Circles of Life

RELIABLE | DURABLE | PRECISE | ADVANCED | RESPONSIVE

Valley
The Leader in Precision Irrigation
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Front Cover: Sugar cane field in Mauritius.
At right top: Aerial view of center pivots in Colorado, USA.

Growing More
“A particularly difficult challenge will be to improve the efficiency of agricultural water use to maintain crop yields and output growth, while at the same time allowing reallocation of water from agriculture to rapidly growing urban and industrial uses. How this will be managed could determine the world’s ability to feed itself.”

MARK ROSEGRANT
INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE
Overview

Growing more food with less water is becoming a critical challenge for agriculture across the world in the 21st century. Rising populations, decreasing water quality, and increasing water scarcity are creating burdens on agriculture. First, a larger population needs more food and fiber. Second, the water quality has decreased due to contamination - many times from traditional agricultural methods. Third, agriculture has a diminishing supply of irrigation water to meet these rising demands.

Improving how water is delivered to farms and put to use in fields is essential for meeting the changing needs of global populations. Improved water management can enhance both food security, food safety, and human nutrition. Tremendous inefficiencies in global irrigation methods are numerous and difficult to manage. Addressing these problems creates many opportunities for progress and economic growth, especially in the developing world.

Some environmental problems have been attributed to irrigation. Overuse of water can indeed cause shortages in river basins or deplete an underground water supply. Overwatering and lack of proper drainage can load soils with salt, damaging the land’s productive capacity. Improperly applied crop chemicals can also leach into groundwater or contaminate surface water.

Above: Different crops can be grown under a single pivot by dividing the crop circle into segments as in this field in Kenya.
Upper left: Center pivot on barley. Upper middle: Valley Precision Corner. Upper right: Valley pivot on jatropha.
Irrigated agriculture is becoming more and more important, as the nutritional needs of the world grow with our population. Yet, irrigated agriculture faces many formidable challenges. However, with modern irrigation management, advanced agronomic practices, and more refined decision-making systems, countries facing these challenges can create a more productive and profitable agricultural base. Societies that capitalize on these opportunities will meet the nutritional needs of their populations and at the same time they can become more competitive in the global marketplace.

At the most basic level, the way that people take care of water must change before they can realize other benefits of enhanced agriculture. To grow more food, the water farmers use must be managed more carefully.

Mechanized irrigation saves more energy and uses less water and labor than other forms of irrigation. It has proven to have the lowest operating costs and longest lifespan of any irrigation equipment available. By using irrigation equipment that is more durable and efficient, farmers are able to increase their revenue, their crop yields, and even the land area they farm. Mechanized irrigation can also help solve other problems, such as waterlogged soils, salinity, and water contamination. Modernizing irrigation practices, then, has both economic and environmental benefits. Mechanized irrigation is an excellent place to begin as countries seek ways to grow more food with less water and human toil.

“At the most basic level, the way that people take care of water must change before they can realize other benefits of enhanced agriculture. To grow more food, the water farmers use must be managed more carefully.”
Development of Drip Irrigation

Drip irrigation was first introduced in 1917 by Dr. Lester Kellar to irrigate avocados in California. In the 1960s this method began to be widely used in Israel, where the desert conditions and limited water supply created the need for a water-saving agricultural irrigation system. Drip irrigation allows water to drip out from small emitters to the soil. The water travels at low pressure through a network of perforated plastic tubing installed on or below the surface of the soil. Drip irrigation has been described as the “leaking faucet” technique since it applies water non-uniformly over a long period of time.

Drip irrigation systems deliver water directly to the soil where it should be most beneficial. They also require less water and allow for easier field access than furrow and flood irrigation systems. Drip systems are particularly suited to the production of vegetable crops that are grown on raised beds, including strawberries, carrots, and tomatoes.

Drip irrigation requires rather intensive management by operators and a sizable initial capital investment. Drip system operators inspect their fields frequently for problems that affect watering uniformity such as plugs and leaks. Filters used with drip irrigation to keep particles from clogging the emitters must be flushed regularly. Drip irrigation systems are relatively expensive with costs as high as $4,000 a hectare for a basic system.

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Development of Sprinkler Irrigation

In the 1920s, sprinkler irrigation was developed. Sections of small pipeline, fitted with vertical tubes topped by sprinklers, were moved into newly planted fields, then removed prior to harvest. In some cases, farmers towed these pipelines by tractor from one field to another.

Next came side-roll sprinkler systems. The main water line served as the axis for the wheels, so it was easier to move. However, this method still required considerable labor because the system had to be moved every few hours. Generally, these side-roll, wheel move sprinklers were used only on shorter crops, such as alfalfa, potatoes, sugar beets, and vegetables. Taller crops could not be grown with those systems.

Introduction of Center Pivot Irrigation

By the middle of the 20th century, agriculture was ready for a better kind of sprinkler system. It was invented in 1952 – the self-propelled center pivot sprinkler. Over that next decade, this new design was gradually accepted as a superior form of irrigation.

The center pivot concept is simple. A long pipeline, attached to a central point, travels over a field in a circle. As it passes over crops, sprinklers spaced along the pipeline emit water, nourishing the crop below.

By the mid-60s, center pivots irrigated a wide range of crops in the western and central United States. Valmont founded the center pivot industry and is now the world leader in the manufacturing and development of mechanized irrigation technology. Valley® brand equipment irrigates more than 5 million hectares in over 90 countries. The company’s products have been improved through several design generations. Today, the equipment is known for being simple to operate, highly reliable, long lasting, and extremely precise in operation.

Unlike surface irrigation, center pivots do not require the extra tillage to prepare a field for furrow or flood irrigation. Eliminating this tillage saves money and time, plus it also allows the farmer to immediately plant another crop in the field – a key factor in the success of multiple cropping. After one crop is harvested, farmers can prepare the field and seed a new crop. They can then turn on the center pivot and irrigate the field so that the seeds quickly germinate, a benefit the drip systems cannot offer.
Water Efficiency

Across much of today’s world, irrigation methods are similar to techniques used as far back as 6,000 years ago. Some farm families still move water by hand, conveying it through earthworks, down furrows, and across the surface of small plots of land. Although innovative in ancient times, when compared to modern irrigation technologies, traditional irrigation uses far more water and human resources than is necessary. Employing appropriate modern irrigation technology in developing countries is the way for progress: increasing agricultural yields, improving national economies, and empowering farm workers to become more productive with their work time.

Irrigation Potential

Adoption of more efficient irrigation practices – along with improvements in water conveyance systems – will increase food security. Modern irrigation practices can improve productivity per unit of water used, while changes in conveyance systems will get more water to farms.

Traditional irrigation systems face a number of problems, such as low efficiency in water distribution and use, unreliable water delivery, vandalism of structures, poor maintenance, and insufficient cost recovery. Steps taken to improve the productivity of such irrigation projects have generally fallen into three categories:

- The first concerns timeliness of water delivery. Predictable distribution ensures that water is available when crops need it most. This helps reduce stress-related yields and quality losses. Reliable supply also encourages farmers to make higher levels of investment in their cropping operations. Both improvements can increase the value of cropland output.
- Another way project managers try to enhance productivity is by storing unused water and applying it on newly irrigated land.
- A third kind of improvement involves the reduction of waterlogging and salinity problems. These problems decrease yields and degrade productive land. Eliminating over-application of water can result in production increases due to reduced salinity levels and improved aeration in crop root zones. Water saved through efficiency can go to other areas that are underserved.

A fourth trend should be added – conversion to mechanized irrigation. Traditional flood irrigation methods waste a great deal of water. Besides low water efficiency, over-watering also leads to low crop yields, especially as salts are brought up into the crop root zone. The precise water application afforded by mechanical move irrigation uses half as much water as flood, and allows control of leaching of salts. When water is applied uniformly across a field and in the exact amounts needed by the crop, the crop yields can be dramatically higher and the soil does not become waterlogged or overly salinized.

Fresh Water Conservation

A recent World Bank report stated that unless current trends in water use are reversed, the world’s water crisis will worsen. The world needs a healthy and growing food-producing sector. Irrigation will provide enormous value in terms of food security. With growing concerns over the world’s fresh water supply, mechanical move machines provide a sensible alternative to inefficient forms of water application, such as surface flood irrigation. Water use in irrigation could be lowered dramatically with no loss in food production.

Mechanical move machines greatly reduce excess water use by applying precise amounts of water to crops at the right times and in the right quantities. Modern mechanized equipment is extremely water efficient. Specialists define irrigation system efficiency as the ratio between the water applied by irrigation system and the water used by the plants on that field.

Traditionally, surface irrigation methods achieve efficiencies ranging from 40% to as high as 70%, if field runoff is collected in holding ponds for reuse. In much of Asia, surface irrigation efficiency typically is 25% to 40%. Losses of water in the distribution system and in farm fields account for this inefficiency.

The irrigation efficiencies achieved by center pivot and linear move machines range from 75% to 95% depending on sprinkler package design, irrigation scheduling,
and other agronomic practices. Practices such as LEPA (Low Energy Precision Application) can optimize the water efficiency of mechanical move irrigation technology. Exact quantities of water are delivered to crops, and with proper design, runoff and evaporation losses are nearly eliminated. Mechanical move irrigation technology, such as pivots and linears, ranks side by side with drip irrigation as the most water-efficient forms of irrigation available today.

Another problem with surface irrigation is the lack of uniform application. Water must be over-applied on one side of a field so it can flow to all parts of a field. This leads to waterlogging, lower yield and quality, and soil degradation. Uneven water distribution in surface irrigation is a key cause of reduced crop quality and yields.

A center pivot or linear machine can apply water at 88% to 95% uniformity, compared to 40% to 70% uniformity with surface irrigation.

Crop Input Application

Center pivots and linear move irrigation equipment apply water precisely as do well-managed drip irrigation systems. Precise water application ensures that crops get the right amount of water at exactly the right time, rather than too much or not enough water. The precise water application capabilities of mechanical move irrigation equipment can also be used to apply other crop inputs. For example, fertilizer can be mixed with irrigation water and applied during the growing season. Pivots and linears can thus deliver nutrients to crops, as well as water, when the growing plant needs them most.

Applying nutrients during the growing season reduces the need to apply heavy doses of fertilizer before the crop is planted. It is in the early part of the season – when soils lay bare to wind and water – that the risk of erosion is greatest. When the soil washes away, so do fertilizer and crop inputs. This is one way in which water quality can be compromised. Fertilizing plants later in the season, when a crop canopy protects the soil, helps keep fertilizer where it belongs.

Other chemicals can also be applied through center pivot or linear move irrigation equipment. Farmers can thus treat insect outbreaks or control weeds as they apply irrigation water. Once again, applying chemicals only when they are needed helps keep them in fields and out of aquifers, streams, rivers, and lakes.

Complementary Agronomic Advances

Delivering water to crops at the optimal time and efficiently applying it in exactly the right amounts are only part of the answer. As irrigation becomes more reliable, farmers become less susceptible to risk because they know the water will be there when they need it.

Optimizing water use should be accompanied by the adoption of complementary agricultural inputs. Unless farmers use improved seed, fertilizers, pesticides, and new cultural practices, in addition to modern irrigation, they will not maximize the potential benefits which modern technology offers.
Water Availability and Scarcity

In total, there is enough water to support a world population many times larger than the present one. Unfortunately, water is unevenly distributed across the surface of the earth. Many regions lack access to sufficient affordable fresh water. Competition among fresh water users in the agricultural, domestic, and industrial sectors is increasing as their water demands grow.

Agriculture accounts for approximately 70% of human water usage today. However, the agricultural share of the water supply will decline as the water demand of households and industry increases.

The United Nations Environment Programme (UNEP) defines as “water stress” those countries where local water supplies average less than 1,700 m³ per person per year, and “water scarce” as those less than 1,000 m³. In 2007, about 450 million people lived in 29 countries where the internal renewable water supplies were less than 1,700 m³ per person per year. By 2025, one in three people will live in water stressed areas, and 1.8 billion people will live in areas with absolute water scarcity (FAO). In general, Africa and Asia are already showing signs of a worsening shortage in freshwater availability, and water quality is also declining globally.

Countries and regions where water resources are under particularly strong pressure are especially good candidates for increased food imports and irrigation modernization.
Environmental Impact

The world has approximately 280 million hectares of irrigated land. If just 1% of this land was converted from traditional irrigation methods to precision methods, more than 7 million cubic meters of water could be conserved annually. This is equal to enough water for nearly 103,000 households per year worldwide. These savings would make a major contribution in solving water shortages around the globe. Precise, uniform application not only conserves water, it also increases crop yields, quality, and revenue. Modern irrigation methods can help the world grow more food with less water.

Water Quality

One of the major issues facing surface irrigation is water contamination from chemicals. Fertilizers, pesticides and other pollutants can leach into groundwater and pollute streams, lakes, and rivers when chemical-laden irrigation water is over-applied and flows from farm fields into other waters.

Mechanized irrigation enhances environmental safety. By applying only as much water as the soil can absorb, runoff is eliminated or reduced significantly.

Using mechanized irrigation to apply crop inputs permits more precise control of irrigation rates and timing, which increases the effectiveness of crop chemicals and fertilizer. Potential treatment needs may be reduced. Also, more effective irrigation improves plant health. Lush crops can shade weeds and better withstand insect pressure, making some treatments unnecessary. In similar fashion, the equipment can be used to apply growth regulators and harvest enhancement products on crops such as cotton.

Research has also shown that center pivot irrigation equipment can draw on groundwater that is contaminated by fertilizers and filter that water through the crop root zone. Cleaner water is the result.

Another benefit to using mechanized irrigation is that there is no need for tillage to prepare cropland to convey water in furrows. More protective crop residue cover can be left on fields. Since most water pollution is caused by soil sediment, increased crop residue helps keep soil in place to reduce erosion. When cropland is tilled, chemical contaminants are often carried into waterways on soil particles. Controlling soil erosion thus also contributes to reduced chemical contamination.

In some areas, wastewater treatment is a major challenge. Center pivots and linear move equipment can apply partially treated wastewater onto cropland. Again, crop roots filter the nutrients and clean the water. This results in major savings by avoiding added costs for additional capacity in sewage systems.

Reduced runoff from irrigation can also help protect the productive capacity of soils. Water soaks into the soil rather than running off the field, preventing soil erosion. The center pivot compliments the modern trend towards minimum tillage farming practices. With less tillage needed under center pivots, less soil will blow away in the wind. Mechanized irrigation helps protect the soils that are so critical to farmland productivity.

There are many ways that mechanized irrigation can contribute to enhanced environmental quality – using less water, reducing runoff and potential chemical contamination, and solving soil erosion problems.
Minimizing Infrastructure

The traditional view of the infrastructure required for irrigation has slowed or stopped development in many cases due to the scope in size and/or energy requirements. To deliver sufficient water to meet a plant’s water requirement, surface irrigation requires twice as much water as modern irrigation technology due to field losses. Storage reservoirs, intake structures, canals, turn outs and other components need to be sized accordingly to handle this large volume.

If traditional sprinkler irrigation is being used, 50% more water is delivered than required by the plants. However, the delivery pressure in the field may be as high three bar or more. This requires large, high pressure pumping stations and a high pressure water delivery structure. Also the annual operator costs are much higher due to the additional power required.

Precision irrigation such as drip or mechanical move requires a delivered volume of only 10% to 15% more water than required by the plant at a pressure of 1.0 to 1.5 bars. Drip has a higher infrastructure requirement due to the filtration needed to protect the many water outlets in the lines and tubes from plugging. Mechanical move has a low energy requirement due to requirements for 1.0 to 1.5 bar in the field, and does not have a high filtration requirement since the water application of mechanical move irrigation does not use small orifices to control flow. Typically filters for mechanical move irrigation range from 2.4mm to 4.0mm, if necessary at all. In contrast, the typical filter size for drip irrigation is .08 to .10mm.

In addition to minimizing the infrastructure requirements for new development, mechanical move irrigation also can utilize existing infrastructure that may have deteriorated over time. This reduces the need for upgrades or improvements due to the low energy requirements and the low volume needed to be delivered to the field.

Above: A 90%-95% water application uniformity can be achieved with proper sprinkler package design. Many variables must be taken into account, including the water needs of the crop, soil intake capacity, the available water pressure, wind, heat, and soil salinity.
Water Losses and Efficiency

It should be the irrigator’s attempt to maximize the water retained and transpired by the crops in his field relative to the water supplied at the source. Unfortunately, due to inefficient practices and obsolete technologies, the water loss can be greater than what is utilized by the plant.

By using efficient equipment and practices, an irrigator can maximize the water that actually benefits the plant and reduce the losses which cannot be utilized. To avoid delivery, run-off, evaporation, and deep percolation losses, the following options are suggested:

**Water delivery losses**
- Sealing of supply canal
- Pressurized pipe delivery

**Run-off losses**
- Balance soil intake to water application
- Uniform application
- Minimum tillage

**Evaporation losses**
- Sprinklers close to or within crop canopy
- Reduce surface wetting intervals
- Avoid high wind irrigation applications
- Utilize soil moisture holding capacities for heavier applications

**Below root zone percolation losses**
- Precise scheduling of applications
- Monitor moisture of the soil below the surface
- Uniform application

The overwhelming majority of the world’s irrigators are handicapped by obsolete equipment and technology which limits their ability to employ these practices and minimize the amount of water wasted. The only technologies which enable the irrigator to utilize these practices are mechanical move (center pivots and linears) and micro (drip, micro-spray and sub-surface) equipment. Unfortunately, less than 5% of the world’s irrigators currently utilize these two technologies. The vast majority of irrigators still use technology created thousands of years ago. Is it any wonder that we are facing a crisis in the cost, availability, and quality of water allocated to agriculture?
Management of Soil Salinity

Salinity is a major challenge for irrigated agriculture. It can damage the land, reduce yields, and interfere in the growth of food production. One of the contributors to salinity is waterlogging, often found in surface flood irrigated fields. When soils become waterlogged due to over irrigation and/or lack of proper drainage, salts accumulate in the root zone of plants and on the surface of the fields. These salts impede root system development and nutrient uptake. As a result, crop yields can be reduced by as much as 30%, or in a worst case scenario, it may remove sections or even the entire field from productivity.

In recent decades, millions of hectares in farms throughout the world have suffered from saline soils. Irrigation practices such as flood and drip irrigation can cause the gradual build-up of salts at the root zone of crops, eventually damaging or killing the roots. With the use of mechanized irrigation equipment, salinity buildup in the root zone can be prevented or often even reversed with the ability to leach the salts beneath the crop root zone by controlling the timing and uniform application depth of the water.

Protecting Soil Resources

Protecting current irrigation land from further salinization will help reduce productivity losses. Reclaiming lands already affected by salinity also should be pursued to protect the irrigation land base. Modern precise mechanical move irrigation technology can help in both situations.

Both leading modern irrigation technologies – drip and mechanical move equipment – apply less water than surface irrigation, which eases problems associated with waterlogged soils and poor drainage. However with drip, there is the potential to have salt build up in those regions where the wetted soil meets the dry soil since there is not a uniform application of water as is typical with precision mechanical move irrigation. Extremely careful management and frequent soil and water analyses are the only ways to monitor and manage saline build-up. Only mechanical move irrigation can apply water to flush salts below the root zone while avoiding waterlogging the soil.
Versatility of Cropping

Versatility and Crop Production

Center pivots and linears are used in widely varying climates and topography. The equipment waters a wide range of soil types, from extremely sandy to fine-textured clay soils. It can draw on many water sources, using surface water, aquifer (ground water), saline water, and wastewater.

When first introduced, the equipment was often installed on hilly land in dry regions. In these areas, water was accessible, but surface irrigation was not possible. As this low-cost land was developed, it produced top yields within one to two years.

Today, center pivots and linears in many cases are replacing surface irrigation on flat lands. These farms are being converted to mechanized irrigation for many reasons. Mechanized irrigation uses 25% to 50% less water than surface irrigation and reduces labor up to 75%. These factors allow farmers to raise crops on more hectares, using roughly the same amount of water and less labor. Mechanized irrigation also allows producers to practice superior farm management.

The technology is also used in rainfed farming regions. Even where annual precipitation often reaches 1,200 mm to 1,500 mm, the timing of rain may not match crop needs. If precipitation is highly variable, pivots and linears protect yields during dry years.

Once mechanized move irrigation has proven itself in a region, its importance grows rapidly. Moisture variability during the growing season is a farmer’s biggest risk. With the decreased risk that mechanized irrigation provides, farmers can afford to invest more in their farming operation.

“Unless progress with agricultural yields remains very strong, the next century will experience sheer human misery that, on a numerical scale, will exceed the worst of everything that has come before.”

DR. NORMAN BORLAUG
NOBEL PRIZE LAUREATE
IMPORTANCE OF IRRIGATION
Cropping Options

Mechanized move irrigation allows farmers to overcome physical limitations and technical problems involved with the adoption of new cropping systems. With reliable, precision irrigation, farmers can plant a wider variety of crops.

Mechanized move irrigation machines provide farmers with additional benefits by expanding their options for more advanced fertility and pest management programs. New equipment to cultivate, harvest, and store crops also becomes affordable. Whether enhanced crop value comes from more crop harvests per season, development of a livestock sector built around reliable forage and grain supplies, or simply the production of more nutrient-rich, higher quality food, these trends enrich the farm economy and the individual farmer who uses mechanized irrigation.

While farm profit potential is increased by higher-value crop yields, quality, and diversification, mechanized irrigation also improves the system-wide stability of production agriculture. These signs of progress encourage a greater degree of specialization. Enhanced use of specialized knowledge and labor at the local level – in the forms of a vital farm service sector, improved crop management, training in new farming methods, or pursuit of new marketing opportunities – helps create a more diverse, stronger agricultural sector, creating benefits at the regional and macro-economic levels.

Above: A Valley Dual Span pivot on carrots. Below: Citrus orchards and rice irrigated by Valley pivots.
Benefits of Versatility

Nearly all crops can be irrigated with center pivot or linear irrigation equipment. Common field crops grown with this equipment include: wheat, cereals, cotton, maize and other feed grains, oil seeds, and sugar beets. Vegetable crops and fruits can be grown under mechanized irrigation, including melons, berries, potatoes, beans, peas, tomatoes, lettuce, cabbage, carrots, sweet corn, etc. Because the equipment comes in various heights, even citrus trees, coffee, fruit and nut orchards, and tall crops such as sugarcane are raised under mechanized irrigation equipment. More recently, rice has been irrigated with center pivots and linears, a crop traditionally irrigated by flooding the field.

This versatile equipment allows producers to easily control when and how much water is applied. Under surface irrigation, it is impossible for a farmer to apply precise amounts of water in varying parts of a field. However, with center pivots, the farmer simply pushes a button to turn the equipment on and off as needed, or to change the rate of water application with great precision. And now with the ability to incorporate variable rate irrigation (VRI) with center pivots, growers can apply water even more precisely. VRI uses zone management to determine how much water, fertilizer, or other crop management products are applied to areas as small as 0.5 hectares.

Application flexibility creates other benefits. Where water is scarce, farmers can plant more than one crop in a field. Half of a field is planted with one crop, such as cotton, while the other half is planted with a crop that uses less water, such as wheat. As the center pivot passes over the crops, less water is applied on the wheat and more is applied on the cotton.

Farmers can also plant and water crops to achieve different maturity dates. This can be important for market crops, such as vegetables. The planting dates are varied to have a constant supply of fresh produce. This gives farmers more options and reduces market risk. Pivots allow farmers to conveniently meet their water needs, based on crop development.

Mechanized irrigation also offers advantages in irrigation timing. Water should be applied when the crop needs it most. With many crops, the maximum yield is determined in early growth stages. This process happens at a microscopic level. Crop stress in this critical time will permanently limit yield potential. Using a center pivot, farmers can easily manage the amount of water applied to a crop at crucial times in plant development. Under furrow irrigation, such precision in timing or water application is not possible. Late season water needs, when plants are filling fruit or grain, can likewise be met exactly to ensure that the farmer’s hard work is not lost due to crop stress at a crucial period of the growing season.

Thus, the advantage in controlling the timing of irrigation not only improves crop yields, it can also help farmers increase the number of crops that they harvest. Both factors multiply potential income and cash flow.

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**Percent Increase in Yields over Dryland Farming**

- Alfalfa: 150%
- Cotton: 88%
- Corn: 280%
- Potatoes: 250%
- Carrots: 100%
- Sugar beets: 100%
- Sunflowers: 50%
- Wheat: 67%
- Sugarcane: 189%
- Soybeans: 200%

Irrigation increases yields compared to dryland farming.


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**Variable Rate Irrigation (VRI)**

Each color represents a different application rate in the field. Absence of color represents the areas of the field where the sprinklers are turned off.
Economic Benefit

Role of Water in Food Production

Irrigated farmlands are inherently more productive than rainfed farming methods. Leveraging this productivity, according to the United Nations Food and Agriculture Organization (UN FAO) specialists, will be critical in bridging the gap between food production and food demand. Some key points that underline this reality follow:

- Crop production increased at a rate of 2.3% from 1970 to 1990. About two-thirds of that gain came from improved yields – mainly of irrigated wheat, rice, and maize. Only one-third of the food production gain came from farmland expansion. Irrigation increased both the yield per harvest and the number of harvests.

- One of the key advantages offered by modern irrigation is that it can ensure reliable production under erratic rainfall. Drought lowers crop yields, and also causes a plethora of other social and environmental costs from poor nutrition, natural resource damage, and risk-avoiding behavior of farmers. These costs of drought are also substantial, though they go frequently unmeasured.

- In general, farmers who irrigate are relatively more prosperous than their counterparts who rely on natural rain alone. The FAO states that irrigation increases yields of most crops by 100% - 400%, thus increasing the grower’s profitability.

- Finally, mechanized move irrigation has the potential to transform subsistence farmers into profitable commercial farmers. A center pivot can thus offer to subsistence farmers an exit door from the cycle of eternal poverty in which so many of them are trapped.

Besides the direct benefits to the grower for increased yields, increased quality and reduced operating costs, mechanical move irrigation projects also can significantly contribute to the overall local economy. Directly related are the service industries that develop to support mechanical move irrigation such as installation, service, parts and maintenance. All of these require people with skill levels from laborer to electrician plus administrative support staff. Opportunities exist to learn on the job and develop skills while earning money on a weekly basis and remaining in the rural community. An individual can begin a small business with very little resources and provide a valuable service to the irrigation projects. In developed agricultural countries, the banking and insurance industries encourage irrigation to mitigate farmers’ losses and levelize income. Mechanical irrigation reduces the risk for the entire food chain.

In addition to the direct economic factors are the indirect such as supplying seed, fertilizer, pest management products and other agricultural equipment. These all require people and again provide an opportunity to learn a skill in areas such as integrated pest management, fertility sales and agronomy.

Lastly depending on the nature of the mechanical move irrigation project are the economic opportunities associated with the post harvest handling of what is produced. This may be as simple as requiring truck drivers to haul the crop or as complex as a complete cleaning, grading, packaging and distribution complex. Either requires people to be directly involved or supporting those who are.
Conclusions

Population Growth and Food Supplies

The world population is projected to grow to 9.3 billion by 2050, up from 6.6 billion in 2007. This is an increase of 40% in 33 years.

The impact of population growth on food supply and nutrition will be greatest in countries already challenged by poverty and inadequate nutrition. Even though food supplies have increased substantially over the past 30 years, more than 800 million people still do not have enough food to meet their basic nutritional needs.

For the world as a whole, agricultural production will slow from an average annual growth of 2.3% which has been the rate since 1961 to 1.5% between now and 2030.

Crop Yields and Food Security

According to the UNFAO, 40% of worldwide food production comes from an estimated 280 million hectares of irrigated lands—only 20% of the world’s farmland. Irrigated farms have 100% to 400% higher yields for most crops. Water clearly plays a critical role in food production and this resource is central to major food security concerns, such as:

- Ever increasing human population;
- Increasing food needs;
- Finite natural resources;
- Degradation of natural resources.


Above: Sunflowers under center pivot. Left: Cotton irrigated with low drops.
Growth in Irrigation

Over the past four decades, human civilization has grown more food and fiber by expanding its irrigated agricultural base. This growth is projected to continue into the future as the demand for agricultural products continues to rise.

Investment in new large-scale irrigation projects has fallen off over the past 20 years, but is expected to increase once again as a result of large projects in the Middle East, Eurasia and Africa. Higher commodity prices, a growing population and increased demand for crops to produce biofuels will continue to boost the project business.

Rather than building new irrigation projects, some countries are modernizing their existing irrigation base to become more efficient and productive. As the availability of water becomes more scarce, we will see more countries investing in modern, efficient irrigation methods. Countries that develop vibrant irrigated agricultural segments will position their economies to capture new opportunities from these trends.

The rising populations and demand for water by the domestic and industrial sectors pose a major threat to world food production. To grow more food, the current base of irrigated land will become even more important. Currently, about 2.6 billion people depend on irrigated agriculture for food and jobs, and it is clear that many more will depend on this production system in the future.
About Valmont

Irrigation Leader

Valmont Industries, Inc., is the world’s largest manufacturer and distributor of mechanized irrigation machines, having created the industry in 1954. Valmont’s Valley brand equipment, and the international Valley dealer organization are today known the world over as the most trusted and innovative source of irrigation equipment and service.

Valmont has established valuable relationships with other world-class companies involved in agriculture and public infrastructure. The company has gained vast knowledge from its associations with farm equipment companies, seed, chemical and biotechnology manufacturers, hydrology consulting organizations, public works advisory firms, and the agricultural research community.

Valmont has equipment operating in virtually every part of the world. Valmont’s experiences and partnerships form a unique base of knowledge that the company puts to work for its customers.

Ultimately, Valmont is the most successful company in mechanized irrigation because it has the greatest commitment to the success of its customers – supplying reliable, long-lasting products, the most advanced research and innovation, and outstanding field support and services.
International Sales

Valmont began developing overseas markets in the early 1970s. By 1979, Valmont began to capitalize on these opportunities as governments sought to modernize less efficient irrigation systems and develop arid regions. Over time, Valley products were widely accepted and praised by growers in Europe, the Middle East, Africa, Australia, the People’s Republic of China, and Latin America.

Other Businesses

Over the years, Valmont’s success fostered the growth of additional business lines. Pipe and tubing were added out of necessity. As the company’s pipe markets grew, the product was extended into lighting poles.

Today, Valmont’s Structures Division is the world’s leader in supplying engineered metal structures, including: communication towers and components for the cellular phone industry; lighting and traffic signal structures for public and private markets; utility poles for energy transmission, and electrical sub-station structures. Valmont also makes tubular steel products, fasteners, and other small items. Valmont’s Coatings division is the largest galvanizer in the United States.
Appendix

Figure 1:

Irrigated Area, Worldwide, 1965 to 2003 (Million Hectares)


Figure 2:

Total Irrigated Hectares in the USA

Over the years, the percentage of flood irrigated land has decreased, while the use of center pivots and linears has had the most significant increase of these primary methods of irrigation in the US.

1979 data: USDA statistics
1994 - 2008 data: USDA Farm and Ranch Irrigation Survey
Figure 3:

Trends in Population and Irrigation Withdrawals in the USA, 1950-2005

Data from the United States Geological Survey
http://pubs.usgs.gov/circ/1344/

Figure 4:

USA Center Pivot Irrigated Hectares vs. USA Per Capita Water Usage

Data from USDA Farm and Ranch Survey
and from the USGS "Estimated Use of Water in the United States in 2005."
Using aerial or ground rig methods to apply chemicals can be extremely expensive. With a center pivot, you can apply chemicals directly through the pivot and save a substantial amount of money.

**Figure 5:**

Percent Difference in the cost of Chemical Application Methods  
(Based on 53.5 Hectares and 12 Applications)

**Figure 6:**

Operation Costs of Gravity vs. Center Pivot Irrigation

Data from “Nebraska Crop Budgets, 2010.” http://extension.unl.edu/publications
Crop Versatility of Pivots

Nearly any plant that grows under rain can grow under a pivot.

Abaca (Manila Hemp)  Carrots  Flowers
Agave Fibres  Cashewapple  Fonio
Almonds  Cassava  Fruit, Fresh
Anise, Badian, Fennel  Castor Beans  Fruit Tropical, Fresh
Apples  Cauliflower  Garlic
Apricots  Cereals  Ginger
Areca Nuts (Betel)  Cherries  Gooseberries
Artichokes  Chick-Peas  Grapefruit and Pomelo
Asparagus  Chicory Roots  Green Corn (Maize)
Avocados  Chilies and Peppers, Green  Groundnuts in Shell
Bambara Beans  Citrus Fruit  Hazelnuts (Filberts)
Barley  Coarse Grain  Hemp Fibre and Tow
Beans, Dry  Coarse Grain  Hempseed
Beans, Green  Coarse Grain  Jute
Berries  Coffee, Green  Jute-Like fibres
Blueberries  Coir  Kapok Fibre
Brassiccas  Corn  Kapokseed in Shell
Broad Beans, Dry  Cotton  Karite Nuts (Sheanuts)
Broad Beans, Green  Cow Peas, Dry  Kolanuts
Buckwheat  Cranberries  Lemons and Limes
Cabbages  Cucumbers and Gherkins  Lentils
Canaries Currants  Lettuce
Canola  Eggplants  Linseed
Canola  Fibre Crops  Lupins
Cantaloupes and other Melons  Flgs  Lupins
Carobs  Flax Fibre and Tow
Below: Oats, Coffee, Apples, Pineapple, Raspberries, Pumpkins, Green Pepper, Lemons, Carrots, Corn, Wheat, Cauliflower, Daffodils, Rice, Oranges, Onion, Tomatoes, Sunflowers, Garlic, Watermelon

Maize
Mate
Melonseed
Millet
Mixed Grain
Mustard Seed
Nutmeg, Mace, Cardamons
Nuts
Oats
Oilseeds
Okra
Olives
Onions and Shallots, Green
Onions, Dry
Oranges
Peaches and Nectarines
Peanuts
Pears
Peas, Dry
Peas, Green
Peppermint
Pepper, White/Long/Black
Persimmons
Pigeon Peas

Pimento, Allspice
Pineapples
Plantains
Plums
Pop Corn
Poppy Seed
Potatoes
Pulses
Pumpkins, Squash, Gourds
Pyrethrum, Dried Flowers
Quinces
Quinoa
Rame
Raspberries
Rice
Roots and Tubers
Rye
Safflower Seed
Seed Cotton
Sesame Seed
Sisal
Sod
Sorghum
Sour Cherries

Soybeans
Spices
Spinach
Stone Fruit, Fresh
String Beans
Sugar Beets
Sugar Cane
Sugar Crops
Sunflower Seed
Sweet Potatoes
Tangerine, Manderin, Clementine, Satsma
Taro (Coco Yam)
Tea
Tobacco
Tomatoes
Vegetables Fresh
Vetches
Watermelons
Wheat
Yams
Yautia (Coco Yam)