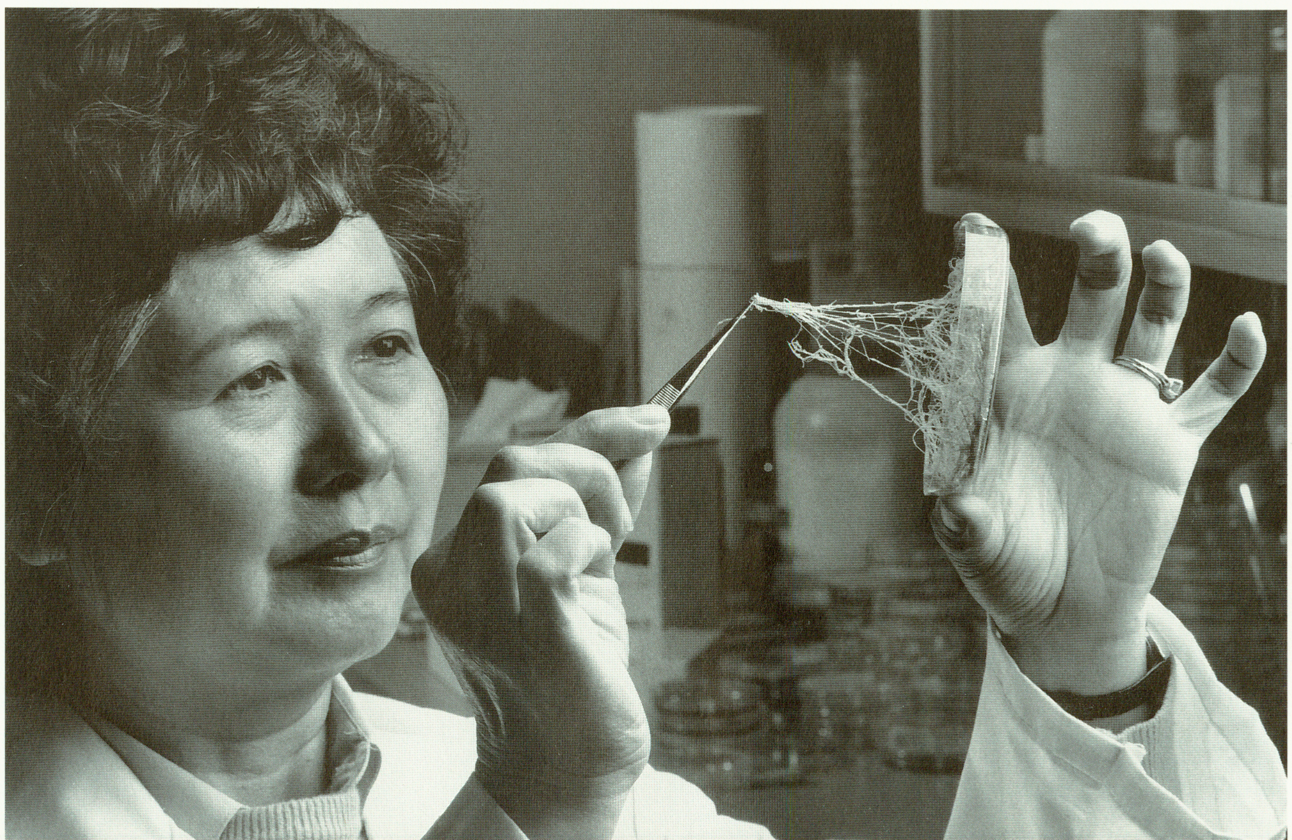
Basic Research

One way to tell the difference between applied research and basic research is to listen to the questions a scientist asks. In conducting applied research, the questions are apt to be: How can we use this stuff? Is there the potential for a new product here? Is there a better way to process this? A faster way? A cheaper way? A safer way? How do we get the bugs out of this invention? How can be make this last longer? Or taste better? Or bounce higher? Or smell sweeter? Like Edison working on the incandescent light bulb, men or women conducting applied research can tell you what they are trying to do.

Basic research questions sound much less specific: What's happening here? Why is it happening? Does it have to happen this way? What on earth is this stuff? What's it made of? How is it put together? How does it behave? What are its properties? Ask basic researchers what they are up to, and they will often reply, with more than a hint of impatience, "We're just trying to find out something about this thing." Or, to put it another way, a researcher on an applied science project is trying to develop a product or a process. A basic researcher is seeking general knowledge.

Even practical-minded industry people frequently call for more, not less, basic research. A Cotton Advisory Committee of cotton farmers and textile industry people was formed in 1948 to recommend needed research to the Southern center. The Committee soon identified 82 priority projects; 28 of them called for new or improved cotton products, and 10 sought better cotton processing machinery. But 25 dealt with fundamental research on the nature and properties of cotton fibers. One of the early directors of the New Orleans lab recalled that in following up on



In the Western center, plant physiologist Sui-Shang Hua removes a bit of hairy carrot roots for propagation in fresh medium. She is studying the influence of host plant roots on development of endomycorrhizal fungi.

these recommendations, his group used techniques like X-ray diffraction "to explore the invisible inner structure of cotton fiber."

Knowledge so obtained, he wrote, "is the foundation for research that eventually leads to more practical developments." He explained, for example, how studies of fiber properties revealed that certain types of cotton, when spun into yarn or woven into cloth, prevent the passage of water better than others. This basic finding led eventually to development at SRRC of water-resistant cotton fabric.

Since 1940, researchers at each of the regional centers have become known and respected by scientists throughout the world for the significance of their basic research. Among these men and women were a succession of brilliant chemists at the ERRC lab who isolated milk proteins and described their properties. And there was the Eastern lab team that found a new method for determining the arrangement of carbon atoms in sugar.

Researchers in Peoria developed the Culture Collection of microorganisms, defining species on the basis of the relatedness of their DNA. Another NRRC team expanded the world's understanding of aflatoxins at a time when little was known of these carcinogens. In the West, a team worked out the chemistry of the pectin enzymes polygalacturonase and methyl esterase with research described by other scientists as "classical." Western researchers also did innovative work in exploring the intricate chemistry of flavors and aromas.

In the South, scientists more than 40 years ago originated conformational analysis and determined the shape of pyranoside rings in simple sugars, opening the door to much subsequent research. In all four centers, scientists practically wrote the book on proteins and the chemistry of fats and oils. (Center scientists, in fact, did write many books on these subjects and two edited the major handbook on industrial fats and oils.)

It has been demonstrated many times that scientists have to have answers (either their own or somebody else's) to fundamental questions before they can find answers to the practical ones. But—and this is a very big "but"—the men and women who administer ARS research feel strongly that even fundamental research should be conducted in directions that appear to lead—at least in a general way—toward solution of a problem or exploitation of an opportunity. It is always a difficult decision for a research administrator to transfer research assets and people from a project with an unclear purpose to one that appears more promising, but it occasionally becomes necessary.

Following are several examples of fundamental research conducted at the regional laboratories in the 1980's, along with some of the possibilities for practical use of the knowledge obtained:

A WRRC scientist asks: How is it that barley, among all the grains, can tolerate salty soil? This is an extremely important question. Soil salinity is accelerating at an alarming rate here and in many other countries, and even moderate levels of salt lower yields of most other crops. So far, Western researchers have identified two different responses to salt stress in barley plants. One is an increase of a specific protein in barley roots; the other is increased activity of ion pumps in barley membranes. At this point, the researcher simply wants to understand the complex processes that occur when barley is stressed by salt. Objective: If he can discover the molecular basis for salt tolerance in this one grain, it's possible that the knowledge will help to breed other crops, including wheat, with similar tolerance.

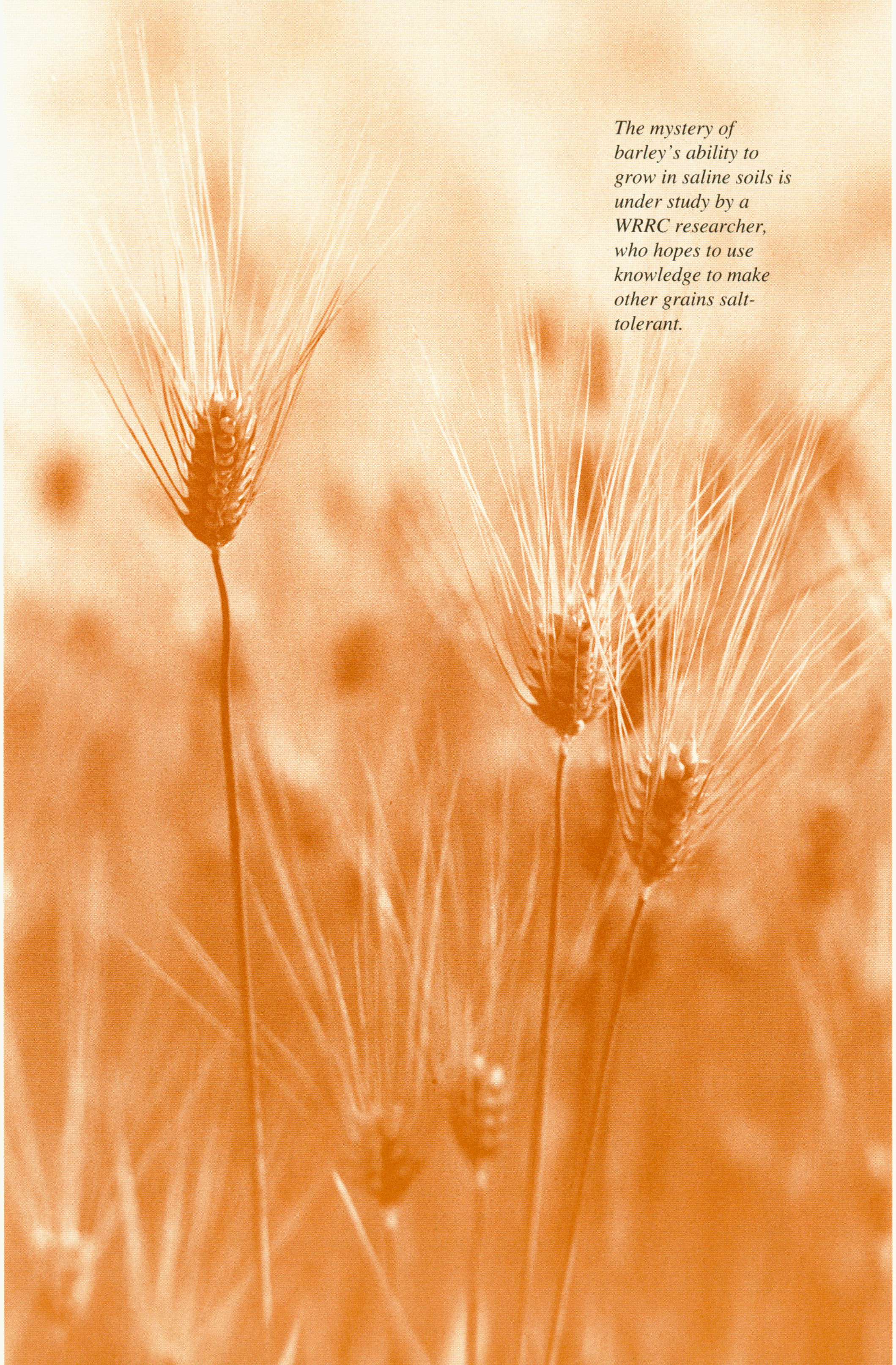
Another WRRC researcher removes tomato flowers from plants and grows them into fruit in culture tubes. This procedure allows her to control the amounts of nutrients and hormones supplied to a plant tissue or organ. She also controls temperature, length of daylight, and acidity. So far, she discovered the existence of an enzyme that triggers ripening of the fruit and is trying to isolate it. Eventual aim: Tomatoes grown for processing that ripen all at once; or the reverse—tomatoes that stretch out ripening over a longer season for fresh market sales.

At the Eastern lab, scientists developed a "nitrogen bomb technique" to isolate functionally active cell walls from plants. The method has allowed them to identify which enzymes in the cell walls are part of the plant's defense system. It also revealed the structural location of a key cell-wall component. Eventual aim: Many potatoes and other crops are lost to microbial attack during storage. Understanding how these pathogens invade plants and how the plants defend themselves is necessary, researchers believe, to help breeders develop disease-resistant crops.

An NRRC biochemist, in cooperation with a former colleague who has moved to Michigan State University, has created a synthetic gene that carries the blueprint for a key protein needed for oilseed plants to produce oil. Using a new instrument called a DNA synthesizer, he constructed the gene from 16 DNA fragments called nucleotides. He used enzymes to link the fragments together. Possible application: Genetically engineered oilseed crops that produce more or healthier oils.

Researchers in the West have developed probes to aid in the study of a hormone called cytokinin that may hold the key to slowing down the natural aging of plants. Longer life would give plants like wheat a little extra time to pack more nutrients into each kernel. Also under study are *mycorrhizae,* friendly fungi that perform a long list of useful chores for crops. Living on plant roots, the fungi send out finely branched, threadlike hyphae that act as miniature pipelines for nutrients. They bind particles together in erosion-prone soils, help plants survive in soils high in toxic metals, and keep crops alive during drought by extracting moisture from soil pores. They also shuttle phosphorus, zinc, and copper from the soil to host plants, reducing the need for phosphorus applications by the farmer. Aim: To find the most effective *mycorrhizae* strains and to understand how they perform their many functions.

Admittedly, this is but a sample of the scores of basic research projects now being explored in the regional laboratories. In terms of practical results, of marketable products, some of the projects can be expected to end in failure. But it is impossible to know in the early stages of research where fundamental questions will lead. One thing is certain: There will be no scientific progress without the knowledge gained through basic research. How much to invest in such work, and in which areas, is a matter for research administrators to determine after consultation with scientists interested in the projects.



The mystery of barley's ability to grow in saline soils is under study by a WRRC researcher, who hopes to use knowledge to make other grains salt-tolerant.