Researchers at Utah State University are curious people. Curious because they want to find out new things and this curiosity is prominent in staff members of the Department of Nutrition and Food Science.

The cover picture shows pastry products made from ground raisins. Our food scientists found that dried pie cherries make excellent quality raisins with a distinctive flavor that can be used in place of regular raisins. New fortified fruit juice powders have been developed that hold special promise for the use of people in less developed countries with limited protein supplies. A new process for making juice from dried prunes has been developed.

These researchers work closely with industry, as in the case of several Utah cheese plants. They strive to develop new and tasty varieties of cheese, solve problems arising from certain types of microorganisms that cause off flavors, and streamline the cheese making process. One of our animal scientists, a poultryman, has even gone into food invention. Through his efforts, new turkey products are being developed and tested, such as turkeyburger patties, turkey meatloaf, turkey ham, turkey bologna, and turkey sausages. Taste tests have indicated excellent public acceptance. Read about these and other research developments in this issue of Utah Science.
AN EDITORIAL

A vigorous organization that stays geared to meet public needs must undergo many changes. In 1888, as Utah State University was founded, Dr. Jeremiah W. Sanborn was appointed President of the college and director of the Agricultural Experiment Station. This combination of president and director continued until 1896 when Joseph M. Tanner was designated President and Luther Foster, Director. Most of the intervening years have seen a close association between the College of Agriculture in the University and the Agricultural Experiment Station. During some periods the offices of Dean and Director have been combined. Gradually, however, the programs of the Experiment Station have become more and more widely dispersed throughout the University. Consequently, a recent examination of the administration of the Experiment Station relative to the structure of the University and the probable future needs of agriculturally oriented research indicated that organizational changes were due. The present replanning and reorganizing of our research programs or commitments to make these last 16 years the most productive in our first 100.

Agriculture today intimately affects the life of each of us, and not only because it is still the provider of food, it is also the husbandry of land, water and air resources and of the accompanying plants and animals that add beauty and meaning to our lives. Agriculture, thus, is relevant to both the nutrition and the social well being of people.

Research programs of Utah's Agricultural Experiment Station are authorized to be as broad as today's concept of agriculture. Experiment Station projects presently exist in 17 departments and six colleges, and the investigations could be even more widely disseminated. Limited resources and priorities for program emphasis have restricted the scope of activities, and efficiency now demands further modifications. During its developing years, Utah's Agricultural Experiment Station was relatively remote from any other agricultural research center. In addition, knowledge about agricultural problems was limited. This pattern was conducive to initiating studies on all aspects of farm and home and natural resource problems. During the last quarter century, however, there has been a tremendous increase in knowledge, and relatively simple problems have been intensively and effectively investigated. In the process, however, new and more complex problems have become evident. These problems, vital to future supplies and the quality of the natural environment require new research techniques and philosophies.

Utah's Agricultural Experiment Station is therefore reorganizing itself to take better advantage of the capabilities of faculty and students and physical facilities in all parts of the University. This means that the available resources of the Station must be concentrated on fewer problems in order to probe the selected questions in adequate depth and to develop meaningful solutions within practicable periods of time.

ORGANIZATIONAL CHANGES

The work of the Agricultural Experiment Station is now carried out in departments located in six colleges of the University: Agriculture, Engineering, Family Life, Humanities, Arts and Social Sciences, Natural Resources, and Science. To integrate the work of the Station more closely with the academic programs of the University, and to better utilize staff capabilities and facilities, the deans of these colleges together with the Vice President for Research and Director of the Station and the Assistant Director are being organized into the Agricultural Experiment Station Council. The Council will consider the research needs of Utah in relation to the resources, capabilities, and the traditional role of the Agricultural Experiment Station and will make recommendations as to research priorities within the Station. It will review research plans, procedures, accomplishments, and budgeting procedures. The Council is responsible for ascertaining that available resources are used most effectively to simultaneously serve the needs of the agriculture and conserve the natural resources and quality of the environment in the State.

Since the majority of Station programs are in the colleges of Agriculture, Natural Resources and Science, the deans of these colleges, together with the Vice President for Research and the Assistant Director, will constitute the Executive Committee responsible for developing, reviewing, and submitting recommendations to the Council.

This new organizational arrangement is an innovation in Agricultural Experiment Station management that will be watched with interest by other stations. We believe it will strengthen and optimize Utah's agricultural research endeavors.

WYNNE THORNE

WYNNE THORNE is Vice President for Research and Director of the Agricultural Experiment Station.

REVIEW AND PLANNING FOR THE FUTURE

As a vital part of the process of reorienting agricultural research at Utah State University to better satisfy (Continued on page 136)
High-protein fruit juice powders

D. K. SALUNKHE, H. R. BOLIN, and KIRTI SALUNKHE

It is a known fact that lack of protein is the world’s greatest nutritional deficiency. The consequences of protein deficient diets are recognized by delay in physical growth and development, emotional and psychological disturbances, intellectual alternations, and the reduction of resistance to disease, delay in subsequent recovery from the diseases, and susceptibility to infections which eventually shorten the life span.

Malnutrition is a world problem. It effects more children than adults. Lack of enough protein (10-15% of total diet/day) affects brain development, makes one susceptible to disease and infection, and many times results in an early death. An all-out assault on under and malnutrition should be made systematically. CARE, Pro-Lac, Foremost, Miltone, PL480, Columbo Plan, Food for Peace, Incaprina, UNICEF, WHO, FAO, and many other organizations idealistically attempt to help, but still the ‘gap’ is becoming wider and wider and the ‘package’ is becoming smaller and smaller.

Today, unfortunately, malnutrition in parts of the U.S.A. and undernutrition in many parts of the world are known but not well recognized. If one happens to be in the Southern States, the Indian reservations, or the ghetto areas of the U.S.; in Southeast Asia; in the South or Central Americas; or in certain countries in the Continent of Africa, he will see many funeral processions. A large number of the deceased have never reached the age of 10. (The senior author’s five brothers and sisters died before the age of 5). This is due not only to lack of food but because of proper education of the parents in nutrition.

Since there is a need for protein supplemented foods, many scientists are trying to develop new products that meet adequate dietary standards yet are tasty, that are culturally acceptable, and are stable (have a long shelf life), economically produced, easily handled and shipped, and have profit potential in domestic and foreign markets.

Figure 1. One of the authors is checking temperature, pressure, relative humidity, and the rate of dehydration of fruit juice powders in the dehydrator.
NEW PRODUCTS

Until recently, the food industry has been much more interested in developing new products that were excellent in color, flavor, and texture than “nutrition.” The administrators of the industry believed that one could not “sell” nutrition. However, this is no longer acceptable to the consumer because we have nutritionally fortified synthetic products such as ‘TANG,’ which contains more vitamin C than orange juice and more vitamin A (carotene) than tomato juice, which travels with our astronauts to the moon. Our newspapers, radios, and television sets educate us about the importance of nutritious food in our diets. In recent years, the food industry is becoming more nutrition conscious in developing new products which are highly acceptable in color, flavor, texture, wholesomeness, nutrition, and ease in “fixing” and serving. In our judgment, high protein fruit juice powders could fulfill the requirements of the consumers.

The protein content of most deciduous fruits is low and its quality in terms of essential amino acids is poor. Therefore, an attempt has been made to fortify fruit juices with protein and then dehydrate them into concentrated nutritious powders in order to provide a product which offers improved stability without requiring refrigeration, is light in weight and low in volume, offers ease in handling and packaging, yet provides a delicious beverage upon reconstitution with water or milk.

New directions and consciousness in “nutrition” will have significant impact on the beverage industry.

During and after World War II, investigations were undertaken to develop powdered fruit juices by the United States Department of Agriculture’s Western Utilization Research Laboratory, Albany, California. Some of the earlier products were lacking in flavor, however.

In our laboratories at Utah State University, fortification, fabrication, and formulation of fruit and vegetable products with proteins and vitamins have been in progress for over a decade (Vitamin enriched apple juice, 1960]. Our experiments have shown that squeezing juice from “cull” fruits and fortifying it with soya, fish, or peanut proteins (10-15%) can produce a delicious drink that should be acceptable not only to the “affluent” people but also for those who are on Food Stamps. These juices may find a place on the American market because of their present high quality.

THE JUICES

To produce apple juice, the fruits were washed, sorted, and pulverized in a hammermill. Measured quantities of pulp were enclosed in heavy cloth —known as “cheeses”—and five or six were interspersed with slatted boards and pressed at one time. A yield of approximately 3 gallons of juice per bushel of apples was obtained. The juice was placed in a storage tank at an ambient temperature and pectinase enzyme, Pectinol A, was stirred into it at the rate of 0.1 to 0.2 percent. The mixture was allowed to stand overnight, usually 12 to 15 hours. At the end of this time, most of the small particles had settled to the bottom and the clear juice could be drawn from the top of the tank. Diatomaceous earth was added to the residue in the bottom of the tank to aid in filtering out the rest of the salvageable juice.

The juice was then run through a flash-pasteurizer where the temperature of the liquid was raised from 60 F to 180 F in 30 seconds. Warm, sterile bottles were filled with the hot juice and capped with sterile, rubber-ringed metal caps.

Peach nectar was prepared as follows: Mature but firm Elberta peaches were picked and allowed to ripen. The fruits are then washed, sorted, halved, pitted, and steamed for 3 minutes at 10 pounds pressure in a canning retort. Heating at 150 F inactivated surface enzymes in the fruit and loosened the skins. The peach halves were then placed immediately in cold water and the skin was removed. Each batch was placed in a steam jacketed kettle with an equal quantity of water.

Figure 2. At the left is a glass of fortified apple juice (containing 10% protein) and at the right is a dish of solubilized soybean protein plus powdered apple juice. In the background is a beaker of clear water. Two glasses per day of the fortified juice are enough to furnish the protein need of an adult.
and heated to 160 F. This mixture was passed through a Fitzmill with an 0.04-inch sieve under an atmosphere of nitrogen. This inert gas was used to minimize the oxidative browning often found in processed fruit or fruit products. The nectar was then heated to 196 F and canned immediately. After sealing, the cans were plunged into cold water for rapid cooling.

Cherry juice was made from Montmoreroy sour cherries by removing the pedicels. They were then washed, sorted, pitted in an Elliot pitter, heated in a steam jacketed kettle to 160 F, mixed with 2-percent diatomaceous earth, and pressed in a cidermill press. The resulting juice was filtered in a Sparkler laboratory filter. It was then heated to 196 F and poured into "R" enamel cans. After sealing, the cans were immediately plunged into cold water to avoid overheating.

The respective juices were then fortified with protein which was enzymatically modified to increase its water solubility and foaming properties. This product (Gunther D-100 WA- containing 62-percent protein and was added as a 20-percent solution.

THE POWDERS

Progressive expansion of the fruit juice industry during the last 10 years is due to the increased demand brought on by the improvement in the quality of dehydrated products.

Acceptable quality is a key factor which determines the commercial success of a product. The quality attributes of fruit juices are color, flavor and body. The detailed analyses for these attributes indicated that marketable qualities of reconstituted juice powder are similar to those of canned juices. In addition, juice powder has the following advantages:

1. It saves weight and space because nearly 80 percent of the water is removed; hence, it is economical in transportation, storage, packaging, and handling to distant markets.
2. Juice powder can be preserved for extended periods without refrigeration.
3. Ease in handling and convenience and rapid reconstitution make it suitable for domestic and military requirements, especially for overseas use.
4. It has concentrated nutritive values after the incorporation of proteins in the juices.
5. It is stable at elevated storage temperatures for extended periods of time.
6. It has high quality and nutritive value at the time of consumption.

Juice powders can be prepared by different procedures, one is the vacuum-puff drying method. This process removes water from the fruit juice in such a manner that a porous structure is formed. The open sponge-like material accelerates the drying rate and also the ease of reconstitution. However, vacuum drying procedures are expensive.

A foam-mat drying method was used in this study because it is more economical and faster. This process consists of whipping together for 5 minutes, various juice-protein-methyl cellulose (a foaming agent) combinations. The resultant foam is spread 1 mm thick on trays and then dehydrated at 160 F for 25 minutes.

After the trays are cooled, the friable, puffed material can be removed easily. The powder is then ground to pass through a 6-mesh screen. Destroying, crushing, screening, and packaging are carried out in a room with humidity below 10 percent to prevent the hygroscopic powders from absorbing moisture and becoming sticky. All the samples of the powder for each variety of fruit are mixed together for uniformity, placed in appropriate size cans, and sealed under half an atmosphere of air pressure. The moisture content of the powder is usually about 2 to 3 percent.

The quality of the reconstituted high protein products is acceptable. The viscosity of the reconstituted products is similar to that of 'malted' and 'shake' products — rather thick. The color of the apple juice is creamy; of the peach nectar, an orange-yellow; and of the tart cherry juice, pink. If the products are served after reconstitution, they have an excellent flavor and consistency.

POTENTIAL

These fruit juice powders have a high nutritional content per unit weight or volume which minimizes shipping and storage expenses. This makes them attractive to hikers, campers, explorers, or housewives who want to be able to serve their growing families a flavorful, growth promoting drink. In addition, these products can be exported to or produced in a foreign country for distribution to areas of low protein availability. Because of the flavorfulness and ease of digestibility, these juices should find wide acceptance.

Other protein sources could probably be used for fortification, such as fish or milk proteins. Fish protein concentrate is an odorless powder that is 80 percent protein. The milk protein powder only contains 29 percent protein. Each particular powder imparts different characteristics to the final reconstituted juice such as viscosity, clarity, and flavor.

PROTECT your HOME and GARDEN where 15 percent of all pesticides purchased are used to help preserve a healthy, attractive, productive environment for work and play.

UTAH SCIENCE
A departmental marriage

C. A. ERNSTROM

Historically, most land grant institutions throughout the United States have had a Department of Food Science in the College of Agriculture and a Department of Foods and Nutrition in the College of Family Life or of Home Economics. So it was a break with tradition when the Institutional Council at Utah State University officially approved (in September, 1971) combining the two departments at USU. The break was made on the assumption that this combination of effort will bring nutritional problems related to food science into sharper focus and encourage nutritionists to help solve related processing problems in the food industry.

In the past three years, American consumers have become keenly interested in the nutritional quality of processed food products. By contrast, the food industry continued to be primarily concerned with further improving keeping quality, flavor and convenience ratings of processed food products, because these were the things the American consumer had demanded over the past 15 to 20 years. Only quite recently has the food industry recognized its growing responsibilities toward the nutritional well-being and satisfaction of the consuming public. The USU departmental merger is expected to strengthen efforts to help the food industry solve nutritional as well as quality, flavor, and stability problems.

The name of the new department is Nutrition and Food Sciences and it will be jointly administered by the Deans of the College of Agriculture and the College of Family Life. The merger permits the streamlining of some courses that have previously been taught in both departments. It also facilitates the coordination of research activities and an increase in productivity per unit cost.

Further efficiencies will be realized when the new department is no longer scattered among seven different buildings and areas throughout the campus. The architectural design, working drawings, and specifications have been completed for a Nutrition and Food Sciences building. The new structure will provide research laboratories, animal rooms, classrooms, teaching laboratories and pilot processing plants for dairy products, fruits, vegetables and meats. The nucleus of an excellent staff is planning and beginning to activate an exciting program, and when the facilities are available, additional staff and equipment will extend their activities.

Most students trained in Nutrition and Food Sciences find unlimited employment opportunities. Recent figures released by the Bureau of Census in the Department of Commerce reveal that the processing of food and kindred products in Utah alone, adds 102.9 million dollars each year to the value of raw agricultural products. The Utah industry involves 233 establishments that employ 7,600 people and have a total payroll of 42 million dollars. In terms of value added to raw products in the state, it is second only to the primary metals processing industry and considerably ahead of any other manufacturing industry in the state.

Food industries are the largest potential employer of Food Science graduates. The industries need graduates to: develop new products, manage plants, find effective ways to market and package products, and create new supplies and ingredients.

C. A. ERNSTROM is a Professor and Head of the Department of Nutrition and Food Science.

Nutritionists are required by food industries to evaluate the effects of processing on the nutritional value of various manufactured foods. They also serve as dieticians in hospitals, rest homes, and other institutions where large amounts of food are served at each meal and where special diets are required. Nutritionists are also employed by associations such as National and State Dairy Councils, and to help with educational programs in schools concerned with the nutrition of children, or pregnant mothers, and others with special needs.

Even though opportunities for university graduates have been generally limited in the past two years, those trained in Nutrition and Food Science have been among the exceptions. The growth of the industry and the relatively few students seeking training in these areas have made the difference. At Utah State University, companies representing various food industries have provided private funds for scholarships to encourage qualified high school graduates to enter the food industry as a profession. The institute of Food Technologists provides scholarships to certain institutions (including USU). The American Dietetic Assoc. has also accredited the Department of Nutrition and Food Sciences at Utah State University so that our graduates in dietetics are acceptable to other institutions as interns in dietetics.

The new USU Department in Nutrition and Food Sciences is eager to improve the nutritional status of the people of Utah and the intermountain area as well as to help the region's food industries. We are concerned with the welfare of those who produce and process food products and those who consume them.

Our food industry service program
allows the talent of our entire professional staff to be brought to bear in the solving of problems related to product development, process improvement, and quality control. Additional staff members will be added as soon as possible to permit us to help some of the food processing areas that we are not now adequately serving. We are particularly interested in strengthening our capability to assist the meat industry, the confectionary industry, and the small food processing industries throughout the area.

Consumers are now primarily being helped by a federally financed extension program through the University. Although inadequately staffed, the program is giving members of minority groups a better understanding of nutrition and nutritional requirements. Immediate plans call for efforts to educate all consumers about food additives and food safety. The emphasis will be on identifying the agencies responsible for certain aspects of the problem and on making facts available about specific food additives and their effects. Efforts will also be made to publicize the kinds of diets that leave the consumer deficient in certain essential nutrients.

Utah State University has been commissioned by the State Board of Education to develop a center of excellence in Nutrition and Food Science. The combining of departments marks one move toward that goal. When the planned facilities are completed, we will be able to fulfill our commission more efficiently than at present, but even now, the department's research program brings substantial out-of-state funds to the state and the University. As our program is expanded, its beneficial results will become increasingly apparent in terms of inexpensive, high-quality, nutritious foods for consumers, produced by innovative, imaginative food industries.
Sub-atmospheric storage of horticultural products

Since 1960, the highest quality apples reaching the grocer's shelves in the late spring are those that have been held under controlled atmospheric storage (CAS). More perishable fruits and vegetables are shipped to market under CAS conditions. Now, newly developed subatmospheric storage (SAS) is receiving wide attention as a successor to CAS.

Under CAS, the atmosphere surrounding the produce contains 3 to 5 percent carbon dioxide and 2 to 5 percent oxygen, with the remainder being nitrogen. The relative humidity and temperature are also controlled. Ideal CAS conditions differ for each fruit or vegetable. Two different fruits such as apples and pears could not be successfully stored together because each requires a different gas composition, which has to be controlled within narrow limits. Other disadvantages of the CAS system are: the high costs of the atmospheric generating equipment; the required gas-tight storage areas (because the atmosphere is toxic to humans); the need to “air out” the storage area before fruit can be removed; and the unavoidable frequent testing of the atmosphere to insure that the relative amounts of oxygen and carbon dioxide are within the prescribed limits. This testing has to be done manually because it has not lent itself to automatic controls or to automation on a commercial scale. In addition, stone fruits do not store well for long periods under CAS possibly as a result of the toxic effects of the carbon dioxide.

Controlled atmosphere storage was discovered by a scientist who observed that apples kept longer in sealed containers than in open storage. The apples respired, or breathed, under both conditions, but in the sealed containers, carbon dioxide gradually replaced some of the oxygen. If the carbon dioxide concentration exceeded certain limits or the oxygen concentration became too low, the fruit stopped breathing and began to spoil. This system was gradually improved and modified to its current status but it was still empirically derived.

Scientists soon noted that fruit stored under CAS had a lower rate of respiration than did fruit stored under conventional cold storage in normal air, even though reducing the temperature does reduce the respiration rate. With a lower respiration rate, the fruit did not “age” as rapidly, less sugar was used up in respiration, and the fruit was sweeter at the end of the storage period.

Reducing the oxygen content around the fruit from 21 percent (air) to 4 percent (CAS) obviously had to slow the respiration rate. For some time after the discovery of CAS, however, the effects of the carbon dioxide were not understood. It was only known that fruits stored better when it was present in a proper amount than when it was absent. Some scientists studying the effects of another gas, ethylene, on fruit provided the answer.

ETHYLENE IS KEY

Ethylene is found in many plant tissues, but it occurs in higher concentrations in the fruit than in other parts of the plant. Eventually ethylene was identified as a hormone that initiates the process in fruits we call ripening. The ethylene must reach a threshold concentration characteristic of each fruit before ripening takes place. The chemical has been used commercially for many years to initiate artificial ripening of bananas, lemons and tomatoes. The principal result achieved by such usage is a change in color. The treated fruit develops a ripe appearance, but its flavor is similar to that of green fruit. To perform its hormone function, ethylene must be adsorbed on an enzyme. Other small molecules having similar (unsaturated) properties can also be adsorbed on the active site of the enzyme. One such molecule is carbon dioxide, which explains its function in CAS. The carbon dioxide competes with ethylene for the active enzyme site but does not initiate the process we know as ripening. If the ethylene in the fruit could be held below the value necessary to initiate ripening, no carbon dioxide would be needed, and fruit could be stored for a long period in the “green” state. If the respiration rate were simultaneously kept low, ideal storage conditions could be achieved. These facts and ideas are the basis for an improved method of storage.

ADVANTAGES OF SAS

The fruit is placed in an air-tight container and 80 percent of the air removed from the container. The effective oxygen pressure inside the container is reduced to 20 percent of its original value [from 21 percent (air) to 4.2 percent]. This reduction in air pressure around the fruit causes some of the ethylene gas in the fruit to diffuse to the surface and into the surrounding air space. At the same time, small amounts of humidified air are introduced into the container. The air eventually flows out of the storage chamber carrying with it the ethylene

L. ELMER OLSON

L. ELMER OLSON is an Assistant Professor in the Department of Nutrition and Food Science.
produced by the fruit. The concentration of ethylene in and around the fruit is thus kept below that which is required to initiate ripening. The temperature and relative humidity in the storage chamber are also controlled. Such a system has been called sub-atmospheric storage (SAS).

Different fruits can be stored together in a SAS because the ethylene produced by one, does not affect another. High or uncontrolled concentrations of carbon dioxide are never encountered. Also, the system can be automated because the necessary controls are readily available for the major variables: air pressure, relative humidity and temperature. The cost of the necessary mechanical equipment such as pumps is less than the cost of the gas generators used in the CAS system. The SAS system, however, is not totally without disadvantages. Most existing cold storage or CAS facilities cannot be converted to SAS because it requires buildings or storage chambers that can withstand atmospheric pressure on the outside with a partial vacuum inside. For new operations, a properly designed building would cost only slightly more than one designed for CAS. The reduced pressure within a SAS facility would also render its refrigeration system a little less efficient than one used for conventional cold storage. These disadvantages are relatively minor, however, and subatmospheric storage is the method of the future for a variety of plant products, including flowers. For example, the ethylene produced by orchids has been identified as the cause of their wilting. Subatmospheric storage of the flowers during shipment and marketing keeps them fresher—longer.

TURKEY PARTS

Last year, 13 percent of the entire crop of turkeys marketed in the United States was sold as turkey parts, such as turkey breasts, hind quarter turkey roasts, turkey wings and turkey drumsticks. Another 38 percent was marketed as further processed turkey items, mainly in the form of precooked turkey rolls and raw turkey roasts.

We expect this trend will continue in future years.

Marketing turkey dark meat presents some real challenges. Large hotels and restaurants are mainly interested in purchasing only turkey breasts. Consequently, processing plants experience problems in marketing the dark meat. Much of it has been sold in the form of hind quarter turkey roasts, consisting of the drumsticks, the thigh and a portion of the back. However, these roasts have been selling on the market for as low as 27 cents per pound. That results in a low price to producers for such high quality meat.

NEW PRODUCTS

To enhance the marketing of turkey, the Utah State Turkey Marketing Board and the State Department of Agriculture are giving financial assistance to research on development of new marketable turkey products at Utah State University. During the past year we have been working with school lunch personnel to introduce products made from turkey thigh meat. These products are designed to meet the budget and nutritional re-
requirements of the school lunch program. We have been particularly interested in determining how the children in elementary schools and young adults in junior and senior high schools accept these products.

Turkey meat loaf prepared from thigh meat, and all the trimmings—onions, catsup, eggs, etc. was prepared and put in a casing that could be used for either freezing or cooking. Taking a meat loaf from the freezer and putting directly into the oven would be a great convenience for the cooks. It was only accepted by 50 percent of the children, however, because of the round slices. When the same meat loaf was prepared in disposable aluminum pans and served as square slices, 80 percent of the students consumed all of the meat loaf. School lunch personnel received this product with enthusiasm since they could prepare it ahead of time, freeze it and cook it directly from the frozen state.

Turkeyburger molded into two and three ounce patties proved to be a convenient item to be served on hamburger buns. Most students accepted turkeyburgers garnished with salad dressing and lettuce.

A ham-type product made from cured turkey dark meat and cooked in a smoke oven also was found to be very acceptable. The turkey ham was produced by binding chunks of thigh meat together into a solid loaf. The meat is brine cured and seasoned before molding into 3 to 4-pound hams and smoked. It has a smooth texture and can be portion cut with a slicing machine and served as a cold cut or heated after slicing. This product was re-ordered several times by some schools. We hope to make this product available on the market for test marketing in the near future.

We have seen a new development in the past few years of extracting the meat from the carcass after all possible meat has been removed by a knife. This process has brought a product on the market suitable for manufacturing all-turkey frankfurters and turkey bologna. This technique has made it possible to produce meat franks and bologna of good quality that are within the price range of the school lunch and other mass feeding programs.

One wholesale poultry company is planning to put on the market 10 to 12 further processed turkey products. Time will be required to work out a distribution and marketing system, but consumers can look forward to having these products available in packages ranging from 1 to 10 pounds.

Rapid continuous process for prune juice production

H. R. BOLIN and D. K. SALUNKHE

Prunes are a concentrated, nutritious, high energy food, marketed in numerous ways — canned stewed prunes, juice, puree, and whole prunes in flexible packages. The largest percentage or prunes reaches the domestic consumer in the form of juice. In 1969 alone, over 41,000 tons of prunes were processed into juice.

Prune juice is essentially a water extract of dried prunes and is produced by two main procedures. In one, the "diffusion" method, the soluble solids of the prunes are leached out in a succession of hot water extractions with each extraction lasting from 2 to 4 hours. This process yields about 500 gallons of juice per ton of prunes and gives juice with a slightly thinner consistency. The other procedure is the "distintegration" process in which the prunes are cooked for about 2 hours, or until they fall apart. At this stage, the extract is either pumped off and fresh water added with further heating, or the slurry is filtered through cloth or a filter pad to obtain the desired juice. The disintegration process yields about 600 gallons of juice per ton of prunes, is faster than diffusion process, and gives a product with more body.

All commercial methods for making prune juice to date are time consuming batch processes. In our day of modern technology, efficient, rapid procedures are needed to keep a product in the competitive market. For this reason, work was undertaken in the Utah State University Food Technology laboratories to develop a fast continuous method for preparing prune juice starting with dried prunes.

NEW PROCESS

This new process is based on the ability of pectic enzymes to rapidly hydrolyze the pectins in a prune slurry to allow easy filtration. In the laboratory, the juice is prepared by first making a slurry of 300 grams of whole ground unprocessed French prunes, 800 ml of water and 0.05 grams of pectinol R-10. This slurry is heated to 60 C and held for 10 minutes; a longer heating times does not accelerate filtration (table 1). The
temperature of the product is then raised to 90°C to inactivate the enzymes. Pits, skins and sediment may be removed by filtration or centrifugation or a combination of these two methods. Forty grams of filter-aid are stirred into the blend and it is filtered through a filter-aid pad. A flow diagram of this procedure is indicated in figure 1. Recovery by this filtration procedure is calculated at 450 gallons of juice per ton of prunes.

The resultant juice is about 19° brix and is lighter and slightly clearer than the regular prune juice. It has a consistency between that of the commercial juices prepared by diffusion and distintegration (table 2), and no sediment forms during storage. The juice does not have any caramelized taste of the regular water extract juice but has a mild fruit flavor.

TASTE TEST

A taste panel of 25 judges rated commercial juice prepared by the diffusion process and the experimental rapid process juice, on a Hedonic scale. The regular juice was rated "like slightly" to "like moderately" by the panel. The rapid process juice was rated "like slightly." The slightly lower preference for the new process juice was evidently because it did not have the recognized cooked taste associated with the water-extract product. However, the juice process can be modified to give a darker product having more caramelized taste by submitting the whole prunes to a baking step before grinding. The extent of the change is dependent on the time and temperature of the baking.

ALTERNATE METHODS

Centrifuging also can be used to remove the fiber from the juice instead of filtration. No filter aid is required but the enzyme treatment is necessary.

A definite density gradient is noticed upon centrifuging the slurry. The denser material, which settles on the bottom, is the endocarp of the seed. The next layer is comprised of the fruit exocarp or skin, followed by the fine pulpy material and then the juice. The top layer contains the seed nucleus or kernel.

Experimentally, two different centrifuging steps were used. First, the slurry was spun in a Fletcher basket centrifuge operating at 1,500 rpm. This removed the seed endocarp and

Table 1. Influence of heating time on filtration rate

<table>
<thead>
<tr>
<th>Heating time</th>
<th>Filtration time</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 min.</td>
<td>14</td>
</tr>
<tr>
<td>10 min.</td>
<td>14</td>
</tr>
<tr>
<td>5 min.</td>
<td>15</td>
</tr>
<tr>
<td>1 min.</td>
<td>34</td>
</tr>
</tbody>
</table>

Table 2. Prune juice viscosity

<table>
<thead>
<tr>
<th>Processing method</th>
<th>Brix</th>
<th>Viscosity (min)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffusion</td>
<td>20.5</td>
<td>45</td>
</tr>
<tr>
<td>Distintegration</td>
<td>18.5</td>
<td>125</td>
</tr>
<tr>
<td>Whole ground enzymatic</td>
<td>19.2</td>
<td>88</td>
</tr>
</tbody>
</table>

*Ostwald viscosimeter used at 21°C with 3.2 ml of juice.
the fruit exocarp. The juice was next passed through a Sharpel centrifuge operating at 15,000 rpm which removed a large percentage of the fine fiber. The final juice still contained more fiber than the filtered product and some settling occurred during storage. However, more fiber could be removed by better centrifuging. In addition, the final juice had to be strained through a fine screen to remove the kernel fragments. Recovery by this procedure was calculated to be 570 gallons of juice per ton of prunes.

**WASTE UTILIZATION**

In using filtration to clarify the juice, a filter-aid is incorporated into the slurry. The material left after filtration is of doubtful value for human consumption since it is a homogeneous mixture of this filter-aid plus broken seed bits and fiber. However, this material could possibly be used as an animal feed or a soil conditioner.

In centrifuging, the solid waste could be separated into different fractions which could in turn be utilized in different ways. For instance, the kernel pieces could be dried and marketed as a chopped nut or made into a paste. The fine fiber and fruit skins could be used to formulate a prune paste and the broken endocarp pieces could be used in decorative or constructive boards.

The rapid enzymatic method of preparing prune juice provides a procedure for producing a mild juice, with more natural fruit flavor. This procedure can be readily adapted to a continuous operation. Because of the short processing time, there would not be an extended lag time between the start-up of the operation and the bottling of the finished product.

**Figure 2.** Flow chart for producing juice from dried prunes.
A PARTNERSHIP WITH UTAH’S FOOD INDUSTRIES

The Department of Nutrition and Food Sciences at Utah State University, as do most university departments, both provides resident instruction and maintains a viable research program. In addition, however, personnel of the department are thoroughly committed to helping Utah’s food industry solve its problems. Toward this end, an industry service program has been incorporated into the department’s extension activities.

C. A. ERNSTROM is a Professor and Head of the Department of Nutrition and Food Science.

The cheese industry in Utah has had a phenomenal expansion during the past 5 years. Production has increased from 20.3 million pounds in 1968 to 32.9 million pounds in 1970. As a result, Utah moved from 24th among her sister states in cheese production to about 13th or 14th. But, as usual, the “plus” growth had its negative side effects.

As cheese production increased, so did the amounts of trim taken from large Swiss cheese blocks during the cutting and packaging operations. USU’s Department of Nutrition and Food Science was approached with a request to find a way to upgrade the value of this trimmed cheese. The trimmings are clean, good quality cheese, but their odd shapes preclude sale as first quality cuts. Such products can easily be converted into processed Swiss cheese and processed Swiss cheese food. This alternative, however, did not seem likely to make much impression on the market, nor

(Continued on page 126)
 Preservation of fruits by drying is perhaps the oldest method used by man. Early man discovered that fruits exposed to sun and wind soon dried and could be stored for future consumption. He also found that heat from fire accelerated the drying process. In the United States, colonists and pioneers preserved apples, beans, and corn by sun drying and by hanging them across the chimney and among the rafters where they furnished decoration as well as winter food supply. During the Civil War, soldiers were supplied with dried apples and peaches. Sun drying has remained popular because it is simple and requires little outlay in equipment, time, and money and also conserves space. The necessary storage space for dried fruits is small—about one-third of that required by their fresh, canned, or frozen counterparts.

During World War I interest was shifted from the time honored sun drying method to artificial dehydration and by the time of World War II, the dehydration industry expanded and flourished to even a greater extent because of war time need to prolong shelf life and conserve shipping weight and space. Extensive research conducted at numerous governmental and industrial research laboratories as well as at universities and colleges in the United States and Europe led to the development of new and more efficient drying procedures. Since World War II the dried food industry has been continually modernizing its processing methods to produce food items that are more nutritious and flavorful.

Despite the recent advances in food technology, the bulk of the dried fruit production throughout the world is nearly 2 billion tons on the dry weight basis. Notwithstanding the economics of sun drying fruits, it is apparent that artificial dehydration offers at least two main advantages. It is more sanitary and more independent of inclement weather. These are the chief reasons for increasing technical developments in dehydration procedures such as cabinet, vacuum, puff, freeze, osmosis, foam-mat, and microwave drying.

**PRINCIPLES OF SUCCESSFUL DRYING**

Successful drying depends upon the removal of enough moisture to prevent spoilage. This must be done as quickly as possible at a temperature that does not impair texture, color, flavor, or nutritional value of the fruit. Proper temperature, humidity, and airflow are highly essential. If the temperature is excessively high or the humidity too low, there is danger of the moisture being removed too fast. This causes case hardening which prevents water vapor from diffusing from the inner cells. The second important aspect of successful dehydration is the killing of micro-organisms which grow prolifically on the raw or fresh fruits after picking because of their high moisture content. Reduction in

D. K. SALUNKHE is a Professor in the Department of Nutrition and Food Science.
CHARLOTTE P. BRENNAND is an Assistant Professor in the Department of Nutrition and Food Science.
H. R. BOLIN is Head of the Fruit Dehydration Section of Food & Vegetable Processing Laboratory, USDA, Western Marketing and Nutrition Division of Albany, California. Formerly a graduate student at Utah State University.

---

**Figure 1.** A basket of delicious and attractive dried fruits.
water content of fruits during dehydration process increases osmotic pressures and thus microbial growth can be reduced because moisture is drawn from the micro-organisms. The third aspect is inactivation or denaturation of enzymatic systems in fruits. The brown color of dehydrated fruits is caused by the activity of enzymes which is increased by the availability of oxygen, increased temperature, and several other factors. One common and simple way to inactivate enzymes is by blanching the fruit in steam or boiling water. Chemical treatments also can deactivate certain enzymes.

**SELECTION AND PREPARATION**

Fruits for drying should be sound, fresh, and at the 'right' stage of maturity—neither under ripe nor over ripe. Selection of the proper variety is an essential factor as certain fruit varieties, such as 'Moorpack' apricots, do not dry successfully. Bruised and over-ripe fruits should be discarded because they become easily discolored and are prone to spoil whereas under-ripe fruits are less colorful and have little flavor after dehydration.

Prior to sun drying or dehydration in a mechanical dryer, the fruits should be washed to remove dust, spray, or insecticides; sliced or halved; and uniformly spread on trays. Usually drying takes 4 to 8 days under the sun depending upon the type of fruit, temperature, humidity, and air movement in the area. Mechanical dehydration takes 8 to 10 hours at 150 to 160 F. To avoid browning and preserve color in cut fruits, the product should be sulfured. Sulfuring is accomplished in two ways:

1. Sodium dip—A dip solution can be prepared by dissolving 6 pounds of sodium bisulfite and 4 pounds of citric acid in 1 gallon of water.

2. Burning sulfur — Sulfur is burned in a slightly vented enclosure, containing the fruit, at the rate of about 0.1 pound sulfur to 50 pounds of fruit.

Although commercial sulfuring does yield light colored dry fruits, consumers' interests are shifting to unsulfured fruits and food with no chemical additives.
DEHYDRATION OF FRUITS

Apples
Selection of varieties: Firm varieties such as Gravenstein, Newtown Pippin, Winesap, Jonathan, Rome Beauty. Delicious varieties are fragile and break during drying hence not recommended.
Sorting: For conformity and maturity. Remove rotted or bruised fruits.
Washing: Wash thoroughly to remove spray material.
Peeling and coring: Remove peeling and cores.
Trimming: Remove both ends and bruised parts.
Slicing: Cut into rings about 1/4 inch thick.
Sulfiting or Sulfuring: 2-3 percent sodium bisulfite to control browning and give light colored finished product. Burn enough sulfur to give about 2,000 to 3,000 ppm SO₂ on the apple slices.
Drying operation: 150-180 F for 10-12 hours.
Turning: As often as needed.
Yield of dried slices: 15 pounds of dried slices from 100 pounds of fruit.
Packing and storing: Tightly pack and store in a dark place at low temperature.

Apricots and peaches
Selection of varieties: (Apricots—Blenheim, Royal, Tilton) (Peaches—Elberta)
Slicing: Halves
Sulfuring: 3 to 4 hours
Drying: Spread out in sun or dehydrate product mechanically.

Pears
Variety: Bartlett
Slicing: Halves
Sulfuring: Approximately 8 hours
Drying: 15 to 24 hours at 150 F.

Prunes, grapes, and tart cherries:
Varieties: (Prunes—French) (Grapes—Thompson seedless and Muscat) (Tart cherries—Montmorency)
Drying: Leave whole. 15 to 18 hours at 150-160 F.

Figs
Varieties: Calimyrna, Adriatic, Black Mission, and Kodata.
Drying: Whole fruit at 150-160 F.

HOW TO DRY FRUITS

Apples are sliced, while peaches, apricots, and pears are halved and grapes, cherries, and figs are dried whole. Drying temperatures usually range from 150 to 160 F. For uniform drying the product should be examined often, trays should be rotated, and the fruit turned over when nearly dry (15-18% moisture content). The time for dehydration depends upon the size of the slices, halves, or whole fruit; amount of water in the fruits; and the amount of water desired in the dehydrated product. The time varies from 6 to 20 hours.

Home made dehydrators can be built very inexpensively by using tin and plywood for the cabinets in which slits have been cut to control humidity and to release water vapor from the fruit and by using a heater or infrared lamp and thermometer.

To sun dry fruits wash, cut, and treat, then spread fruit on the trays and place them in direct sunlight. Four to 8 days will dry the product to about 20 percent moisture content. Air circulation below as well as above will speed up drying operations.

Fruits can be successfully oven dried by using two to four trays and holding the temperature at 150 to 160 F. To prevent scorching, leave the oven slightly open and circulate the air with a small fan. Oven drying is similar to drying in a mechanical dehydrator.

Other dehydration methods are:

1. Freeze-dried fruits — These have excellent quality and flavor similar to that of fresh fruits. At present, however, this is a relatively expensive process.

2. Osmo-dehydrated fruits — When fruit slices are mixed with an equal amount of sugar and stored at room temperature (70 F) for 12 hours, the sugar will remove about 50 percent
of the water. These partially dried fruit slices can then be further dried in a dehydrator at 160 °F for 6 hours. The syrup drawn off, which has some of the natural flavor of the fruit, can be used for pancakes, puddings, or ice cream toppings.

**UTILIZING ALL DRIED FRUITS**

Since a large percentage of water has been removed from the dried fruit, their nutrients — natural fruit sugars, vitamins, and minerals—are in a more concentrated form and these fruits are ideal for consumption as a rich natural flavored confection to be eaten by hand. Dried fruits also are used extensively in recipes. They can be added whole, chopped, or ground. Ground dried fruits can be used to produce delightful confections and pastries or, by adding low methoxyl pectin, to produce jellied prunes, apricots, figs, and other fruits. Dried fruit products can also be produced in more exotic forms depending upon the equipment available. By using the double drum, foam-mat, or vacuum-puff drying techniques, prunes, apricots, figs, and other fruits can be further dried and ground to a low-moisture powder and pressed either into fruit discs for use in cereals or other low moisture products or used directly in product formulation.

**PACKAGING AND STORING DRIED FRUITS**

Dehydrated products should be packaged air tight in dry insect/microbial organism proof containers (glass or plastic jars and tins) at low temperature. The containers should not be exposed to light, high temperature, or air as these can accelerate browning.

Commercial production of dried fruits is a fairly large industry with well over 400,000 tons being produced annually. A large portion of this production is packaged in attractive containers by the numerous packers, and on the grocers' shelves throughout the country, is offered to the discriminating housewife. Each particular product has its own appealing attributes—color, size, shape, texture, and flavor—which the individual housewife can use to accentuate existing recipes or to develop new ones by using her own creativity.

![Figure 4. Flow diagram of fruit dehydration process.](image)

**A PARTNERSHIP WITH UTAH'S FOOD INDUSTRIES**

*(Continued from page 122)*

to produce substantial benefits to either farmers or manufacturers. A more promising option was to develop a distinctive product that would be different from the ordinary run of processed Swiss cheese products.

USU dairy researchers eventually produced two kinds of processed cheese foods from the Swiss cheese trimmings. The first was a Smoked pasteurized process Swiss cheese food. The second was a product called Taco pasteurized processed Swiss cheese food. Once the foods were created, production facilities were needed. This would require a substantial investment by the company, and considerable capital would thus be tied up in equipment and facilities while the market potentials were still unknown.

In an effort to help the company cope with this investment risk, the pilot processing equipment at the University was turned to the production of these products. Currently, Swiss cheese trimmings and other dairy ingredients are purchased by the University from the company, and processed into the Smoked and the Taco pasteurized processed Swiss cheeses. We are thus able to give students some invaluable on-the-job training. The products are then sold back to the company, and marketed to consumers. The facilities of the University are thereby helping a Utah industry determine whether new products will be marketable before it makes a substantial investment in production equipment.

The Department of Nutrition and Food Sciences would like to similarly serve all of the food industries in Utah. The facilities, capabilities, and expertise within the department can be called upon by any of Utah's food industries to help them further their ends and improve their position in the Intermountain West.

**PROTECT** your WATER, SOIL, and AIR—our basic natural resources—from accidental contamination by pesticides or other chemicals on the farm, in the forest, or in the city.

**UTAH SCIENCE**
Regional climatic planning

As interest in protecting the ecology of our state grows, the importance of weather as a major factor in the environment is being recognized. More and more residents of the state including architects, engineers, farmers, businessmen, and sports enthusiasts as well as tourists to the state are requesting climatic information on which to base their plans and activities.

Due to the wide variation in the climate of the state caused by the divergence of latitude, elevation, and other topographic features, the state has been divided into seven semi-homogeneous climatic regions or zones. It is recognized that the climate in each zone may vary considerably from one locality to another, but use of these divisions does make it possible to present in a more manageable form a general review of the climate of the state and its variability.

While each of these divisions cover rather large areas of the state, studies have shown that, in general, the probabilities given do represent a fair guide to the variability of weather conditions at most locations within each region. If a more accurate estimate for a specific locality is desired, these same probabilities can be applied to the long term averages for specific locations within each division. The divisions are outlined on the map below.

If the information given in these summaries does not meet your needs please feel free to contact the National Weather Service Climatologist for Utah at the following address for information on specific localities.

E. ARLO RICHARDSON

January is one of the drier months of the year in the western section of Utah—only September recording less moisture. By contrast, stations in the northern mountains record the greatest precipitation of the year. On January 23, 1943, Tropic in south central Utah recorded 4.50 inches, the wettest 24 hours ever recorded in the state during January.

On the average, January is the coldest month of the year. The lowest temperatures usually follow one of the cold winter storms which blanket the area with snow. The coldest January temperature ever recorded in the state occurred at Strawberry East Portal on January 5, 1913, when 50 degrees below zero was reported. By contrast the mercury climbed to 72 degrees on January 24, 1948, at Saint George. To help offset the normal cold temperatures there is seldom a January that does not have at least a

E. ARLO RICHARDSON is a State Climatologist in the Department of Soil Science & Biometeorology.
brief period with clear skies when temperatures rise to more moderate values.

FEBRUARY

As the days continue to lengthen following the chill days of January, there is a general rising trend in temperatures during the month of February. Occasional relapses do occur, however. The coldest minimum recorded was 50 degrees below zero at Woodruff which occurred on the 6th in 1899 and ties the coldest January day. By contrast on the 27th in 1906 the mercury climbed to 84 degrees at Rockville giving a range of 134 degrees for the month in the state of Utah.

On the average high pressure cells dominate the state only 2 days a month, hence the systems move rapidly across the state and the accumulation of pollutants and fog with resulting low visibility is the least frequent of the 3 winter months. February is the wettest month of the year in Dixie and the second wettest in the northern mountain areas. By contrast, it is the driest in the Uinta Basin. The greatest 24-hour precipitation occurred on the 1st of the month in 1963 when 5.08 inches deluged the station at Deer Creek Dam in a little over 12 hours. This amount is the second greatest 24-hour precipitation in the state. Snow continues to accumulate in the northern mountains with an average fall of over 31 inches.

March in general is a stormy month. Low pressure systems dominate the region on the average of 5 days each month—the largest number of days in any month of the year. As a result of these storms, the month is one of the wetter months of the year except in the Uinta Valley and southeast sections of the state. Much of the precipitation still falls as snow but the snowcover from these March storms does not last long, except in the mountains, as temperatures continue to climb. Measurable precipitation can be expected on about one-third of the days in most areas of the state. The greatest 24-hour precipitation recorded during this month was 4.20 inches at Manila March 20, 1932. The range of temperatures in March is a little less than February—only 126 degrees. The lowest temperature so far recorded was 37 degrees below zero on the 2nd in 1917 at Strawberry East Portal, while the mercury climbed to 89 degrees at Saint George on the 19th in 1925.

JANUARY

**DIVISION TEMPERATURE DATA**

<table>
<thead>
<tr>
<th>Div # no</th>
<th>Avg Hi</th>
<th>Avg Low</th>
<th>Avg Temp</th>
<th>Avg High</th>
<th>Hi Low</th>
<th>Avg days</th>
<th>Probability (%)</th>
<th>avg temp will be within given degrees of normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37</td>
<td>14</td>
<td>26</td>
<td>23</td>
<td>69</td>
<td>-39</td>
<td>30</td>
<td>±1° 36 39 50 60</td>
</tr>
<tr>
<td>2</td>
<td>52</td>
<td>26</td>
<td>39</td>
<td>25</td>
<td>72</td>
<td>-15</td>
<td>22</td>
<td>±2° 36 39 52 65</td>
</tr>
<tr>
<td>3</td>
<td>37</td>
<td>17</td>
<td>27</td>
<td>20</td>
<td>68</td>
<td>-44</td>
<td>27</td>
<td>±3° 36 39 52 65</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>14</td>
<td>27</td>
<td>26</td>
<td>69</td>
<td>-40</td>
<td>30</td>
<td>±4° 36 39 52 65</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>8</td>
<td>20</td>
<td>25</td>
<td>62</td>
<td>-50</td>
<td>31</td>
<td>±5° 36 39 52 65</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>3</td>
<td>17</td>
<td>27</td>
<td>61</td>
<td>-43</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>39</td>
<td>14</td>
<td>26</td>
<td>25</td>
<td>69</td>
<td>-35</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

**DIVISION PRECIPITATION DATA**

<table>
<thead>
<tr>
<th>Div # no</th>
<th>Avg pcpn</th>
<th>Greatest snowfall</th>
<th>Least snowfall</th>
<th>Avg snowfall</th>
<th>Avg days of snowfall</th>
<th>Est % sunshine</th>
<th>Expected pcpn amounts (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.7</td>
<td>1.7</td>
<td>.1</td>
<td>8</td>
<td>7</td>
<td>61</td>
<td>1.1 1.0 .7 .4 .2</td>
</tr>
<tr>
<td>2</td>
<td>1.2</td>
<td>3.7</td>
<td>.1</td>
<td>3</td>
<td>4</td>
<td>68</td>
<td>2.3 1.9 1.2 .5 .1</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>3.1</td>
<td>*</td>
<td>10</td>
<td>50</td>
<td>56</td>
<td>2.4 2.1 1.5 .9 .6</td>
</tr>
<tr>
<td>4</td>
<td>1.0</td>
<td>2.7</td>
<td>.3</td>
<td>10</td>
<td>8</td>
<td>56</td>
<td>1.8 1.5 1.0 .5 .3</td>
</tr>
<tr>
<td>5</td>
<td>2.1</td>
<td>4.5</td>
<td>*</td>
<td>11</td>
<td>40</td>
<td>40</td>
<td>3.4 2.9 2.1 1.2 .8</td>
</tr>
<tr>
<td>6</td>
<td>.5</td>
<td>1.4</td>
<td>*</td>
<td>8</td>
<td>52</td>
<td>52</td>
<td>1.0 .8 .5 .1 *</td>
</tr>
<tr>
<td>7</td>
<td>.6</td>
<td>2.0</td>
<td>.1</td>
<td>5</td>
<td>7</td>
<td>60</td>
<td>1.2 1.0 .6 .2 .1</td>
</tr>
</tbody>
</table>

# Div no 1—Western, 2—Dixie, 3—North Central, 4—South Central, 5—Northern Mountains, 6—Uinta Basin, 7—South East
* Less than .05 inches
### FEBRUARY

**DIVISION TEMPERATURE DATA**

<table>
<thead>
<tr>
<th>Div #</th>
<th>Avg max</th>
<th>Avg min</th>
<th>Avg temp</th>
<th>Avg range</th>
<th>Hi max</th>
<th>Low min</th>
<th>Avg days 32 min or less</th>
<th>Probability (%) avg temp will be within given degrees of normal ±1° ±2° ±3° ±4° ±5°</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42</td>
<td>19</td>
<td>31</td>
<td>23</td>
<td>74</td>
<td>-32</td>
<td>26</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>57</td>
<td>30</td>
<td>44</td>
<td>27</td>
<td>81</td>
<td>7</td>
<td>24</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>21</td>
<td>32</td>
<td>20</td>
<td>75</td>
<td>-36</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>44</td>
<td>18</td>
<td>31</td>
<td>26</td>
<td>75</td>
<td>-39</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>36</td>
<td>11</td>
<td>24</td>
<td>25</td>
<td>65</td>
<td>-50</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>37</td>
<td>9</td>
<td>24</td>
<td>28</td>
<td>67</td>
<td>-36</td>
<td>28</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>45</td>
<td>20</td>
<td>33</td>
<td>26</td>
<td>81</td>
<td>-27</td>
<td>28</td>
<td>14</td>
</tr>
</tbody>
</table>

### MARCH

**DIVISION TEMPERATURE DATA**

<table>
<thead>
<tr>
<th>Div #</th>
<th>Avg max</th>
<th>Avg min</th>
<th>Avg temp</th>
<th>Avg range</th>
<th>Hi max</th>
<th>Low min</th>
<th>Avg days 32 min or less</th>
<th>Probability (%) avg temp will be within given degrees of normal ±1° ±2° ±3° ±4° ±5°</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>51</td>
<td>26</td>
<td>38</td>
<td>26</td>
<td>80</td>
<td>-12</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>66</td>
<td>36</td>
<td>50</td>
<td>30</td>
<td>89</td>
<td>12</td>
<td>11</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>51</td>
<td>28</td>
<td>39</td>
<td>23</td>
<td>84</td>
<td>-15</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>51</td>
<td>24</td>
<td>38</td>
<td>28</td>
<td>83</td>
<td>-20</td>
<td>27</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>43</td>
<td>18</td>
<td>31</td>
<td>25</td>
<td>75</td>
<td>-32</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>21</td>
<td>35</td>
<td>29</td>
<td>79</td>
<td>-16</td>
<td>29</td>
<td>19</td>
</tr>
<tr>
<td>7</td>
<td>55</td>
<td>27</td>
<td>41</td>
<td>28</td>
<td>88</td>
<td>-10</td>
<td>25</td>
<td>28</td>
</tr>
</tbody>
</table>

**DIVISION PRECIPITATION DATA**

<table>
<thead>
<tr>
<th>Div #</th>
<th>Mean pcpn</th>
<th>Greatest monthly</th>
<th>Least monthly</th>
<th>Avg snowfall</th>
<th>Avg days meas pcpn</th>
<th>Est % sunshine</th>
<th>Expected pcpn amounts (inches) for selected probabilities 10% 20% 50% 80% 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.7</td>
<td>1.7</td>
<td>.1</td>
<td>6</td>
<td>7</td>
<td></td>
<td>1.2 1.0 .7 .3 .2</td>
</tr>
<tr>
<td>2</td>
<td>1.4</td>
<td>4.3</td>
<td>*</td>
<td>2</td>
<td>4</td>
<td>70</td>
<td>2.8 2.3 1.4 .5 *</td>
</tr>
<tr>
<td>3</td>
<td>1.4</td>
<td>3.4</td>
<td>.3</td>
<td>10</td>
<td>8</td>
<td>55</td>
<td>2.3 2.0 1.4 .8 .5</td>
</tr>
<tr>
<td>4</td>
<td>1.1</td>
<td>2.8</td>
<td>.2</td>
<td>8</td>
<td>7</td>
<td>68</td>
<td>1.9 1.6 1.1 .5 *</td>
</tr>
<tr>
<td>5</td>
<td>2.0</td>
<td>5.8</td>
<td>.4</td>
<td>31</td>
<td>9</td>
<td>50</td>
<td>3.3 2.8 2.0 1.1 .6</td>
</tr>
<tr>
<td>6</td>
<td>.5</td>
<td>1.3</td>
<td>*</td>
<td>5</td>
<td>8</td>
<td>62</td>
<td>.9 .8 .6 .2 *</td>
</tr>
<tr>
<td>7</td>
<td>.6</td>
<td>1.2</td>
<td>*</td>
<td>3</td>
<td>6</td>
<td>70</td>
<td>1.1 .9 .6 .3 *</td>
</tr>
</tbody>
</table>

### DECEMBER 1971

**DIVISION PRECIPITATION DATA**

<table>
<thead>
<tr>
<th>Div #</th>
<th>Mean pcpn</th>
<th>Greatest monthly</th>
<th>Least monthly</th>
<th>Avg snowfall</th>
<th>Avg days meas pcpn</th>
<th>Est % sunshine</th>
<th>Expected pcpn amounts (inches) for selected probabilities 10% 20% 50% 80% 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.8</td>
<td>2.1</td>
<td>.1</td>
<td>5</td>
<td>8</td>
<td>65</td>
<td>1.3 1.1 .8 .4 .3</td>
</tr>
<tr>
<td>2</td>
<td>1.3</td>
<td>4.5</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>70</td>
<td>2.6 2.2 1.3 .4 *</td>
</tr>
<tr>
<td>3</td>
<td>1.6</td>
<td>3.6</td>
<td>.1</td>
<td>9</td>
<td>9</td>
<td>62</td>
<td>2.5 2.2 1.6 1.0 .7</td>
</tr>
<tr>
<td>4</td>
<td>1.2</td>
<td>2.8</td>
<td>.1</td>
<td>7</td>
<td>8</td>
<td>67</td>
<td>2.1 1.8 1.2 .7 .4</td>
</tr>
<tr>
<td>5</td>
<td>1.9</td>
<td>4.7</td>
<td>.3</td>
<td>30</td>
<td>10</td>
<td>56</td>
<td>3.0 2.7 1.9 1.2 .8</td>
</tr>
<tr>
<td>6</td>
<td>.5</td>
<td>1.3</td>
<td>0</td>
<td>2</td>
<td>9</td>
<td>62</td>
<td>.9 .8 .5 .3 .1</td>
</tr>
<tr>
<td>7</td>
<td>.6</td>
<td>1.9</td>
<td>*</td>
<td>1</td>
<td>7</td>
<td>68</td>
<td>1.2 1.0 .6 .2 .1</td>
</tr>
</tbody>
</table>

# Div no 1—Western, 2—Dixie, 3—North Central, 4—South Central, 5—Northern Mountains, 6—Uinta Basin, 7—South East

* Less than .05 inches
Prior to the 18th century lawns were more closely aligned with natural meadows, being a mixture of grasses and flowering plants. Turf or lawn management depended upon the experience and knowledge passed from a master craftsman to an apprentice or, in many cases, from father to son. As such, it was considered more of an art than a science. Early lawns were cut with scythes, and clippings were carried away as normal practice.

Turf management actually began with the maintenance of golf courses and received a real boost with the invention of the rotary mower in the 1830s and the first motor-driven lawn mower in the early 1900s. Turf management was further advanced by the organization of such groups as the U.S. Golf Association, the Professional Golf Association, the Green Section of the USGA, the National Golf Foundation and the Golf Course Superintendents Association of America.

The modern era of turf management began immediately after World War II. According to the National Golf Foundation, the number of golf courses increased at the rate of about 350 per year for the period 1961-70, at which time there were slightly over 10,000 golf courses in the United States.

The rapid increase in the demand to manage turf areas to support specific uses has resulted in a phenomenal increase in this phase of agriculture. The annual investment just for the maintenance of turf in the United States is approaching $5 billion. About 70 percent of this annual expenditure is for the care of residential lawns. Highway right-of-ways, cemeteries and golf courses account for 11, 8.5 and 6 percent, respectively, with the latter growing at a phenomenal pace. Moreover, it has been estimated that the total value of turf areas in the United States is about $17 billion. In Los Angeles County, California, a county of slightly over 4,000 square miles, half of which is composed of mountains and desert, the maintenance of principal turf areas exceeds $100 million annually. In Michigan, the turf industry is estimated at $350 million annually.

Of the turf grasses, the bluegrasses are the most widely grown in Utah. Some popular varieties are Common, Fylking, Merion, Newport, Nugget, Pennstar and Windsor. They are very aggressive, capable of spreading rapidly by rhizomes and, therefore, able to heal injuries and invade new areas even though the turf is in active use.

irrigation must be provided throughout the growing season. While our soils have a high pH, they are generally well supplied with mineral nutrients. Of the hundreds of different species of grasses, only the bluegrasses, the bentgrasses, the fescues, and the ryegrasses are adapted to the production of turf in this region. There are, however, other adapted grasses such as tall fescue, brome-grass, wheatgrass, buffalograss and native bunch grasses that provide excellent cover for highway right-of-ways, golf course roughs, and other similar areas.

Of the turf grasses, the bluegrasses are the most widely grown in Utah. Some popular varieties are Common, Fylking, Merion, Newport, Nugget, Pennstar and Windsor. They are very aggressive, capable of spreading rapidly by rhizomes and, therefore, able to heal injuries and invade new areas even though the turf is in active use. With proper management and mowing heights of 3/4 to 1-1/2 inches, the bluegrasses produce a tough, dense sod. Their chief disadvantage is that they become dormant in periods of hot, dry weather. In our area this can be minimized with irrigation.

The bentgrasses have wide usefulness because of their ability to produce dense sod under close mowing.

WILLIAM F. CAMPBELL is an Associate Professor of Agronomy in the Department of Plant Science.
Of the three species grown, only *Agrostis canina*, the Velvet bentgrass, is adapted to partial shade as well as sunlight. All of the species are very aggressive under close, frequent mowing. Some varieties are Kingston, Penncross, Pennlu, Toronto, Astoria, Common and Highland.

The fine bristle-like character of the leaves make red and Chewings fescues a tough turf. They tolerate drought, infertile soils and shade. Some varieties are Pennlawn, Rainier and Wintergreen.

The ryegrasses—Manhattan, Norlea and Astor—are used primarily as temporary turf. They germinate very quickly and rapidly occupy the soil during the period when slower growing permanent turfgrasses (bluegrass, Penncross, Pennlu, Toronto, Astoria, Kentucky 31 tall fescue) are becoming established. After 3 or 4 years the ryegrasses usually disappear from the turf.

**SALINITY**

Salinity is perhaps one of the largest single cause of pollution in waters and soils in the United States. The term salinity is usually synonymous with total dissolved solids or salts. These salts are usually the bicarbonates, sulfates and chlorides of calcium, magnesium and sodium. Many soils of the arid and semi-arid western United States contain naturally high amounts of these chemicals. When water with a high quantity of such substances is added for irrigation, the problem is intensified.

Approximately 25 percent of the golf courses within Utah experience some problems with saline soils. In affected areas it is difficult to establish and to maintain a turf cover. There are, however, ways of getting around this problem. One, providing sufficient fresh water is available, is to leach out the salts. Another way is to use salt-tolerant species and varieties. The salt-tolerance rating for general turf quality is Seaside bent, Alta fescue, Kentucky bluegrass. Others have reported that Arlington, Seaside, Pennlu and Old Orchard varieties of creeping bentgrass had the most salinity tolerance; Congressional and Cohansy were intermediate, and Penncross was least.

Cordukes, in a study on turfgrass tolerance to road salt, reported that Norlean perennial ryegrass and Kentucky 31 tall fescue were particularly salt tolerant and would be most useful components of turf mixtures along highway right-of-ways. Cordukes also noted that in salt-laden soils the total final percentage germination of Fylking Kentucky bluegrass was delayed. This could be very important when rapid re-establishment in an area is essential. Further studies by Cordukes indicated that salt uptake by turf plants was less in soils of higher pH than in more acid soils. In our own studies, we observed that the germination of Common, Fylking and Windsor Kentucky bluegrass could be enhanced in NaCl solutions by the addition of CaSO₄ to the medium. LaHaye and Epstein have suggested that calcium ions play a crucial role in the regulation of the salt economy of the plants and specifically in the selective transport or exclusion of sodium and other salts by the plant cell membranes.

**IRRIGATION**

Plant species differ in their demand for water. For example, it has been demonstrated the bermudagrass, buffalograss, crested wheatgrass and the fescues are rather drought tolerant. A well-developed, deep root system and an ability to store water in their roots are characteristic of these plants and may account for their drought tolerance. Kentucky bluegrass and Colonial bentgrass were intermediate in drought tolerance, while annual bluegrass and creeping bents were least tolerant. The concept that bermudagrass needs less water than other grass species is not supported by fact. When given the amount of water needed for satisfactory maintenance of growth, the amount of water used in transpiration was about equal to that of other grasses.

The quantity of water needed for turfgrass depends on the type of soil. The capacity of the soil to maintain the water needed for the turfgrasses is a function of its infiltration rate and structure. The infiltration rate, in turn, is determined largely by the number and size of pores in its surface and is greatly influenced by management.

---

3 Unpublished results—research supported in part by a grant-in-aid from Golf Course Superintendents Association of America.
Compaction by heavy use greatly reduces the porosity and infiltration rate. Such soils should be aerated and loosened to increase the water intake. The infiltration rate of the soil will determine how fast water can be applied without causing run off. Thus, the frequency of water application for good turf growth is a function of the available water-holding capacity of the soil. Silt loam soils, with a good balance of sand, silt and clay usually have the highest available water holding capacity.

New grass seedlings are shallow-rooted and require frequent light waterings, which, in hot weather, benefit summer weeds more than the grasses. A good general rule is to irrigate less frequently and with enough water to replenish the entire root zone to a depth of 6 to 8 inches. Normally this can be done on a 4 to 5 day schedule. Excessive or too frequent irrigation maintains a saturation or a near saturation point in the root zone and restricts the rooting depth to the surface few inches of soil. In such conditions, there is a tendency for new grass roots to develop mainly in the thatch above the soil surface because of the good aeration conditions existing there. When a sizable fraction of the grass roots are in the thatch, the turfgrass will require irrigating every day and possibly, more than once a day during hot, dry periods.

Grass roots will penetrate deeper when irrigation management provides water as needed, avoids excessive applications, and permits the soil to dry partially between irrigations. The grass will be healthier and less subject to stress symptoms if severe climatic conditions do occur.

FERTILIZATION

Frequently, the difference between a good turf management program and an indifferent or a bad one is the fertilization practice employed. Turf areas, whether used as playing fields or aesthetically, must still have an adequate supply of the essential nutrient elements throughout the growing season. Since nitrogen is the key element in such management, constant liberal quantities must be supplied for the maximum development of leaf and root density. We are fortunate in Utah in that, in many cases, nitrogen is the only major element we need to apply. Turf grasses in our state may, however, respond to phosphorus, but the slight response obtained does not justify the additional cost.

The form and the manner in which nitrogen fertilizer is applied will influence the plants' response. The inorganic forms are highly soluble and release nitrogen quickly. As such, they should be applied whenever the grass is dry to avoid burning on contact. Excess nitrogen in this form is, however, readily leached from the soil. Therefore, small quantities should be applied several times during the growing season.

In the organic form, nitrogen is released for plant uptake by the action of soil microorganisms. Since the action of the microbes is a function of soil temperature, it may be necessary to supply nitrogen in the inorganic form early in the spring and use the organic form during periods of hot weather. With the organic form of nitrogen fertilizer, leaching and burning problems are nil and also fewer applications are required during the growing season. The cost per pound of nitrogen, however, is several fold greater than that in the inorganic form. Further, the rate of release of nitrogen from the various organic forms is quite variable and requires knowledge and knowhow in using these compounds.

CLIPPING

The objective in mowing turf grasses is to cut periodically at heights that will stimulate a more prostrate type of growth without weakening the plants. Uniformity, whether short or long, is important for appearance. Yet, it is probable that more damage is done to lawns and other turf areas by improper mowing than by any other practice. It is important that not too much of the leaf area be removed at any one time. A rule-of-thumb is never remove more than 1/3 to 1/2 of the leaf surface at one mowing. For most turf grasses this is clipping them at a height of 1 to 3 inches. Clipping shorter than these lengths may gradually weaken the grasses by repeatedly defoliating the plants. Repeated excessively close mowing gradually exhausts the food reserves to the point where the plant loses its ability to endure drought, heat, diseases and
competition with aggressive weeds. At the other extreme, under no condition should the grasses ever be allowed to produce seed heads, since this will exhaust the food reserves and retard leaf and shoot development for a considerable period.

Under our semi-arid conditions, temperature is an important determinant of the height at which clipping is tolerated. Where soil and night temperatures are cool, the fine-leaf fescues and some bluegrasses will tolerate 1/2-inch mowing. At higher temperatures they require 1- to 3-inch mowing heights to survive. By contrast, bentgrasses will tolerate 1/4-inch daily mowing under putting-green conditions.

Clippings are always removed from putting greens. On other turf areas, however, removal is not essential, providing the clippings are short enough to disappear into the cut grass. Excess clippings should be removed as they serve as incubators for disease spores that are usually spread at the next mowing. Where clippings are removed, extra fertilizer will be required to replace the nutrients they contain.

**INSECTS AND OTHER PESTS**

Turf areas should be clipped in the fall as long as they continue growth. Permitting a long growth at this time merely encourages an increase in insects, mice, and other pests. Examples of turf insects in Utah include sod webworms, cutworms, white grubs, and billbugs. They can be classified into two main groups based on their feeding habits: leaf feeders—the webworms and cutworms, and root feeders—the grubs and billbugs.

Other turf pests that produce unsightly conditions in our turf areas are earthworms (night crawlers), gophers and sometimes mice and ants.

**DISEASES**

Generally speaking, turf grass diseases can be separated into two groups: infectious diseases, caused by fungi, bacteria, viruses, and nematodes; and noninfectious or physiological diseases, caused by nutritional deficiencies, unfavorable environmental conditions, mechanical injury, and genetic defects. The infectious diseases, however, are caused mostly by fungi. The perennial disease problems with which we are concerned in Utah are Helminthosporium—leaf spot and foot rot; Rhizoctonia—brown patch; Sclerotinia—dollar spot; and snow mold and fusarium patch caused by Typhula and Fusarium, respectively.

A properly managed turf area is normally more resistant to diseases of all kinds. It is the only way of controlling physiological diseases. Recommendations for chemical control of the pathogenic diseases is not clear because of the concern over environmental pollution with mercurial compounds.

**WEED CONTROL**

Weeds were formerly considered pests only in farmers' crops. In our modern era, however, we now have weeds of irrigation ditches and other aquatic places, lawns, roadsides, parks, golf courses, and various additional landscaped areas. We are concerned because of competition for light, moisture, and plant nutrients. In turf management we are further concerned because they detract from the aesthetic value of the turf area. Even with good management practices, weeds invade our turfs. Among the most persistent weeds are those that have their growing points just above the surface of the ground and thus are not injured by frequent close mowings. Such plants usually have a very short stem or crown with a rosette of leaves near the ground; they may also have a mat of rhizomes or stolons. Examples of such weeds are dandelions, crabgrass, quackgrass, and annual bluegrass, all of which are serious problems.

Several factors influence the development of weeds in turf-plantings. Excessive traffic on these areas, use of unadapted grass species, and failure to maintain proper levels of nutrition and irrigation lead to weed invasion. Other factors that should receive equal attention are: plant injury from mechanical maintenance equipment, insects, diseases, and nematodes; excessive shading by trees and buildings; unfavorable chemical and physical properties of soil; use of poor-quality seed and sod; inadequate seedbed preparation; and failure to seed at the proper time.

---

**Figure 3.** Putting green showing evidence of good management.
Cultural practices probably have the greatest impact on the invasion, persistence, and increase or decrease of weeds in turf areas. If the turf is maintained in a good, competitive, vigorous state of health, weeds will have little chance to invade. Even under the best management practices, however, there are always some weed species that will invade turf areas and survive, making supplemental maintenance a necessity.

Some soils may contain as many as 2,000 viable weed seeds per cubic foot of topsoil. Another source reported 1-1/2 tons of weed seed in an acre of topsoil. With new urban developments or golf greens, it is perhaps best to consider preplanting weed control practices such as sterilization. Ideally, the chemicals used for sterilization of the seedbeds should give intense action for a short period of time, then dissipate to permit planting turf grasses. The most widely used preplanting herbicides are soil fumigants such as calcium cyanamide and methyl bromide. These compounds not only destroy the viability of weed seeds, but they also kill the vegetative rootstocks of such weeds as quackgrass, bermudagrass, and bentgrass. Because of its great volatility, methyl bromide has to be applied under a sealed cover, whereas calcium cyanamide, a dry powder, can be incorporated into the soil surface. Usually an area may be seeded within 48 hours after it has been treated with methyl bromide, while it is necessary to wait from 3 to 6 weeks when treated with calcium cyanamide.

The best weed control in established turf areas is to avoid maintenance practices that encourage growth and spread of weeds. For example, continuous dampness encourages the spread of crabgrass and annual bluegrass. Applying fertilizers when the turf grasses are dormant because of unfavorable weather only aids the spread of hardier weeds. The improper use of herbicides fails to control certain grasses, such as goosegrass.

Once weeds have invaded an established turf, they should be properly identified to ascertain the best way of eliminating them. In addition, attempt to determine the cause of their invasion, and then correct the cause. Eliminating the weeds without correcting the cause is only a stopgap method of control.

Mechanical means are the oldest and most commonly used methods of destroying isolated patches of weeds. On larger infected areas, however, turf growers have gone to herbicides with rather good success. For example, the herbicides Dacthal and Betasan have given 100 percent control of barnyard grass and crabgrass in established Kentucky bluegrass lawns in Colorado. The herbicides 2,4-D and Banvel-D have likewise given good control of broadleafed weeds in turf areas.

**FUTURE**

The future of turf management is indeed a very bright one. Increasing population, together with expanding public interest in open spaces will combine to increase the pressure and accelerate the demand for more golf courses, parks and playgrounds. The 4 day work week is rapidly approaching reality. This increased leisure time will undoubtedly see many more people taking up the game of golf. This fact is substantiated by the increased interest in golf at the elementary and secondary school levels. Moreover, if we can use the past 10 years as a guideline, we should expect an additional 20 golf courses to be constructed in Utah by 1980.

The shortage of and the competition for good turf maintenance labor will induce automation on a grand scale. Irrigation will not only be automated, but accurate sensing instruments will monitor soil moisture as well as the salinity levels. Mowing will be reduced to a minimum by either dwarf varieties or regulated by growth retardants. Such dwarf varieties are already under development at Rutgers University, and work with growth retardants in turf management is being conducted at Utah State University, University of California at Riverside, and perhaps a few other institutions as well.

To reduce environment pollution, new and different means of controlling insects, weeds and diseases will be

---

4 Personal communication
3 Unpublished results—research supported in part by a grant-in-aid from Golf Course Superintendents Association of America.
WATER SPRAY SAVES HAY LEAVES

M. J. ANDERSON and C. H. MICKELSEN

High-quality forage is essential for top production in dairy cows. Alfalfa hay is the basis of the ration for most dairy cows in Utah.

When possible, the preferred way to harvest hay is to cut with a swather-conditioner. The hay is then allowed to remain undisturbed until thoroughly dry. When the proper amount of dew is present, the hay is baled. The ideal moisture content is reached when leaves, petioles and finer stems are softened sufficiently to prevent shattering, but not enough is present to support mold. If conditions are right, losses are minimal. However, the outlined procedure has the following disadvantages:

1. Frequently, there may not be dew at the desired time,
2. Baling must be done at inconvenient times, and
3. Rains may occur while waiting for the dew. To find if these problems could be minimized, a fine spring of water was applied to dry wind-rowed alfalfa hay for an attempt to duplicate the effects of dew.

The results of these studies demonstrate that spraying of dry windrowed hay with a fine mist can duplicate the action of dew for baling hay. This will enable legume hay to be baled during periods when leaf loss would be excessive. The period of time for baling can be extended several hours during the day and the time of day may be more conclusive to baling. With the proper application of spraying intensity and time delay between spraying and baling, yield and quality of hay can equal dew-baled hay. However, the studies conducted to date were not extensive enough to establish the amount of water that must be applied or to establish the proper timing over a range of conditions.

The amount of moisture that must be applied will depend upon:

1. Temperature,
2. Humidity,
3. Air movement,
4. Delay between spraying and harvesting,
5. Condition of the hay at the time of spraying,
6. The type of sprayer used, and
7. The size and compactness of the hay window. A hot, dry day with a breeze would evaporate water more rapidly than a cool day; thus, more water should be applied. If hay is already a little tough, then only a small amount of water would be desired. A very fine mist would result in a higher evaporation rate during the actual spraying than if the droplets were larger. Penetration of water into the windrow would be more difficult in large and/or compacted windrows than if the windrows were small. Too much spray would cause hay to spoil.

The interval between baling and spraying is important. Our observations indicate a time interval is re-

M. J. ANDERSON is an Associate Professor in the Department of Dairy Science and is also a Federal Collaborator for the Agricultural Research Service.
C. H. MICKELSEN is an Associate Professor in the Department of Dairy Science.
ADVENT OF IRMA

(Continued from page 121)

the Babcock test has proved increas­ingly inadequate. Most consumers are now acutely protein conscious, and milk provides unusually high quality protein. Many attempts have been made, therefore, to accurately measure its protein content. Unfortunately, most of the tests are prohibitively expensive. One, a dye-binding process, is gaining in popularity because it is rapid and comparatively easy to run. But it is still relatively expensive. The dye-binding test also may indicate high protein production when measuring samples from cows that have mastitis. IRMA’s ability to measure fat, lactose and protein gets around this difficulty since the correlation between lactose and protein is a guide to possible mastitis. The instrument can also be combined with a “somatocrit” cell counter,” and it then gives a foolproof indication of whether a cow has mastitis. This sort of information would be especially valuable to dairy men who want to scientifically upgrade their herd.

IRMA’s versatility and efficiency must obviously have a higher price tag than a Babcock test. But by housing her in a “central” laboratory where she would be readily available to any who want her services, costs per sample could be kept low.

Utah’s Dairy Herd Improvement Association (DHIA) could utilize IRMA to give its members a precise indication of their animals’ protein and/or solids-not-fat production. Manufacturers of dairy products could use IRMA to find out just what they are buying from their suppliers in terms of protein. And IRMA could also give them accurate information about their finished products. All in all—it would seem that the advent of IRMA into Utah could be advantageous to a lot of people.

EDITORIAL

(Continued from page 111)

future needs, each department is currently reviewing past and current research and is surveying and evaluating the problems of the State within the department’s area of responsibility. The faculty of each department is formulating departmental goals that will orient its programs toward a concerted attack on the most urgent problems besieg­ing the state. As these analyses and plans mature, informed citizens of the state and leading scientists of the nation will be invited to review these proposals with us and to offer suggestions as to future directions and means for goal attainment. Anyone interested in specific areas of agricultural research can receive information about reviews and plans as they reach the discussion stage.

required to soften the leaves and prevent shattering. Unfortunately, we did not achieve success in this study and feel more work is required. Excessive delay would result in complete evaporation, and the efforts would be wasted. With the proper application of spray, we feel a delay between 5 and 10 minutes would be desirable.

This study did not consider the economics of spraying hay. For spraying to be successful, it must be economical. A 6-percent increase in digestible dry matter per acre should result in at least this much increase in milk or meat if not more. Whether this would pay for the added cost would depend upon the following factors:

(1) Could the sprayer be pulled by the baler? It should be possible to attach a spraying unit which would spray one or two rounds before the baler.

(2) How far must water be hauled? Too great a distance would cost more than what is saved.

(3) How crucial are the daylight hours in baling hay? Size of operation availability of labor and machinery would be important in determining whether spraying is justified.

(4) The use to which the hay producer will use his hay. If tonnage alone is his interest, a producer may not find a 4 percent increase economical; whereas, a producer-feeder may find spraying economical.

Spraying of hay to save leaves can be made to work. Many questions still exist including whether it could improve economically.