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UTAH SCIENCE

UTAH AGRICULTURAL EXPERIMENT STATION SPRING 1983 VOLUME 44 NUMBER 1

UTAH'S BEST
MADE BETTER



SPRING 1983 VOLUME 44 NUMBER 1

UTAH SCIENCE

UTAH AGRICULTURAL EXPERIMENT STATION

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ABOUT THE COVER

COVER PHOTO BY Cedric N. Chatterley

The long-awaited warm season turns our attentions to the bounties of the earth and growing food. This issue highlights high-performance varieties tested by experiment station personnel which are most suited to Utah's arid climate.



CANNED RAINBOW TROUT

D. T. BARTHOLOMEW, C. A. ERNSTROM, and V. T. MENDENHALL

A FORMER BY-PRODUCT of a local trout farm* is being converted on a test basis into an appealing, nutritious food at Utah State University. This newly available food can help provide a growing population with protein and job opportunities.

By the year 2000, it's expected that we will have the challenge of feeding an estimated 6.3 billion people (Cazier 1981). In the third-world countries where malnutrition is prevalent, protein shortages are particularly critical. An attractive solution is to provide high-quality protein foods (particularly animal proteins) from edible materials that are currently wasted (Noble 1975).

The oceans are contributing less than 5 percent of the total protein consumed in human diets in the 1980s (Wittwer 1983). The present global yields of fish from aquatic sources amounts to approximately 7×10^7 tons of fish/year. Marine species account for 5.5×10^7 , brackish water species for 1.5×10^6 , and fresh water species for 1×10^7 tons. If this large harvest were utilized completely, it could satisfy about 15 percent of all human needs for protein energy. The potential yield of fish from all aquatic sources suitable for exploi-

tation by man is estimated to be about 2×10^9 tons/year (Keay and Hardy 1978). Such a remarkable tonnage of high-quality animal protein could be essential in the years ahead.

MANAGED PRODUCTION

Commercial aquaculture operations have been successfully producing rainbow trout, carp, and catfish for several years. In the Intermountain area of the Rocky Mountains, the emphasis has been on rainbow trout, (*Salmo gairdneri*), with trout fillets being the main food that is marketed. In its chemical composition, rainbow trout is similar to salmon, which is to be expected from fish of the same genus (*Salmo*) (Table 1). What remains of the filleted fish is considered a by-product and is called a fish frame (Figure 1).

A Utah Producer

The local trout farm had been selling frozen trout fillets of various sizes for several years, the managers began to wonder after discussions with USU if marketable food products could be created from the meat being disposed of as by-product on the filleted fish frames. An agreement was made in December 1981 for producing canned trout in the

Department of Nutrition and Food Sciences at Utah State University.

The local trout farm supplies fish and fish frames to the University at no cost and then buys back the canned fish at a fixed percentage of their wholesale price. The University processing and research costs are paid by the local trout farm when they buy back the processed fish which they market. The trout producers will eventually set up their own canning facility when a retail market has been established.

From Eggs to Fillets

Trout eggs that are removed from spawners are hatched in the trout farm facilities. The fingerlings produced from the eggs are transferred to growing ponds where they grow to maturity. The yields are one pound of fish from 1.8 lbs. of feed. The fish are harvested when they reach the appropriate (approximately 7 to 20 oz.) filleting size. Evisceration and filleting take place at the trout farm's processing facility, where the fillets are also packaged and frozen. The left-behind fish frames account for 15 percent of the live weight and contain over 60 percent by weight of edible trout meat that is comparable in quality to the trout fillets.

*The fish canning project is being done in conjunction with White's Trout Farm of Paradise, Utah.

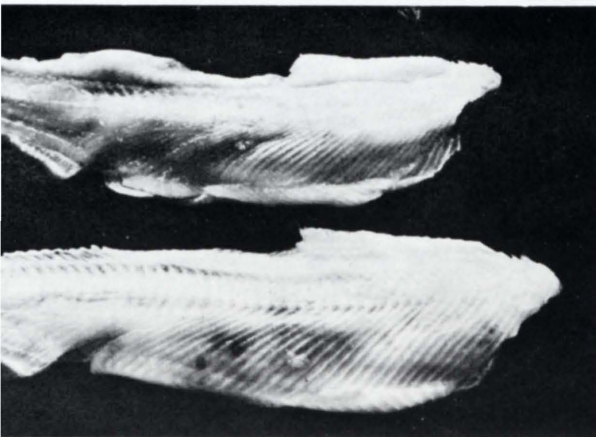


FIGURE 1. Trout fish frames



FIGURE 3. Cooking loosens meat from bones



FIGURE 4. Hand deboning

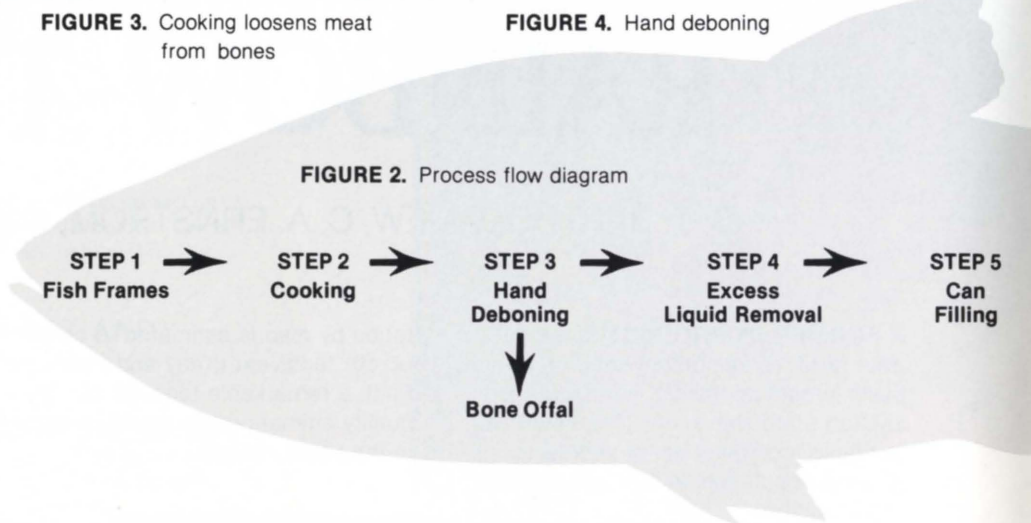
Preliminaries at USU

Before USU personnel could experiment with the production of commercial-quality, canned trout that would meet FDA (U.S. Food and Drug Administration) requirements, several steps were necessary. An approved processing schedule for canned trout was obtained from the National Food Processors Association. Needed processing equipment was obtained and installed. The FDA requirements for processing, can-seam teardown, inspection, and shipping records were met.

The Canning Operation

Canning of flake-style trout began at USU late in January of 1982 and followed the process flow diagram in Figure 2.

Fish frames are picked up three times a week from the trout farm and transferred to the processing facility in the USU Nutrition and Food Science building. Prior to processing, fish frames are held in plastic bags at White's and USU at 0-2°C (32-36°F) to retard microbial spoilage. Cooking of the fish frames in a boiling water bath for up to 1 minute loosens the meat from the bones (Figure 3). Unless the frames are over- or undercooked, the flesh can easily be removed by hand (Figure 4). This trout meat has good muscle integrity and has proved excellent for canned



trout products. The hand-deboned meat may be held at 0-2°C (32-36°F) in covered plastic meat tubs for 1-2 days or canned directly. The trout skeleton is the meat by-product of our processing operation (Figure 5).

Excess liquid was not initially removed from the hand-deboned trout meat. This caused problems during storage because the liquid that collected on the bottom of the meat tubs formed a gel. (The gellation was due to water soluble proteins that leached from the fish.) In turn, the gel and meat mixture on the bottom of the storage tubs could not be easily separated and caused some canned product to be underweight for meat. Permitting the trout meat to drain for 20-30 minutes (Figure 6) after hand-deboning eliminated the gel problems.

Cans are filled by hand and each can is weighed on a digital, top-loading balance, to insure that the cans are not underfilled (Figure 7). Salt brine is added, can lids are put in place, and the

vacuum sealer creates the required 5 inches of mercury vacuum within the can. Two can sizes have been used, including a 307 × 113 can (6.5 oz., tuna-can size) for retail marketing and a 603 × 408 can (65 oz., No. 5 squat can) for institutional use.

The filled cans are cooked in a commercial-sized batch retort (Figure 8). The filled cans are processed at 116 or 121°C (240 or 250°F) for the proper processing time, which is determined by can size. Cans are removed from the retort after cooling and are air dried. After labeling and boxing, the processed cans are held at USU until shipped by the trout farm to retail or institutional outlets.

Present Outlook

During the several months that canned trout has been produced at USU, quality has been consistently maintained. Only one lot was described as having a muddy or earthy flavor, probably due to

WHITE'S

Flake Style
in Water

Rocky
Mountain
Rainbow

TROUT OF

PARADISE

NET WT. 6½ OZ. 184 g

INGREDIENTS: TROUT, WATER
FRESH FROM STREAMS OF THE
WASATCH ROCKIES, SALT.

PRODUCED AND PROCESSED BY
WHITE'S TROUT FARM
PARADISE, UTAH 84328

WHITE'S

Flake Style
in Water

Rocky
Mountain
Rainbow

TROUT OF

PARADISE

NET WT. 6½ OZ. 184 g

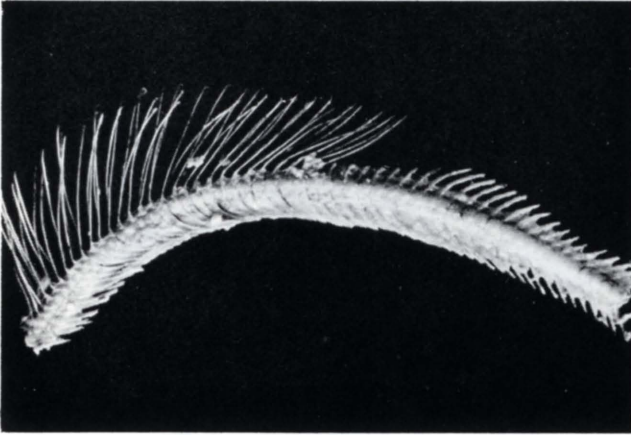


FIGURE 5. Trout skeletal frame after meat removal.



FIGURE 6. Draining eliminates gel problems



FIGURE 7. Weighing insures equal can weights

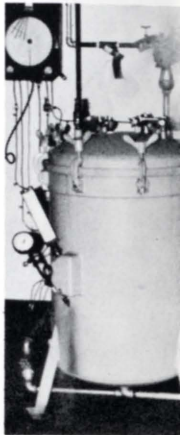
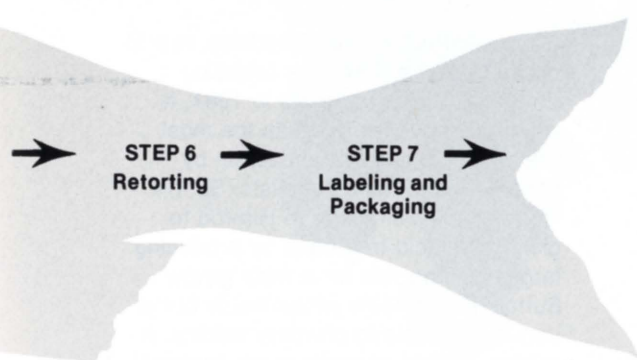


FIGURE 8. Filled cans are retorted (cooked) at 121°C.



a compound called geosmin. Since geosmin is produced by actinomycetes and blue-green algae in pond waters, there may be seasonable variations in its production. That possibility will need to be investigated to avoid any additional lots of unsatisfactory canned trout.

Local market tests of the canned trout were highly successful and the trout farm's marketing efforts are now focused on larger retail grocery chains.

Fish frames mechanically deboned at Beehive Machinery, Sandy, Utah, gave meat yields as high as 82 percent. The mechanical process produces a finely ground meat rather than flakes, and it can be best used in minced fish and fish sausage products.

Research to find a better way to mechanically separate the trout meat from the bones has a top priority. Hand deboning and can filling are currently the most costly elements of the trout canning operation amounting to over one half of the production costs. The

commercial potential would be higher if production costs could be lowered.

The hand-deboned, trout meat from the previously discarded fish frames has been fully satisfactory in canned trout meat products and should have a bright economic future. Meat from trout frames was worth approximately \$0.01/lb. in 1982. In the canned flake style product, that meat has a 1983 retail value of over \$2.70/lb.

The fish canning project at the Department of Nutrition and Food Sciences is an example of the product development and food processing assistance that can be provided to Utah companies that lack their own expertise. Our department welcomes opportunities to provide answers to food development and processing challenges in the future.

TABLE 1. Composition of rainbow trout and salmon from the genus *Salmo*.

Product	Calories per 100 grams	Moisture	Protein	Fat	Carbohydrate	Ash
Rainbow Trout, raw ^{a,c}	195	66.3%	21.5%	11.4%	0%	1.3%
Rainbow Trout, canned ^{a,c}	209	63.2	20.6	13.4	0	2.4
Chinook Salmon, raw ^{a,c}	222	64.2	19.1	15.6	0	1.1
Chinook Salmon, canned ^{a,b,c}	210	64.4	19.6	14.0	0	2.0
Rainbow Trout, mech. deboned, raw ^{a,d}	184	68.5	18.2	11.8	0	1.3
White's Rainbow Trout, canned ^{a,b,d}	158	72.3	18.0	9.0	0	2.3

^aCaloric values used for protein were 4.27 calories per gram and for fat 9.02 calories per gram, according to the Atwater procedure found in USDA Agriculture Handbook No. 8.

^bSolids and liquids analyzed.

^cAgriculture Handbook No. 8 values.


^dUSU laboratory analysis of White's canned trout and mechanically deboned trout meat.

ABOUT THE AUTHORS

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GRAPE TO MAKE YOUR OWN RAISINS

J. L. ANDERSON, M. G. WEEKS, W. A. VARGA, G. SCOTT, and C. P. BRENNAND

THE BASIS FOR NEARLY ALL the commercial production of raisins in the United States is the Thompson Seedless grape, the same white seedless fruit that is so popular as table fare. Unfortunately, the Thompson Seedless is not well adapted to northern Utah conditions. In our grape variety trials, Thompson Seedless has suffered bud damage and crop reduction when winter temperatures drop below 10°F; at below 0°F, the vines may be killed to the ground. Consequently, we have evaluated other seedless grapes for their potentials as table grapes and for the home production of raisins.

Seedless Grapes

Canadice is a relatively new, pink, seedless grape developed by the New York Agricultural Experiment Station. It is quite winter hardy and has been the heaviest producer of the seedless grapes currently under evaluation. *Canadice* has a good flavor, especially if it is not allowed to overproduce. Because of its tough skin, however, it is less desirable for raisin making than are some of the other seedless grapes.

Glenora is another new seedless grape from New York. The purple fruited *Glenora* has a distinctive flavor and texture. This variety tends to be a meaty rather than a juicy grape and it has a greater potential for the table than as a raisin grape. *Glenora* is quite susceptible to powdery mildew and requires a fungicide treatment program if quality fruit is to be produced.

Himrod, *Interlaken* and *Lakemont* are all white, seedless, American hybrid grapes also developed by the New York Experiment Station. They have a common heritage (Ontario × Thompson Seedless), but each has distinctive characteristics. *Himrod* is quite winter hardy, is very responsive to growth-enhancing gibberellic acid treatment (see later section), and (without the hormone treatment) dries to make a very good raisin. Its primary drawback is that the berries tend to shatter and drop from the cluster as they approach maturity. As a consequence, *Himrod* does not develop as high a sugar content as do some of the other seedless grapes. Nevertheless, it has been rated quite high as a table grape.

The fruits of *Interlaken* are smaller, ripen earlier and are less responsive to gibberellic acid treatment than those of *Himrod*. The berries make a fairly good raisin. In 1981, taste panelists significantly preferred *Himrod* to *Interlaken* whereas in 1980, the reverse was true. *Interlaken* is less winter hardy than is *Himrod*. Utah's cold temperatures in January and February of 1982 severely damaged *Interlaken* buds, resulting in an 80 percent crop reduction.

Lakemont is a good quality grape when grown in areas with a long enough season to allow it to mature properly. During most years, sites along the Wasatch front do not have an adequate growing season (receive enough heat units) to mature *Lakemont* for use as a table grape or for raisins.

Suffolk Red is a red, seedless, hybrid grape from the New York breeding program. During our tests in 1981, it was ranked with *Himrod* as the most preferred table grape and raisin by observers and taste panelists. *Suffolk Red* responds similarly to *Himrod* to gibberellic acid treatment by producing large-sized berries for a table grape. *Suffolk Red* is fairly winter hardy but is very susceptible to powdery mildew. A mildew control program is necessary to produce *Suffolk Red* grapes of acceptable quality.

Perlette is an early ripening European grape that is grown in California to precede Thompson Seedless as a table grape on the commercial market. The summer seasons in northern Utah are usually long enough to mature *Perlette*, and in such years *Perlette* will dry into an acceptable raisin. *Perlette* is much less winter hardy, however, than are American grapes such as *Concord*, or American hybrid grapes such as those listed above. During the winter of 1981-1982, *Perlette* vines were killed to the ground at the Farmington Field Station. In addition, *Perlette* is very susceptible to powdery mildew. Growers of *Perlette* grapes will have to train the vines so that they can be covered to protect them from cold winter temperatures and follow a mildew control program.

Venus is a new hybrid grape released by the Arkansas Experiment Station. It is a medium-sized, purple grape with a very pleasing flavor. *Venus* appears very promising as a source of fresh table grapes, but not of raisins. Based on our

CAPTIVATOR



LAKEMONT



HIMROD



SUFFOLK RED



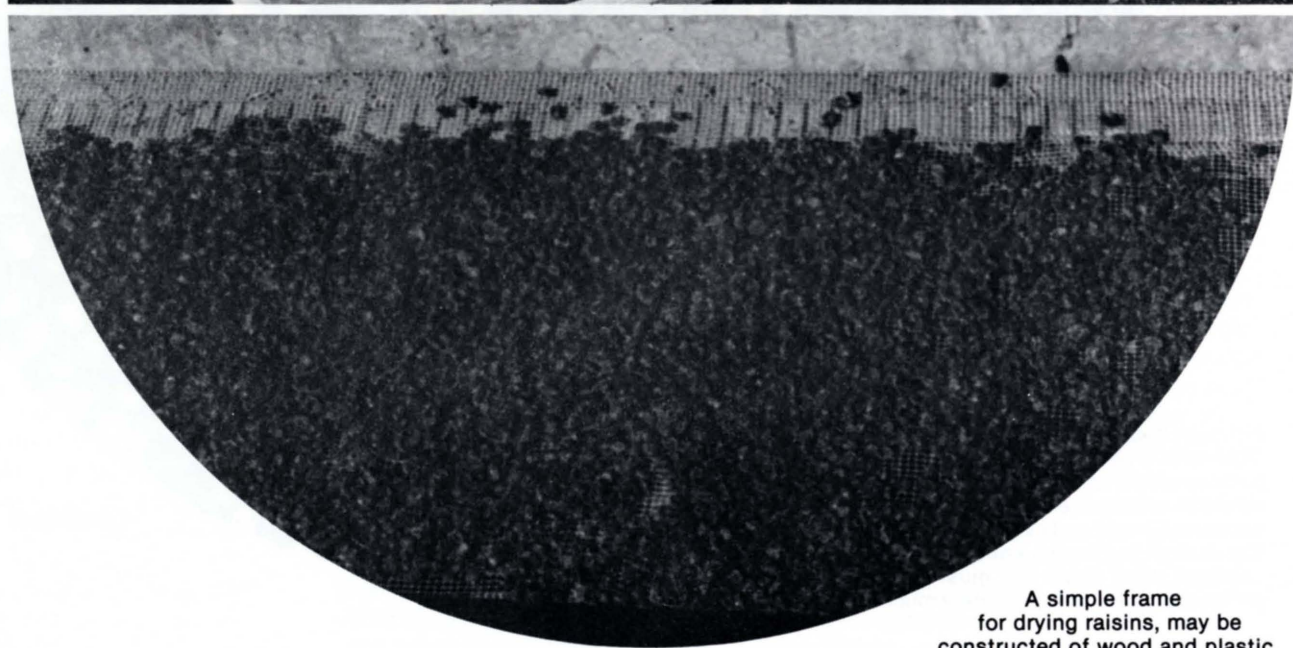
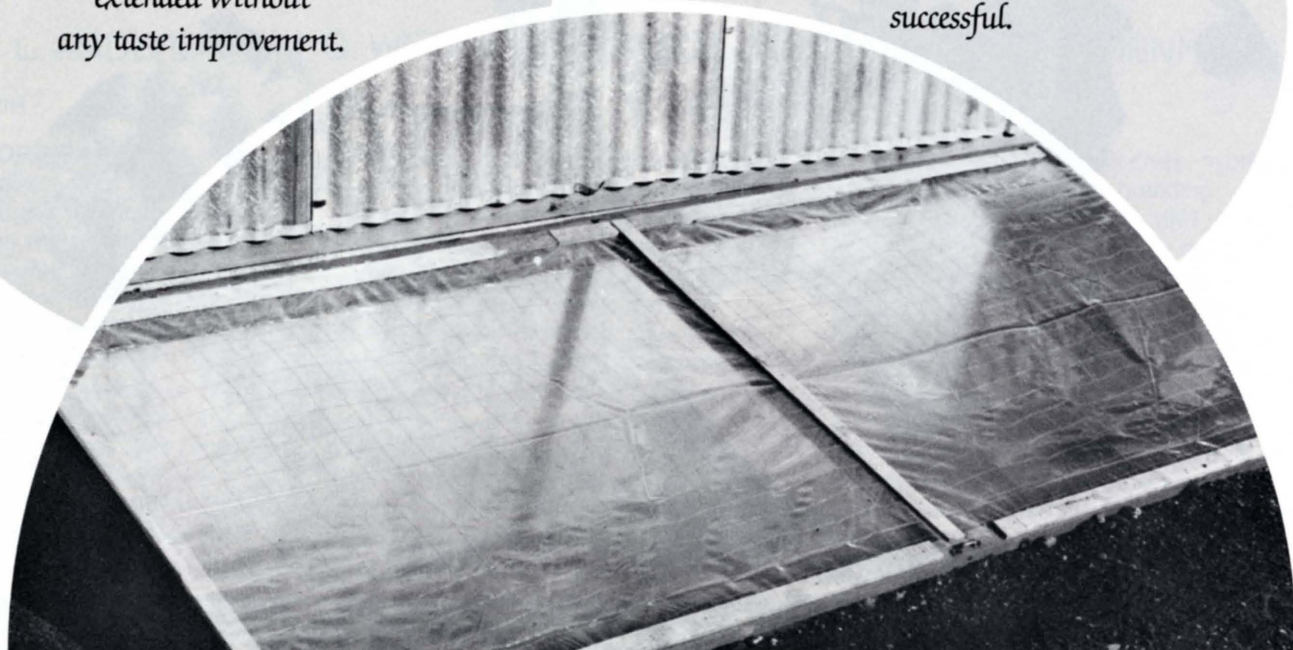
LAKEMONT

Although beautiful, *Captivator*, a seeded multi-purpose grape, is not as well suited to raisins as are the white seedless *Himrod* and *Lakemont*. The *Suffolk Red* makes a good seedless table grape but must be protectively treated for powdery mildew.

Himrod and
Suffolk Red are
most preferred
for home-grown table grapes
and raisins in Utah.

Plant hormones
should not be used
on raisin grapes as
the drying time is
extended without
any taste improvement.

Closed cold frame
and
greenhouse
drying has
been very
successful.



A simple frame
for drying raisins, may be
constructed of wood and plastic.



trials, the variety can be recommended for fresh use only.

Powdery Mildew Control

Though the seedless grapes listed above differ in their susceptibility to powdery mildew, none of them are immune, and the disease can be a problem wherever they are grown. Powdery mildew is most likely to be a problem when warm summer days are followed by cool nights and dew formation.

The classical control for powdery mildew is application of sulfur as a wettable powder, a dust, or as a flowable formulation. To control powdery mildew, sulfur treatments should be applied when the grape shoots are 3, 6, and 12 inches long and then repeated every 7 to 10 days if conditions remain favorable for disease development. Benomyl treatment will also control powdery mildew and is effective for about 14 days.

Gibberellic Acid

Seedless grapes are much smaller than are most seeded grapes and require hormone treatments to attain the size wanted in table grapes. All Thompson Seedless grapes sold on the fresh market have been treated with gibberellic acid, a naturally occurring plant hormone. The hormone should NOT be used with grapes being grown primarily for drying. Such treatments extend the drying time without improving raisin quality.

American hybrid grapes vary in their responses to gibberellic acid treatment.

Few are as responsive to treatment as Thompson Seedless. Himrod and Suffolk Red berry size is significantly increased when the vines are sprayed with 150 ppm solutions of gibberellic acid at the shatter stage and again 7 to 10 days later.

Raisins

In California, raisins are made by sun-drying Thompson Seedless grapes on paper trays in the field. Rain during the drying process can ruin the raisin crop. Such sun drying of grapes is not practical in northern Utah because they mature so late in the season that temperatures are inadequate, and the risk of rain is much greater than during raisin season in California. Also, American hybrid grapes have much thicker skins than do Thompson Seedless or Perlette. The hybrids therefore require a longer drying time than do the European grapes.

Greenhouse conditions during the late summer offer the Utah grape grower an alternative to California-style sun drying. Temperatures in a non-airconditioned greenhouse often exceed 120°F during bright sunny days and are ideal for drying raisins.

Even without a greenhouse, however, you can still turn your grapes into raisins. All you need is a cold frame, which can be used in the spring to start bedding plants or vegetables for later transplanting to the field. The cold-frame cover of 4 mil plastic should be slanted to the south. A hardware cloth bench within the cold frame will support the grapes while they are drying.

To ready grapes for raisin making, remove the stems and spread the

grapes either on brown wrapping paper on greenhouse benches or on your cold frame's hardware cloth. Drying may be hastened by blanching the grapes prior to drying. Blanching causes the skins to split, allowing a more rapid dehydration. In our studies, however, blanched grapes did not make nearly as acceptable a raisin as did non-blanched grapes of the same variety.

In September 1981, the temperature in a closed cold frame often exceeded 120°F. Raisins dried in the cold frame were comparable in quality to those dried in a greenhouse.

Electric dehydrators may also be used to dry grapes. Drying time will vary depending on drier model and fruit load. Himrod, the only variety we used in a commercial Magic Mill dehydrator, raisined in 9½ days. This time was decreased to 7 days when the grapes were pre-scalded. Grapes dried in the drier appeared lighter or more golden in color than did comparable grapes dried in a greenhouse or cold frame.

ABOUT THE AUTHORS

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George Scott is a former graduate student who helped with the project.

Charolette P. Brennand is an assistant professor of Nutrition and Food Sciences specializing in flavor chemistry and sensory evaluation.





D. R. WALKER

apple growing

A BLEND OF ART AND SCIENCE

THE PRODUCTION OF APPLES HAS CHANGED considerably the past few decades. Before dwarf trees became available, it could take 8 to 12 years for the trees to come into production. Over the years, we've learned more about the insects, diseases, and weeds that infest our orchards and how to control them to a better extent. Growers can now use fewer chemicals but with more effectiveness, and in many cases predator insects are being allowed (even encouraged) to control those that harm the trees or fruit.

A number of mutations, sudden unexplained changes, have occurred within apple trees and enhanced the

color of the fruit, though other qualities remain the same. Another mutation has given us the so-called spur trees. Shoots on these trees grow much less, though there are about the same number of leaves as on non-spur trees. The spur trees are smaller and require much less pruning and often fruit as much or more than do the standard-growth type of trees.

Generations of apple growers put their fruit in bushel boxes in the field as they picked it. They then had the problem of moving many small boxes from the orchard to the packing shed. Now they put their fruit in pallet boxes that hold 22 bushels. With a fork lift on

their tractors, they move the pallets around their orchards and onto trucks for delivery to the packing shed.

Commercial growers and home gardeners of the 1980s use chemicals on their trees for many purposes. They have chemicals that control insects, diseases, and weeds, and others that thin fruit, reduce fruit drop in the fall, enhance fruit color, and loosen fruit for easier harvesting.

All of these changes have improved the quality of the fruit. The most significant change in apple production, however, has been the advent of dwarf fruit trees.

*The most significant
change in apple production
is the advent of
dwarf fruit trees.*

Dwarfing Improves Production

Today's popular apple trees are a result of work done at the East Malling Research Station in England decades ago, in which researchers collected genetically dwarf trees throughout Europe and England. The trees were vegetatively propagated and evaluated through years of testing for their size and other desirable characteristics. Today, there are 8 to 10 rootstocks that have different degrees of dwarfness that are used in the apple industry.

Dwarf trees tend to fruit much earlier than standard trees. Some are producing in their third and fourth years and giving a respectable yield in the fifth. Another distinct advantage is that the trees can be placed close together. Thus, the total yield per acre is much greater than with standard trees, particularly in the early years of production. This is especially important to commercial growers because of the large investment they must make in trees and land, years before any income is realized. Additionally, giving trees proper care the first few years is expensive. The earlier that returns can help offset these expenses, the better.

Thirty years ago, growers were planting their trees 40' x 40' apart in an orchard, with 28 trees per acre. The trees did not bear at all for 7 or 8 years and not well until they were 10 to 12 years old. Some varieties did not bear for 12 or more years. Northern Spy, a very good apple, is rarely produced because it does not bear for several years unless ringing occurs or it is placed on dwarf rootstocks.

Now growers can plant hundreds of trees per acre. Apple trees on dwarf rootstocks have been planted on a commercial basis 6' x 12' apart, which allows 605 trees on an acre. Using a fully dwarf stock (Malling 9), growers have planted up to 1,000 trees per acre. The factors that determine acceptable spacing are: (a) the size of equipment you can obtain to work between the rows and (b) the trees' need for adequate light for their growth and fruit development. Shaded trees will

not grow well nor produce large, well-colored and good-tasting fruit.

Utah Tests

To evaluate the major size-controlling apple rootstocks under Utah conditions, an orchard was established at Farmington, Utah, using 4 different rootstocks (Malling 111, 106, 7, and 26), spur and non-spur Red Delicious trees, and Golden Delicious apple trees. The Malling 111 rootstocks produce trees about 3/4 as large as the standard-sized tree. Malling 106 and 7 produce about a 2/3-size tree and the Malling 26 rootstocks produce a tree that is about 1/2 (or less) as large as a standard-size tree. The trees were planted at different spacings 10' x 20', 9' x 18', 7' x 14', and 6' x 12' depending upon the degree of dwarfing induced by the rootstock (Table 1). The trees were planted in 1973.

Early Yields

When yield records were first taken in 1977, some combinations of rootstocks and spacings were producing as much as 412 bushels per acre, while others were giving 25 bushels per acre. In 1978, many spacing, cultivar, and rootstock combinations were yielding nearly 500 bushels per acre of Red Delicious and up to 700 bushels of Golden Delicious. The trees spaced the farthest apart on Malling 111 and 106 yielded about 300 bushels per acre in 1978, largely because of fewer trees per acre.

Based on three years of collecting yield records (1977-1979), Malling 106 rootstock trees produced an average of 294 bushels per acre, or 57 bushels more per year per acre than did Malling 111 rootstock trees (with both on 10' x 20' spacing) and an average of 488 bushels per acre or 37 bushels more per year per acre than did Malling 7 trees that were on 9' x 18' and 8' x 16' spacings.

Malling 26 trees are much smaller than the other trees. In this study, a

good planting distance for these trees was 6' x 12', resulting in 605 trees per acre, which, during the early years, resulted in an average production of 683 bushels per acre. In contrast, the Malling 7 and the Malling 106 appeared to be an optimum distance apart when planted at 8' x 16' (340 trees per acre).

After Year Five

Production in the early years is important, but so is a profitable level of sustained production over the years. Trees on semi-dwarf rootstocks (Malling 111, 106, and 7) require more time to develop their mature size than do those on the dwarf stocks such as Malling 26. But maybe trees that ultimately grow larger are more productive in the long run. To evaluate that possibility, we can consider the orchards' yield records the following three years (1980-1982).

Malling 106 rootstock trees produced an average per year (1980-82) of 281 bushels per acre more than did the Malling 111 trees (with both at 10' x 20') and an average of 162 bushels per acre per year more than the Malling 7 trees at 9' x 18' and 18' x 16'. Assuming a good spacing for the rootstocks is 6' x 12' for the Malling 26 and 8' x 16' for the Malling 7 and 106 trees, average yields per year (1980-82) per rootstock were 812, 890, and 1072 bushels per acre, respectively. The Malling 26 rootstocks (at 6' x 12') produced more fruit per acre for their first three years, but the Malling 7 and 106 (at 8' x 16') produced more than the Malling 26 in 1980-82. During the entire 6-year period, production averaged 747, 681, and 803 bushels per acre for the Malling 26, 7, and 106 rootstocks, respectively. The Malling 7 and 106 trees may yield more than the smaller trees in the future.

Malling 106 produces well but it is susceptible to collar rot. This disease increases in occurrence when water remains near the trunk of the tree through irrigation or water logging of heavy soil. It can be reduced some by

*Beautiful Malling 26
apple trees are ideal
for the home gardener.*

having irrigation furrows away from the trunk and proper watering. It has not been a problem in our study. Nevertheless, the University is recommending Malling 7 rootstocks for apple production until a better control for collar rot can be obtained and more is learned about the Malling 26 trees.

We already know, however, that Malling 26 trees do not require a ladder for picking and are easy to harvest. They have produced 2 to 3 bushels per tree the past few years. They are beautiful small trees and would be very good for the backyard gardener.

The standard Red Delicious (Sharp Red) produced 66 bushels more per acre on the average over the 6 years than did the Oregon Spur-Red Delicious trees. The Red Delicious trees produced 27 bushels more than the Golden Delicious trees per acre per year during the 6-year period when comparable rootstocks and spacing are summarized. Golden Delicious apples bruise easier than the reds, and, if not picked very carefully, the bruises will be evident a day or two after picking and result in cull fruit. The Golden also russet easily if sprayed on hot days, and they are subject to sunburn, which means a dark-

orange russet spot on the fruit. They are very good pollinators for Red Delicious, but they are harder to grow and pick than the Red Delicious trees. Generally, they do not store as well after January because of their not having a continuous cuticle or wax covering around the apple. Their acceptance, however, is increasing rapidly. Years ago people did not want a yellow apple when red apples were available, but now they know the taste of a Golden Delicious and often choose that above a Red Delicious.

Spacing is Crucial

Trees spaced 10' x 20' simply did not produce as much fruit as trees planted closer together. Trees on the second widest spacing in the experiment (9' x 18') produced substantially more fruit in 1980-82 than they had the previous three years. The average yield from this spacing has caught up to those from the next two closer spacings (8' x 16' and 7' x 14').

Trees planted at the widest spacings filled in so they formed a tight hedge row pattern during the last three years and had utilized all of the room available

to them. Yet their yields averaged at least 200 bushels less than those from trees on the next widest spacing (9' x 18'). After 7 years, all trees had filled the space they had been given. They are now being pruned so that equipment can pass between rows.

Average vs. Optimum

From figures obtained by the Fruit Tree Survey booklet and the Utah Agricultural Statistics published by the Utah Department of Agriculture, one can obtain the number of acres of apples produced in Utah and the average production. These figures indicate an estimated average production the past 10 years of 253 bushels per acre per year. Our studies indicate that nearly all of our cultivar, rootstock, and spacing combinations produced at least twice the state average considering even the first 6 years of bearing.

In the third year of bearing, four of our combinations were producing over 1,000 bushels per acre. The fourth year of bearing, had 9 combinations producing over 1,000 bushels per acre, with Golden Delicious on a Malling 7 rootstock at 6' x 12' spacing producing over 1,600 bushels per acre. In the fifth year of bearing, 80 percent of the combinations used, produced over 975 bushels per acre, which is nearly four times the state average. That same year, 40 percent of the treatments produced over 1,200 bushels, with some reaching 1,600 and 1,700 bushels. This fruit was all of excellent quality and good marketable size.

Thus, with a well-planned and well-cared for orchard, growers can produce a very good yield of quality fruit.

TABLE 1. Effect of scion, rootstock, and spacing on yield of apple trees per acre.^{1,2} Average yield, bushel per acre, 1977-1982, Farmington, Utah.

Scion	Rootstock	Spacing and number of trees per acre				
		10' x 20' (218)	9' x 18' (269)	8' x 16' (340)	7' x 14' (444)	6' x 12' (605)
1. Sharp Red	106	467 ³	748			
2. Sharp Red	111	416 ³				
3. Sharp Red	7		755			
4. Sharp Red	26			763	618	
5. Top Red	106					480
6. Oregon Spur	106		619	804		
7. Oregon Spur	111		551			
8. Oregon Spur	7			599	805	
9. Oregon Spur	26			491	691	753
10. Red Spur	26					622 ⁴
11. Golden Del.	106	600	687			
12. Golden Del.	111	312				
13. Golden Del.	7			682	840	1,082
14. Golden Del.	26					681 ⁴
15. Gold Spur	26					589 ⁴

¹Trees planted in 1973, unless otherwise noted.

²Figures represent an average of 8 to 10 trees.

³Yield data for 1980 missing. Figures are an average of the other years.

⁴Trees planted in 1974.

ABOUT THE AUTHOR

David R. Walker is a professor of Plant Science at Utah State University with a PhD in Pomology from Cornell University. His research interests are focused on improving the quality and yield of fruit grown in Utah orchards.

Vegetable Varieties for Utah

HUNDREDS OF VEGETABLE

VARIETIES from throughout the United States, Western Europe, the Orient, and in fact all parts of the world, are available to commercial growers and home gardeners in Utah. The principal sources are 15 wholesale companies and more than 50 retail companies within the United States who provide catalogs from which the varieties may be ordered. Several wholesale companies operate within Utah, one of which also provides a retail, mail-order catalog. Nurseries, feed and seed stores, and garden centers stock a variety of vegetable seeds that mostly come from U.S. wholesale packet companies in the Northwest, Midwest, and East. The problem, thus, is one of choosing correctly.

How Will It "Do" in Utah?

It is the varietal testing program carried out by Alvin R. Hamson and William A. Varga of USU's Plant Science Department at the Farmington Research and Extension Center, Farmington, Utah, that gives a valid answer to that question. Commercial growers and home gardeners alike need information on the performance of likely varieties in Utah, and the performance tests must be conducted by an agency that has no bias based on prospective sales of any particular variety or hybrid. It is also important that the evaluation trials be conducted as near as possible to the area where the vegetables will be grown. Fortunately, environmental conditions at the Farmington Station are similar to those of the major vegetable growing areas in Utah. Farmington is also characteristic of the entire Great Basin area, including southern Idaho, western Wyoming and Colorado, eastern Nevada, and northern New Mexico and Arizona.

Revered Oldsters to Upstart Newcomers

Vegetable varieties may be separated into three distinct groups. One can be classed as "heirloom" varieties, those that have been available for many years but remain popular because of their unusually high quality. Examples include the Blue Lake Pole bean, Detroit Dark Red beet, Scarlet Nantes carrot, Prize Head and Buttercrunch lettuces, Utah Yellow Sweet Spanish onions, Lincoln pea, Wisconsin SMR18 cucumber, Yolo Wonder pepper, Buttercup winter squash, DX 52-12 tomato, and Crimson Sweet watermelon. These varieties have never been replaced because each provides inherently unique qualities.

The second group includes most of the remaining varieties. These are not of particularly high quality, but are offered by many commercial seedsmen. Vegetable gardeners tend to remember variety names with which they've had experience, and this can mean a continued demand for varieties that are not exceptional in their performance. Beyond a tendency to stay with the familiar, many gardeners simply do not hear about better developments. The inertia inherent in this process results in a tendency to resist new varieties.

Seed companies with active research departments, however, are continually developing new varieties and hybrids that they try to market as superior to existing varieties or hybrids. These constitute the third group.

Evaluation Factors

An evaluation program is essential to properly classify the performances of all available varieties. Without accurate performance data, no one can identify the superior varieties. This is particularly important in the Great Basin area because of its extremes in climatic

factors. As an example, summer daytime temperatures are high with generally cool temperatures at night, sometimes compounded by the cold drainage that occurs from canyons, as happens along the Wasatch Range. Growing seasons are often short because of late frosts in the spring and early frosts in the fall. Characteristically wide fluctuations in temperature and moisture require that varieties produce well even under less than desirable conditions. The Great Basin's (and Utah's) extremes in growing conditions, mean that recommendations appropriate for other areas of the United States may not be valid. Varieties often perform differently in the Great Basin area than elsewhere.

For many years, vegetable varieties or hybrids were evaluated primarily on size, appearance, and yield. With interest in home gardening expanding since the mid 1970s, the more frequent direct contacts between consumer and vegetable grower at roadside stands, and increasingly popular pick-your-own merchandising, other quality considerations have been added. Home gardeners are particularly interested in texture and flavor of vegetables and whether they will retain high quality for extended periods of time. Durability is also important to the market gardener, who must display his/her product for some time after harvest for sale to the public. Because seedsmen are becoming aware of these trends, many new introductions are touted on the basis of their high culinary quality. As usual, though, only a controlled trial can determine if claims are valid for Utah growers.

Farmington Results

Outstanding new hybrids that have been identified through varietal trials at the

Some outstanding vegetable varieties for Utah include (1) Melody Spinach (2) Buttercrunch Lettuce (3) Buttercup Winter Squash (4) Premium Crop Broccoli (5) Yellow Baby Watermelon (6) Jet Set Cucumber (7) Savoy Ace Cabbage and (8) Pioneer Carrots.





Farmington Station include the following: The *Earlisweet beet* is ready a week to ten days earlier than the Detroit Dark Red, which has been considered the standard for many years, and it is of equal or superior quality on the basis of tenderness, sweetness, and flavor.

Pioneer carrot is a somewhat elongated Nantes type of unusual sweetness, tenderness, and flavor. The pioneer also holds well (without splitting) throughout the growing season.

Melody spinach is so attractive, productive, and mild in flavor along with unusually good bolting resistance that it is clearly the choice above all other varieties or hybrids.

The *premium Crop broccoli* produces a head averaging 8 to 12 inches in diameter. Its florets are deep blue-green in color, very fine and tender in size, and tend to remain in tight buds for a week to ten days.

The *Savoy Ace hybrid cabbage* produces large heads with unusually tender crinkles or savoyed leaves of excellent sweetness and mild flavor.

Slicing *cucumbers* have generally appeared attractive, but often have rather strong, bitter flavors. New hybrids such as *Jet Set* and *EuroAmerican* are long, slender, of bright green color, and with such a very tender skin that they may be eaten without peeling. Their mild, sweet flesh is totally devoid of the bitter character.

The *Zucchini Elite summer squash* is productive, develops long, slender fruits of deep green color flecked with slightly lighter color, and they have remarkable tenderness and good flavor. The *Dixie Hybrid* is an unusually uniform and attractive yellow crookneck with excellent flavor. *Peter Pan Hybrid* is a scalloped type summer squash that maintains its tenderness even as it increases in size.

The *Summet cantaloupe* is early in production, large in size, very attractive due to its good netting and ribbing, and has a golden yellow color on maturity. Best of all, its fine-grained flesh is firm in texture and has superb flavor and sugar content.

The developments in *sweet corn* are absolutely outstanding. The new sugary extender type characterized by *Sugar Loaf* is sweet with tender pericarp and with a pleasant, malty flavor. The tenderness and sweetness hold well on the plant for at least 10 days and the variety maintains good quality after harvest. The bicolor corn, *Double Delight*, is the first truly noteworthy bicolor type since it has superb tenderness, sugar content, and flavor. Among the white types of corn, past judgments have generally been compared to a relatively late maturing hybrid, Silver Queen. We now have the *New Platinum Lady*, which is of distinctly superior quality in tenderness and sweetness.

There are many interesting developments in *tomato* hybrids. One that has stood the test of time for at least 25 years is the *Moreton Hybrid*. This rather large tomato on an indeterminate trailing vine is excellent when eaten fresh, and has sufficient quality for early canning. The small tomato, *Presto*, which is a somewhat enlarged cherry-type ripens unusually early, is productive and high in quality, making a veritable mound of red, ripe tomatoes on a small determinate bush vine. The firmness and flavor of the fruit hold well even into mid summer. The *Sweet 100* tomato produces a long, indeterminate vine that is well suited for trellising. The tomatoes are borne in such a profuse pattern that they appear like grapes in long clusters. These small tomatoes are unusually sweet and flavorful. The *Early*

Cascade tomato is a high-quality variety that has good foliage cover with a relatively extensive indeterminate vine. Its remarkably attractive fruits do not split even with rainfall and have an easy peeling characteristic and good flavor that made this tomato suitable for canning.

Many available varieties of *peppers* are highly productive and of good to excellent quality. These include the yellow *Gypsy Hybrid*, which is unusually productive but also very mild in flavor. One of the largest, most attractive peppers also with a very mild sweet flavor is the *Valley Giant Hybrid*.

Two hybrids of *eggplant* proved outstanding in our trials. One, the *Ichiban*, is a small, high-quality, oriental type. The other is the larger, conventional type, *Dusky*, which ripens sufficiently early to be grown easily throughout the Great Basin area.

Many watermelon varieties of only fairly good quality have been sold over the past years. Consumers have been particularly frustrated in trying to find a watermelon of high quality. Hybrids are now available that produce sweet, flavorful, fine-textured melons that hold well as they mature, so that the process of choosing a quality melon has become much easier. These new hybrids include *Yellow Baby*, which is an early producing watermelon with deep yellow-colored flesh, relatively few seeds, and excellent sweetness and flavor. *Sugar Belle* is a melon from the Orient and is of the Sugar Doll type except that the texture of its flesh remains firm and fine-grained, and the sugar content is unusually high. This early producing melon will maintain unusually good quality for several weeks during the summer. The most notable watermelon of all those we have tested is the *Triple Sweet Seedless*. This is a triploid type

*An evaluation program
is essential to properly
classify the performances
of all available varieties.*

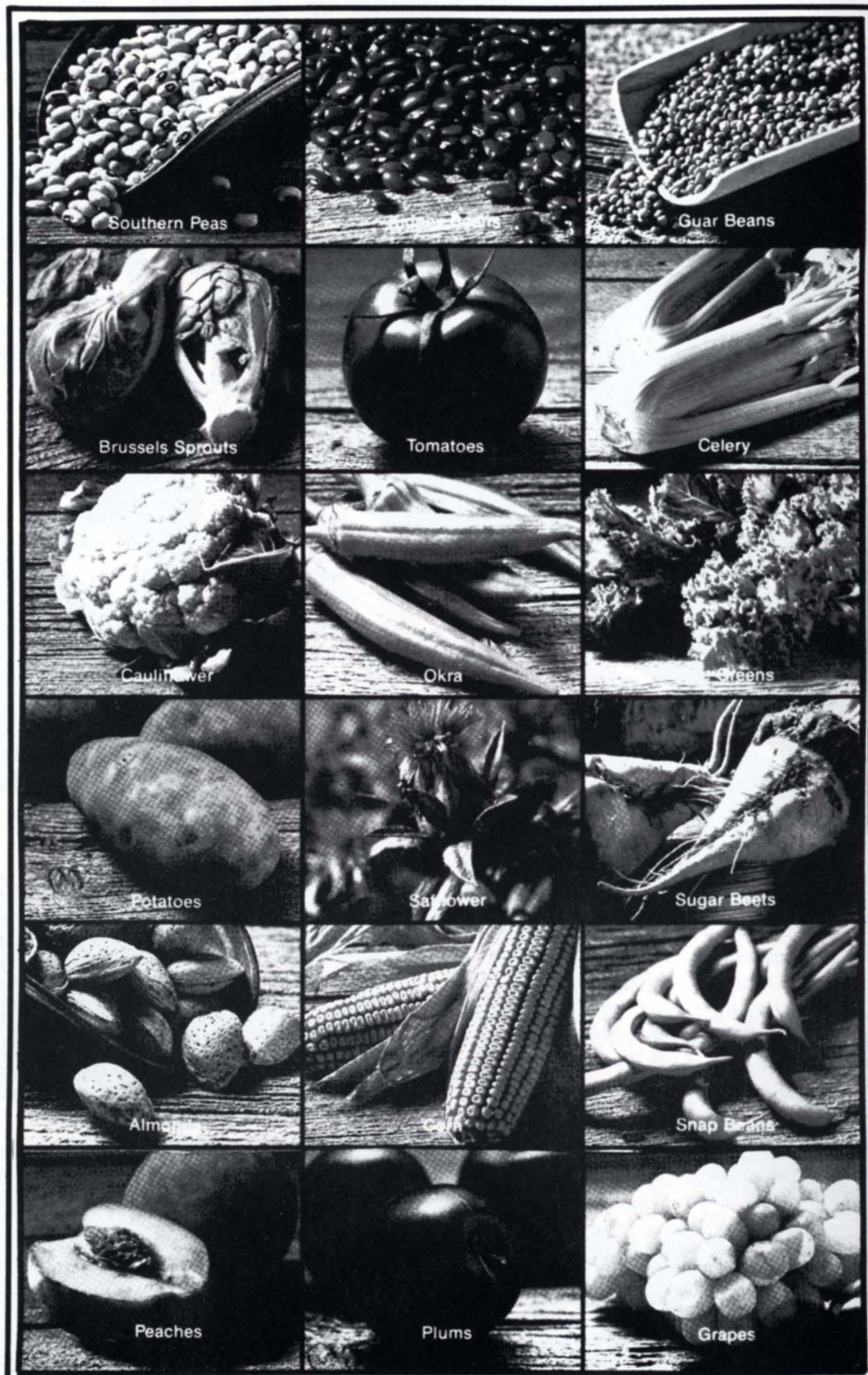
that has solid interior flesh of fine, firm, crisp texture with only small vestigial seed coats. Since a watermelon softens first near its seeds, this variety holds its firm, crisp texture over an extended time at maturity.

Many plant breeders are enthusiastically developing hybrids of superb quality. Their results are now coming at an accelerated rate as compared to just a few years ago. The Farmington program of continually evaluating the quality characteristics of new hybrids is, therefore, more valuable than ever. If a variety proves up in a Farmington Trial, it can be expected to do equally well elsewhere in Utah and the Great Basin area.

ABOUT THE AUTHORS

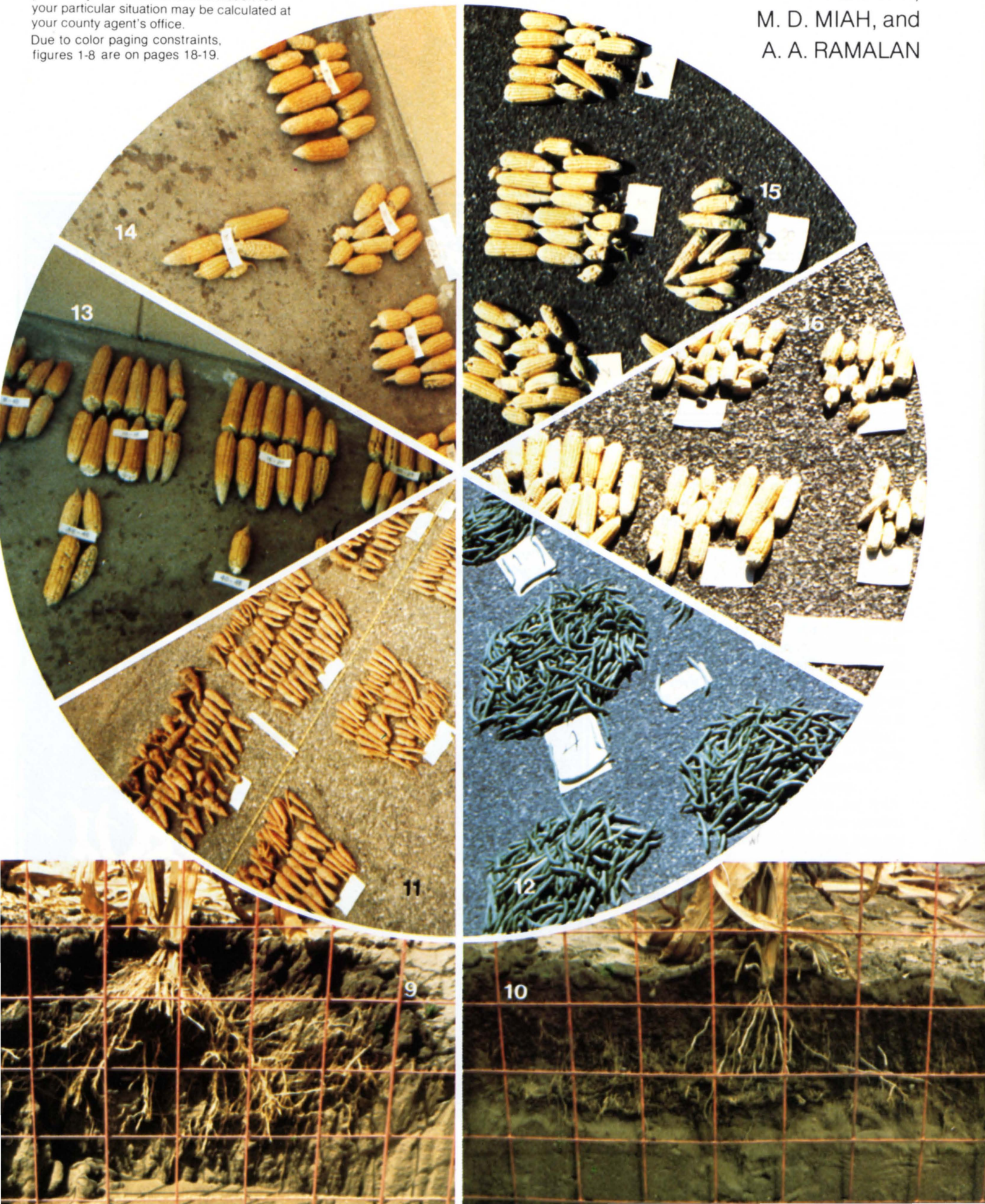
Alvin R. Hamson is professor in the Plant Science Department and extension specialist in horticulture. His tests of vegetable varieties are performed at the Farmington unit of the Agricultural Experiment Station. He is an internationally recognized authority in the field of vegetable production.

William A. Varga is a research associate in the Plant Science Department and directs horticultural research efforts at the display gardens at the Farmington research unit of the Experiment Station. He is a landscape garden consultant and is writing a weekly column on home gardening for the Desert News.



FIGURES 11-16. Yields obtained from Point Source circles beginning at 5 feet out from sprinkler head and continuing to 50 feet. Best yields vary with conditions. Information for your particular situation may be calculated at your county agent's office. Due to color paging constraints, figures 1-8 are on pages 18-19.

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A VEGETABLE GARDENER'S GUIDE TO IRRIGATION

HIGH-CROP YIELDS ARE ENCOURAGED by applying irrigation water in a timely manner and in proper amounts. The extremes are to sprinkle-irrigate in small daily doses and to surface-irrigate in large amounts once a week. We wanted to develop a scientific basis for evaluating the effects of different irrigation frequencies and amounts on vegetable crop response. While subjecting corn, carrots, onions, and beans to various irrigation treatments, we also determined the crop water production functions.

Materials and methods

Successive field experiments were conducted at the Utah State University Agricultural and Irrigation Engineering River Lab during the summers of 1981 and 1982. The site is located by the Logan River in the mouth of the canyon about a quarter mile downstream from First Dam (see Figure 1). The 15 cm* of top soil is loamy sand, underlain by 30-45 cm of sand, which was hauled in over the river-washed gravels.

Two circular areas, each of 30.5 m* in diameter, were tilled twice with a rototiller in early May. Four bags of 16-16-8 and two bags of 34-0-0 fertilizer (22.7 kg* each) were spread evenly over the areas with a hand spreader, which

made our fertilizer application equal to 205 kg/ha N, 100 kg/ha P and 50 kg/ha K.* The fertilizer was then incorporated with a final pass of the tiller. Each circle was divided into nine or twelve segments (pieces of pie).

Three replications of sweet corn (Golden Beauty), carrots (Nantes) and onions (White Spanish) were planted in rows parallel to the center radius line of each segment in each circle (Figure 2). Green beans (Bush Blue Lake) were then planted along the borders between segments. Planting was done by hand using a small garden planter in mid to late May 1981. Plant spacings between rows and along hills and depths are shown in Table 1.

A single sprinkler (Rainbird 30E, 3/16 by 3/32-7° nozzles) was placed in the center of each circle (Figure 2). Control valves were connected at each sprinkler riser and on the lateral pipe. Operating pressure was maintained at 50 to 60 psi at the sprinkler during irrigation. Circle 1 was irrigated every four days, while Circle 2 was irrigated every other day. One of two rows of catch cans was placed parallel to the prevailing wind

and the other perpendicular. Cans were located 1.52, 4.57, 7.62, 10.67, and 13.72 m from the sprinkler in each of the four radial lines. The average value of four collector cans was used for each irrigation in accumulating the can data.

Daily maximum and minimum temperatures, dry and wet bulb temperatures, pan evaporation, solar radiation, wind speed, and rainfall values were taken at the site. The amount of water applied during each irrigation was based on expected crop water needs or evapotranspiration (ET), which had been calculated with the Penman equation using an Apple II computer program written for the USU Extension Service.* An irrigation volume that matched the calculated ET was maintained in both circles at about 5.3 m from the sprinkler head. Thus, the area close to the center of the circle was over-irrigated and the area toward the circumference was under-irrigated, as indicated by the water application cross-section A-A in Figure 2.

Weeding was done by hand. Carrots were hand thinned, and sweet corn and onions were thinned and some transplanted to adjust for the effect of germination and nonuniformity.

Harvesting of each segment was accomplished after first dividing the middle two rows into 1.52 m sections, starting at 1 m (1.52 m for corn and beans) away from the sprinkler head. Green beans were harvested three times at one-week intervals. Fresh weights, taken immediately after each harvest, were accumulated for use in yield comparisons. The fresh weight of sweet corn ears with husks was considered as yield, while the fresh washed weight was used for carrots. Onions were harvested from more than two rows because of germination problems.

*Note: 100 kg/ha = 89 lb/ac, 1 ha = 2.47 ac, 1 meter = 3.28 feet, 2.54 cm = 1 inch, 1 kg = 2.2 lb.

FIGURES 9 and 10. A comparison of Sweet Corn root profiles. The deeper roots in Figure 9 resulted from less frequent but heavier water applications (4-day intervals at six meters from the center of the circle). Figure 10, corn at twelve meters from the center, was irrigated every 2 days.

FIGURE 11. Carrot (Nantes) yields from all water levels. The better quality carrots were approximately six meters from the center, 1981.

FIGURE 12. Green Beans (Bush Blue Lake) yields from all water levels. The highest yields were approximately seven meters from the center, 1982.

FIGURES 13 and 14. Sweet Corn (Golden Beauty) yield from all water levels, 1981. The best yield quality was attained with the 4-day irrigation interval (Figure 13) where irrigation and rain matched crop water needs. Figure 14 corn was irrigated every 2 days.

FIGURES 15 and 16. Sweet Corn (Golden Beauty) yield from all water levels, 1982. Figure 15 (4-day irrigation interval). Note this group was two meters further out from the center than best group in 1981. Small ears may have been due to winds during pollination.

*A visit to your county agent's office will give you access to the same program so you can calculate values for your location.



FIGURE 1. Site location layout of the 2-day (left) and 4-day (right) Point Source circles at the USU Agricultural and Irrigation Engineering River Lab. (Summer 1982).

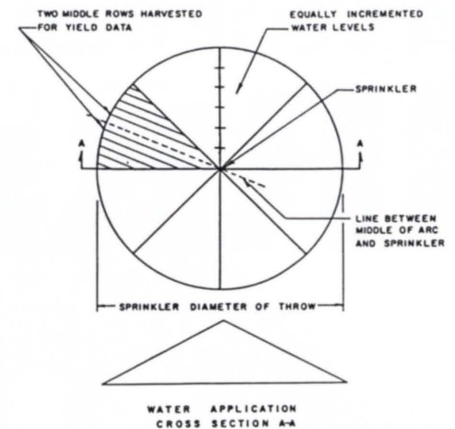


FIGURE 2. Schematic Diagram of the Point Source sprinkler irrigated test plot showing triangular water application cross section.

The onion yield data were consequently computed as weight per onion rather than per unit area.

Results and discussion

Season-applied irrigation water plus rainfall and crop yields for each of nine sample sections are summarized in Table 2. Crops in circle 2 (2-day irrigation interval) received more total water than did those in the 4-day circle. Yields, however, were consistently higher in circle 1 (4-day cycle) except where over-irrigation was experienced close to the sprinkler. This effect is shown in Figures 3 through 6, respectively, for 1981 sweet corn, carrots, beans, and onions and in Figures 7 and 8 for 1982 sweet corn and beans. The yield differences were attributed to the plants under the more frequent irrigation having access to proportionately smaller amounts of irrigation water for transpiration because so much water was being evaporated from the continually wet soil surface. All crops, except carrots, showed noticeable decreases in yield close to the sprinkler, particularly at the 4-day irrigation interval. Sweet corn, bean, and onion yields were highest in samples that were taken approximately 5.3 m from the sprinkler. At that point, irrigation plus rain totals matched calculated evapotranspiration values.

Rainfall just prior to planting and harvesting of all crops in 1981 except sweet corn put the soil at approximately field capacity, and gave a net soil water depletion of almost zero over the season. Deep percolation was assumed to be nearly zero except within about 3 m of sprinklers, where yellowing of the corn and bean leaves was observed.

TABLE 1. Plant spacings and planting depths.

Crop, variety	Distance			Depth (cm)
	Along row (cm)	Between rows (cm)		
		1981	1982	
Sweet corn (Golden Beauty)	15	76.2	61	3.8
Carrots (Nantes)	3-6	45.7	—	1.2
Onions (White Spanish)	2-5	45.7	—	1.3
Green beans (Bush Blue Lake)	10	single row	61	1.9

Note: 1 inch = 2.54 cm.

The 1982 effects of 4-day and 2-day irrigation intervals rooting depths are shown in Figures 9 and 10 for sweet corn root profiles. The advantages of applying heavier irrigations, which included better root patterns at the 4-day interval, are obvious when Figure 9 is compared with Figure 10. This effect (limited root-zone soil water availability) may also help explain the lower yields of corn that were on the 2-day irrigation frequency.

Yield quality was also affected by irrigation amount and frequency. The percentage of oddly shaped carrots was particularly high at the higher water levels (Figure 11). At the lower water applications, the carrots were rubbery and had an off flavor. Similar effects were also evident for green beans (Figure 12). Representative replications of sweet corn from the 4-day and 2-day irrigation intervals appear in Figures 13 and 14 (1981) and Figures 15 and 16 (1982), respectively. The better quality from the 4-day irrigation interval is obvious. For the 2-day interval, quality was best with the highest irrigation amount. That quality plus yield, however, required about 50 percent more water (1981) than under the 4-day interval (see Figure 3).

Conclusions

Based on 2 years of data, we conclude that frequent irrigations with small amounts of water, even on a sandy soil such as in this study, should be *discouraged* for vegetables. More benefit can be obtained from less frequent, heavier irrigations that are specifically designed to meet each crop's evapotranspiration needs. To match your irrigation interval and amount to the water holding capacity of your soils and your crops' water requirements, visit your county agent's office. You can find out there how to process data on your specific situation through the USU Extension Apple II Irrigation Scheduling Program.

ABOUT THE AUTHORS

Robert W. Hill is a professor in the Agricultural and Irrigation Engineering Department at USU. He is directing the research project studying crop water use and yield interactions and irrigation scheduling funded by the Utah Agricultural Experiment Station. He has written computer programs for the USU county extension agents to use in irrigation scheduling.

Ireneo De La Cruz Agulto, M. D. Mirjahan Miah, and Aliyu Abubakar Ramalan are PhD candidates in the Agricultural and Irrigation Engineering Department.

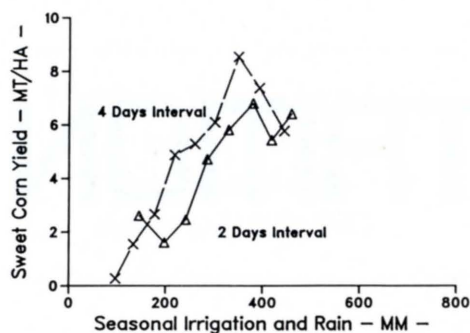


FIGURE 3. Sweet Corn (Golden Beauty) yield and available water, USU, 1981.

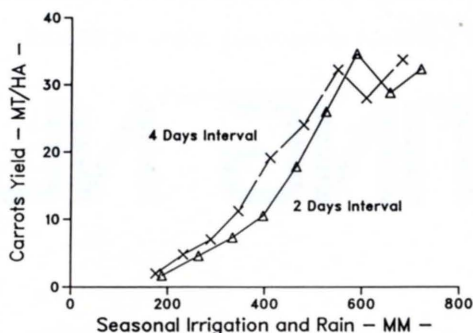


FIGURE 4. Carrot (Nantes) yield and available water, USU, 1981.

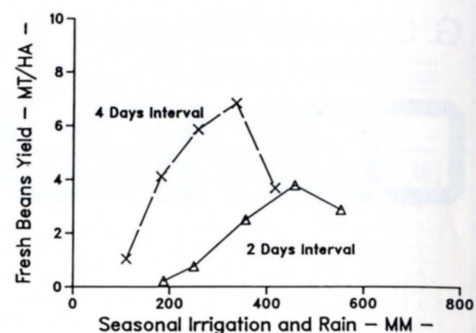


FIGURE 5. Green Beans (Bush Blue Lake) yield and available water, USU, 1981.

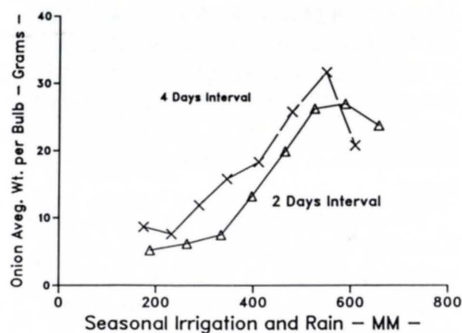


FIGURE 6. Onion (White Spanish) yield and available water, USU, 1981.

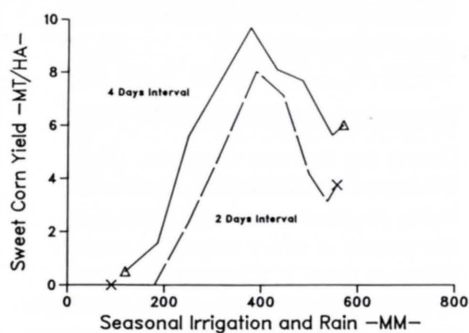


FIGURE 7. Sweet Corn (Golden Beauty) yield and available water, USU, 1982.

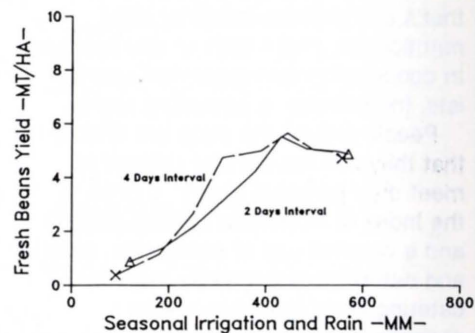


FIGURE 8. Green Beans (Bush Blue Lake) yield and available water, USU, 1982.

TABLE 2. Vegetable crop yield and seasonal water availability, AIE River Lab, USU, Logan, Utah, 1981 and 1982.

Crop	Irrig. Interval (days)	Irrigation level, I, and distance from center of circle to mid-point, m									
		I ₁ 14.5	I ₂ 13.0	I ₃ 11.4	I ₄ 9.9	I ₅ 8.4	I ₆ 6.9	I ₇ 5.3	I ₈ 3.8	I ₉ 2.3	
1981											
GREEN BEANS (Bush Blue Lake)	YIELD (Tons/Ha) ^a	2	—	—	—	—	0.22	0.76	2.49	3.78	2.86
	4	—	—	—	—	—	1.04	4.11	5.86	6.84	3.67
	IRRIG + RAIN (mm) ^c	2	—	—	—	—	188	250	356	458	553
	4	—	—	—	—	—	110	182	258	337	417
CARROTS (Nantes)	YIELD (Tons/Ha) ^a	2	1.7	4.6	7.3	10.5	17.8	26.0	34.6	28.8	32.3
	4	2.0	4.8	7.0	11.2	19.1	24.0	32.2	28.0	33.7	
	IRRIG + RAIN (mm) ^c	2	188	264	334	397	465	526	589	658	721
	4	175	232	289	346	411	480	550	609	683	
SWEET CORN (Golden Beauty)	YIELD (Tons/Ha) ^a	2	—	2.61	1.61	2.46	4.72	5.81	6.80	5.43	6.41
	4	0.27	1.55	2.66	4.88	5.29	6.09	8.54	7.38	5.77	
	IRRIG + RAIN (mm) ^c	2	—	146	198	242	286	330	381	419	460
	4	97	134	178	219	261	302	350	394	445	
ONIONS (White Spanish)	YIELD (g/Onion) ^a	2	5.20	6.15	7.46	13.19	19.90	26.26	26.98	23.76	26.18
	4	8.64	7.58	11.84	15.77	18.28	25.78	31.68	20.78	16.64	
	IRRIG + RAIN (mm) ^c	2	188	264	334	397	465	526	589	658	721
	4	175	232	289	346	411	480	550	609	683	
1982											
GREEN BEANS (Blue Lake)	YIELD (Tons/Ha) ^b	2	0.4	1.2	2.6	4.7	5.0	5.6	5.0	4.9	4.7
	4	0.9	1.4	2.1	3.1	4.2	5.5	5.1	5.0	4.9	
	IRRIG + RAIN (mm) ^c	2	91	180	250	311	389	445	499	537	557
	4	120	187	250	307	377	432	485	547	570	
SWEET CORN (NK 199)	YIELD (Tons/Ha) ^b	2	0.0	0.0	2.3	4.8	8.0	7.1	4.2	3.1	3.8
	4	0.5	1.6	5.6	7.4	9.7	8.1	7.7	5.6	6.0	
	IRRIG + RAIN (mm) ^c	2	91	180	250	311	389	445	499	537	557
	4	120	180	250	307	377	432	485	547	570	

^aYield represents the average of three replications.

^bAverage of two replications.

^cThe amount of rainfall received by each crop was (1981) Green Beans, 50 mm (2-day) and 56 mm (4-day); Carrots, 86 mm; Sweet Corn, 51 mm; Onions, 86 mm; (1982) Green Beans, 76 mm and Sweet Corn, 59 mm.

Note: 1 ton/acre = 2.25 Ton (metric)/hectare, 1 inch = 25.4 mm, and 1 oz. = 28.4 grams.

COMPUTING NUTRITION

HOPE FOR THE BEWILDERED—

that's one promise made by USU nutritionists. And it isn't an idle promise. In cooperation with extension specialists, the promise is becoming reality.

People around the state are finding that they can have a diet tailored to meet their personal needs. Thanks to the Index of Nutritional Quality (INQ) and a creative use of computers, calorie and nutrient needs can be met—while catering to an individual's food preferences.

The INQ made its debut in the 1970s.¹ According to the basic concept, the number 1 is used to describe a food that has equal amounts of a particular nutrient and energy (calories) based on a standard.* A value over 1 indicates a good source of that nutrient. A value under 1 is a poor source. The INQ is calculated for each nutrient in a given food as follows:

$$\text{INQ} = \frac{\% \text{ nutrient requirement}}{\% \text{ energy requirement}}$$

The INQ can be presented in bar graph form (adapted from Figure 3) to identify insufficient nutrients in diets such as iron for infants; in analyzing a school lunch menu for school-age children; or to indicate nutritious snacks for teenagers.² The Index also makes it easier to correctly select foods for weight loss or to control intakes of fat and cholesterol and ratios of polyunsaturated to saturated fatty acids. For the elderly, the INQ can help identify foods that supply adequate vitamins and minerals without too many calories. Those who want to be vegetarians can use the INQ to good advantage to insure adequate nutrition.

The food industry itself could apply the INQ in planning and designing new

foods, evaluating current food fortification programs and in determining enrichment policies.²

Computers take the INQ To You

During the last two years, the Utah Extension Administration has been trying to place small, self-contained computers in every county Extension Office in Utah. A program was then written for these computers that put the nutrient density concept into a teaching format.

The USDA Handbook 8 provided the food data. Because of the limited storage capacity of the computers, only 326 foods were included. These foods were selected from the foods most frequently reported as being consumed in the western United States according to the USDA Food Consumption Survey, 1977-78. The twelve nutrients that are considered are commonly thought of as "indicator" nutrients. That is, based on food composition, it is assumed that if these nutrients are contained in a diet in sufficient amounts, the other nutrients will accompany them.

The Nutrient Density Diet Analysis computer program delivered to each county can provide a relatively fast and accurate analysis of an individual's food intake during one day. It gives extension agents a basis for extending their nutrition education programs. Using the computer program, an individual can analyze his/her day's food intake for its contents of energy, carbohydrate, fat, protein, vitamin A, vitamin C, thiamin, riboflavin, niacin, calcium, iron, vitamin B₆, and magnesium. The results allow for each user's sex, age, current activity level, and current or desired weight based on information provided on a standard form (Figures 1 and 2).

The food consumption data require that the potential user of the computer program recall his/her food intake for a 24-hour period. The recall method, believe it or not, can provide a more

accurate record than may be obtained by asking a person to write down food as it is consumed. The computerized list of 326 foods is then consulted to find the proper code number and the serving size, after which, all of the recorder information is entered into the computer.

The computer program* is very "user friendly"—which means that it asks helpful questions to promote accurate information input. For example, if your reported activity level did not total 24 hours, the computer would suggest that you try again.

This use of the computer by Extension personnel builds upon the public's growing acceptance of the equipment as a valid tool which can supply up-to-date information tailored to a specific situation. For dietary calculations, the incredible speed of the computer is invaluable. But not even computer-assisted learning can provide all of the answers.

You Receive Nutritional Insights

A sample of the answers it does give is shown in Figure 3. Every printout will show all of the data typed into the computer, including the foods eaten. A brief explanation of the Index of Nutritional Quality is included along with the bar graph format. The nutrient analysis cites the actual amount of the nutrient, in INQ terms and in percent of the Recommended Dietary Allowance (RDA). A bar graph illustrates the individual's nutrient and calorie intakes via breakfast, lunch, dinner, and snacks. A composite graph illustrates totals for all foods consumed that day. (An individual food can be analyzed for its

*Generally, the Recommended Dietary Allowance (RDA).

¹R. Gaurth Hansen. An Index of Food Quality. Nutrition Reviews, Vol. 31, No. 1, January 1973, p. 1-7.

²Bonita W. Wyse, Ann W. Sorenson, Arthur J. Wittwer, and R. Gaurth Hansen. Nutritional Quality Index Identifies Consumer Nutrient Needs. Food Technology, January 1976, p. 22-40.

*This program and related instructional materials, for personal use on home computers, are now available for \$25 from Georgia Lauritzen, UMC 87, Utah State University, Logan, Utah, 84322; (801) 750-3464.

UTAH SCIENCE

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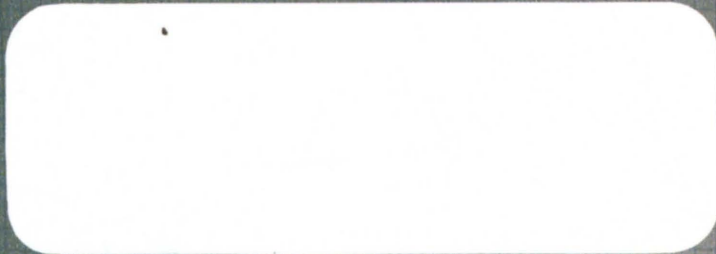
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