an hour north east, Lars Hirch farms 192ha in Rolling Hills, in the Eastern Irrigation District, alongside a craft distillery business which uses various grains grown on the farm, and a cow calf operation.

He has also upgraded older pivot systems to low pressure drop tube pivots with more efficient water conserving sprinkler heads.

His usual water allocation was initially cut from 24in (600mm) to 12in (300mm), but subsequent rains increased this to 18in (450mm).

Heat

That was good news for Mr Hirch's 54ha of timothy hay, which usually receives more than 20in (500mm) of water.

"Because of the heat, I had already used a lot of water on the first cut of timothy, which I harvested a bit early to take advantage of the good growth.

"The barley crop does not need as much water, usually 15in, so I was allowed to move allocation from that field to the timothy for the second cut."

Cows grazing on community pasture came home a month earlier than planned though because of a lack of grass.

"My plan was to harvest the

Cory Vanden Elzen farms 520 hectares of irrigated crops in Coaldale, Alberta, which lies in the St Mary's River Irrigation District that has had some of the tightest restrictions on water use this season.

second cut of timothy early also and hopefully graze the cattle on the regrowth," he explains.

The experience is making him reconsider whether to grow timothy, with its shallow rooting requiring frequent watering and poor tolerance to hot weather.

Carrot farmer Nicolai Drost, also in the Eastern Irrigation District, is experimenting with South African developed Rainmaker technology which claims to convert irrigation water into rainwater, reducing water requirements by up to 30 per cent.

"Rainwater is more effective, so you need less of it," he explains.

The technology disperses ozone (O_3) into the irrigation water and, by adding a catalyst in hydrogen peroxide, helps oxidise minerals that cause hard water, dissolving carbonates and phosphates, while removing contaminants, such as algae and bacteria.

Nutrients

The result is a highly oxygenated water that acts like rainwater, easily penetrating the soil, and providing nutrients to crops while improving soil health, according to manufacturer Rainmaker.Earth.

Mr Drost, who needs 15in (375mm) of combined rainfall and irrigation for early harvested carrots and 20in (500mm) for late harvested or stored crops, plants his crops in a tight bed placement to close canopies earlier to reduce evaporation and so help improve water use efficiency.

"The risk is increased disease pressure," he says.

All three farmers use mostly experience and manual probes to judge irrigation needs.

"We have used monitoring technology in the past," Mr Drost says. "At the time the Pessl system was not very user-friendly with little tech support, but we may try similar technology again in future."

Mr Vanden Elzen uses a Dutch auger to hand sample in different locations in fields to whatever depth he is interested in a couple of times a week.

"I decide how much to use based on each crop's development stage, as each seems to have different critical times," he says.

Some growers are starting to use field-installed moisture sensors, he adds, while variable rate technology is being developed.

"It is expensive though, and I am not aware of anyone using it on a field scale."

Precision irrigation is a main focus of the Mueller Irrigation Research Group at Lethbridge College Research Farm.

The farm uses 154ha of irrigated land to research improving water use efficiency, says Dr Willemijn Appels, senior research chair.

Her team have found variable rate technology, particularly on sloping or rolling ground, that yields can vary by around 6 per cent compared with flat ground in potatoes.

"On a field with 50 per cent sloping ground, that could be a significant boost," says Dr Appels.

Trials

But creating variable irrigation maps requires a lot of monitoring and sensor technology is still being developed.

One set of trials at the farm is looking at microwave sensors mounted on the pivot to observe radiation from soil.

"That is indicative of moisture content to about 30-40cm depth, so could be a nice way of mapping out spatially where you have or do not have water.

"The downside of microwaves is there are a lot about near a city, such as Lethbridge, so getting the technology right is a challenge."

Incentivising individual farmers to improve and invest in water use efficiency on farm is not always easy, Dr Appels adds.

Dr Appels says: "Water rights are given to irrigation districts which get an allocation of surface water — they do not pay for that water.

"They redistribute it to farmers within their geographical area and the farmers pay the irrigation district to maintain the infrastructure to deliver it to the farm gate, but it is irrespective of how much water they deliver.

"So if you get 10mm or 150mm you pay the same amount per acre.

"In some cases that area price is hefty — it can be anything from CA$20-28/acre, but in some cases it is CA$0 if the district also has a lot of income from oil or gas revenue, for instance."

That means farmers investing in advancing their irrigation equipment or sensors will not see a return through lower water bills.

However, that increased water use efficiency across a district does mean irrigation districts potentially can expand the area of irrigated land available for farmers to purchase, Mrs Jarvis Redelback says.

"Irrigation districts have been expanding through their existence.

"We now irrigate about twice the land area using the same volume of water as was diverted in the 1970s."

On-farm improvements have contributed to that efficiency increase, especially in recent years with 84 per cent of the 600,000ha irrigated with low pressure drop tube pivots compared with 47 per cent in 2015.

Mrs Jarvis Redelback says. "These systems offer efficiencies of over 85 per cent."

But investments in infrastructure improvements have also driven efficiency increases, with programmes to reline open canals or convert to buried pipelines, and automating delivery systems all improving efficiency or saving water.

Investments in infrastructure improvements have driven farm efficiency increases including programmes to reline open canals or convert to buried pipelines.

Lars Hirch farms 192 hectares in the Eastern Irrigation District, alongside running a craft distillery business that uses grains grown on the farm and a cow calf operation.