Protein extracted from tobacco leaves.

"A Revolutionary Upheaval"?

Tobacco For Protein

by Bruce Siceloff

Biologists, nutritionists, and agricultural authorities are convinced that tobacco can and eventually will be cultivated and marketed as a source of protein. But until more agronomic and economic research is done, no one is prepared to say how soon that will happen, and on how large a scale.

From the breeding laboratory to the field to the processing plant, tobacco grown for protein will be a new crop altogether – a distant cousin of burley and flue-cured smoking leaf. If it is ever grown on a commercial scale in North Carolina, even the most enthusiastic observers predict it will be only as an alternative, coexisting with the traditional tobacco crops rather than supplanting them.

Since the early 1970s, scientists in several laboratories – including the U.S. Department of Agriculture (USDA) Tobacco Research Laboratory near Oxford, N.C. – have worked to find ways both to extract protein from tobacco leaves and to utilize the tobacco pulp once the protein has been removed. Begun in the aftermath of the 1964

A staff writer for the Raleigh News and Observer *since 1976, Bruce Siceloff frequently reports on the tobacco industry. Photos were taken by Jesse Lam at the USDA Tobacco Research Laboratory near Oxford, N.C.*

Surgeon General's Report on Smoking and Health, the USDA research initially focused on developing a "safe" cigarette by removing the harmful components of the leaf. But the Oxford scientists soon discovered that the process they had developed, called homogenized leaf curing, also was ideal for removing the high-quality protein that earlier researchers had found to be abundant in tobacco leaves. So they shifted their interest to the nutritional prospects of tobacco.

A leading spokesman for the protein potential has been Dr. Donald W. De Jong, who directed the USDA protein research until 1979, when he left the Oxford lab for a private-industry research job. De Jong sees the American research in this field in a global context. "There's a lot of interest in tobacco protein overseas. Groups in France and Italy are now working on it. They're even shorter on protein than we are. It'll take off eventually, I'm sure – perhaps when pressures [for protein] get a little tighter."

But De Jong also realizes that the new use of the product would have to fit into the local agricultural economies. He doubts that the high-technology feats of the protein-extraction plant will ever push flue-cured tobacco out of the field it has dominated for a century. "I envision it as a dual system," says De Jong. "You'd have farmers growing leaves pretty much the traditional way, and you'd have another, parallel system that would put more emphasis on protein production. Farmers could opt to go along with either one."

State Officials Cautious

North Carolina officials agree with De Jong about the potential value of tobacco for the nutritional needs of a hungry planet. "I am convinced, in the long run, whether from tobacco or other sources, that leaf protein is going to become a diet source for animals and humans," says Dr. Thurston Mann, tobacco research chief for the N.C. State University (NCSU) Agricultural Research Service.

Even so, North Carolina farm leaders are not pushing for further study that would answer crucial questions about its viability as a commercial crop. They seem to fear some of the answers, already suggested by preliminary study, that further research would likely reveal. In discovering new protein uses for tobacco, scientists also may succeed in developing a new, inexpensive form of smoking tobacco. Researchers are confident that deproteinized tobacco – the green, mushy pulp that remains after protein has been extracted from the leaves – can be processed into a mild smoking leaf that could cut into the portion of flue-cured leaf blended into every cigarette.

The flue-cured tobacco grown in five southeastern states, prized for its high nicotine content and aroma, makes up about 45 percent of the tobacco used in American-made cigarettes. Flue-cured's share in the cigarette blend has declined in recent years, due to the rise in cheap imports and changes in cigarette manufacturing practices, and it could be expected to drop even more with the introduction of an inexpensive filler tobacco.

USDA scientists now believe that tobacco grown almost anywhere – and varieties exist from the equator to Siberia – can be deproteinized and then processed into a mild, low-tar filler that is somewhat less flavorful than flue-cured but also less costly to produce. If a satisfying tobacco aroma could be developed in processing plants anywhere in the country, and if this deproteinized leaf became acceptable to cigarette manufacturers on a wide scale, it could threaten the Virginia-to-Florida flue-cured belt's multi-billion dollar monopoly on flavor.

"It would cause a revolutionary upheaval in North Carolina," says John H. Cyrus, N.C. Department of Agriculture tobacco affairs chief. "I doubt you could prevent it from being grown all over the country. That would mean the elimination of the [federal] tobacco program, the tobacco auction system, and so on."

While cautious about the protein potentials of tobacco, state officials also realize they cannot afford to ignore the implications of recent research. "We're looking into the feasibility of it. If it's going to happen, we want to be in on the ground floor," Cyrus says. "Maybe we can get a jump on the rest of the country. We don't want to stand idly by and let someone out in California take the rug from under us and run with it."

In the summer of 1980, the N.C. Farm Bureau, the largest and most influential farm advocacy group in the state, quietly started a protein-extraction pilot plant near Wilson. "We want to be as sure as possible that this stuff does not become a direct competitor with flue-cured tobacco," says John W. Sledge, president of the N.C. Farm Bureau. Like Cyrus, Sledge seems to understand the importance of being "in on the ground floor." But thus far, Farm Bureau officials have refused to release details on their protein project, saying only that they will delay public discussion until they can report some results. A clue to the direction of their efforts may lie in Sledge's suggestion that deproteinized tobacco be marketed as animal fodder or fuel for methanol production.

Considering the many political and economic threats to the existing tobacco farm system and the fervor with which state officials defend tobacco, their caution is not surprising. But what if De Jong and other researchers are right? What if tobacco could become a source of protein for a hungry world?

Promises and Problems of Tobacco Protein

A high-quality protein called Fraction-I and other useful proteins are abundant in the leaves of all green plants. In 1947 a team of California scientists first identified the enzymatic reaction that isolates Fraction-I in tobacco. Dr. Samuel G. Wildman, a recently retired UCLA biologist, was part of that team and has been a pioneer in tobacco protein research for the past three decades. Scientists have recently learned to extract protein from a variety of plants including alfalfa, spinach, cotton, rice, wheat, tomatoes, and corn. But only from tobacco have they learned to extract Fraction-I easily and in an unadulterated, crystalline form.

A single acre of tobacco grown for protein purposes, Wildman reports, could yield:

- 1,188 pounds of insoluble proteins that could be added to bread and other solid foods or used like soybean extracts;
- 1,166 pounds of several water-soluble, tasteless, and odorless proteins known collectively as Fraction-II, which could become an additive to beverages, soups, and snack foods or could replace soybeans as a major source of animal feed, thus freeing more soy protein for people of developing nations;
- 286 pounds of pure, crystalline Fraction-I protein, which far exceeds soy protein in nutritional quality and has potential medical uses.

Of the nine amino acids considered essential to the human diet, Fraction-I has concentrations of eight which are equal to or greater than the minimum set by the United Nations Food and Agricultural Organization. For all nine amino acids, soy protein has less than half the levels of Fraction-I. In a test to measure what is called the protein efficiency ratio, rats fed Fraction-I gained 22 percent more weight in four weeks than did rats fed milk protein, which was the yardstick for the test. And soy protein tested about 20 percent below milk protein.

While Fraction-I probably would be too expensive for ordinary food use, its purity and high digestibility may give it valuable medical applications. Wildman believes, for example, that it could be added to the liquid diets of patients with pancreatitis, gastrointestinal tumors, and other diseases involving maldigestion and malabsorption. It might be fed to infants who are allergic to cow's milk and who cannot get human milk. Patients with aggravated kidney disease, who must severely limit sodium and potassium consumption and must undergo frequent hemodialysis to wash these salts from their blood, might need dialysis less frequently if mineral-free Fraction-I were made an important part of their diets.

To get the protein yields described above, farmers would grow and handle tobacco more like a silage crop than like traditional smoking tobacco. They would sow seeds directly into the field, up to 150,000 plants per acre, and harvest the crop with a mower in about six weeks, when, according to Wildman, the leaves of the 18-20 inch-tall plants have their peak protein content. The cut plants would sprout new stalks and leaves, allowing up to six successive harvests in a growing season of six to eight months. Wildman projects that a single acre of such a "close-grown" crop could produce up to 66 tons of tobacco per year. This harvest could

Tobacco harvested in a "close-grown" method for use in protein extraction.

measure 6.6 to 13 tons of dried leaf, depending on moisture content, compared to a conventional dried leaf crop in North Carolina of about one ton. The 6.6 tons from a "close-grown" crop would produce 2,640 pounds of protein – almost four times the protein gained from one acre of soybeans, according to Wildman.

Tobacco growers would have to make a major adjustment in traditional planting and harvesting methods for a "close-grown" crop. Flue-cured and burley are sown in seedbeds during winter and transplanted to the field in the spring, about 6,000 seedlings per acre (in contrast to Wildman's 150,000 seeds directly planted). Farmers harvest about four leaves per plant each week, moving up the stalk as the leaves mature. Then the flue-cured is scorched in a curing barn until it turns golden and sweet; burley is air-cured in unheated barns.

Some agronomists doubt that Wildman's projections for protein yields could be realized in North Carolina. They point out that his estimates depend on a growing season longer than the state's average of five and one-half months, and they warn that direct seeding of tobacco – as opposed to the traditional transplanting – would bring new weed, disease, and pest problems that would limit protein yields. Also, the widely used flue-cured and burley strains have been bred so that much of the leaf protein breaks down quickly as the plant matures (protein is not desirable in cigarette smoke because it burns poorly and with the bitter odor of burnt feathers).

But no plant has been more thoroughly studied and manipulated in the breeding laboratory than tobacco, and protein researchers are confident that plant geneticists can develop new strains that will produce more protein and release it more readily than do the breeds that have been tested by Wildman in California and De Jong in North Carolina. If the researchers are right, Wildman's projection of more than a ton of proteins per acre could prove to be low rather than high.

USDA researchers have paid attention to the concerns of farm leaders that a market must be found for the tobacco pulp remaining after the protein extraction. At Oxford in the 1970s, De Jong developed a process called homogenized leaf curing (HLC) in his quest for a safer cigarette. In the HLC process, immature, green leaves are washed, chopped, and ground into a semi-liquid slurry that is pressed into a sheet with the juices squeezed out of it. De Jong extracted leaf proteins from this liquid. Researchers hope that, by chemically manipulating the juices squeezed out of it, they can learn to neutralize the tobacco components that turn into carcinogens in cigarette smoke.

The deproteinized leaf comes out as a green mush that is dried and pressed into sheets much like wood chips made into particle board. It is low in tar and nicotine. It does not have a pleasant smell at first, but it acquires one. "After three years on the shelf it has a good aroma and a nice color," says Dr. T.C. Tso, a USDA researcher in Beltsville, Md.

De Jong believes deproteinized smoking tobacco could be produced more cheaply than conventional leaf since the "close-grown," multiple-harvest method would produce greater yields per acre while requiring far less labor since it could be mechanized from seed to processing plants. "The tobacco companies told us informally that they could use a material that was bland, that had some

Leaves being fed via conveyor belt to vertical pulverizer.

nicotine in it, provided it did not have an objectionable odor that had to be masked," De Jong says. "They could add the flavoring to it – that would be no problem."

Developing deproteinized tobacco as a cigarette filler product could be the key to making the "close-grown" crop commercially viable. But North Carolina tobacco leaders, viewing this possibility as too much of a threat to current flue-cured and burley production, have instead advocated less lucrative uses such as methanol production or animal fodder.

Further Research Needs

Tobacco proteins could be used for food and medical purposes only after years of testing by the U.S. Food and Drug Administration (FDA) to ensure safety. "We need to do a lot of research with the protein, to feed it to animals and even, down the road, feed it to humans," says Dr. James F. Chaplin, director of the USDA lab at Oxford. "[We need] to try to extract protein on a commercial basis, on a large scale." More study is needed, too, to find the best ways to grow and market this new crop and to perfect the smoking quality of the deproteinized tobacco.

Work at Oxford, stalled for more than a year after De Jong's departure in 1979, cranked up again early in 1981 under his newly appointed successor, Dr. Denise Blume. Dr. Blume said she was resuming study of protein extraction and development of a "safer" cigarette, but she said the Oxford lab would need to find additional funding before it could set up a pilot plant for protein extraction in summer 1981. USDA researchers hope further research can improve the smoking quality of deproteinized leaf. Farm leaders in North Carolina, however, do not seem to share their hope.

N.C. State University (NCSU) researchers, for example, who frequently work with Oxford scientists, are waiting for Blume to take the lead in protein study. "Right now, we're committed to the continued production of a quality [traditional tobacco] product as a smoking material," says Mann, the NCSU tobacco research chief. And, even in spring 1981, the N.C. Farm Bureau would not release specifics on its pilot extraction plant near Wilson.

Echoing the concerns of Farm Bureau President Sledge, N.C. Department of Agriculture tobacco chief Cyrus, and other farm leaders who want to protect flue-cured tobacco's dominant position in the industry, Chaplin downplays De Jong and Tso's insistence that deproteinized leaf can be developed as a smoking material. "We want to develop protein use in a way that dovetails into the existing tobacco industry. We've about come to the conclusion that it's going to be really difficult to use tobacco both for smoking and for protein," Chaplin says. Chaplin's lab, occasionally threatened with termination of funding by the anti-smoking lobby in Washington, owes its continued existence in part to the good will of North Carolina's congressional delegation, which tends to respond to such groups as the Farm Bureau on tobacco matters.

Conclusion

Most tobacco policymakers, farm researchers, and farm leaders seem hesitant to embrace the advantages that tobacco-for-protein may offer. The long-term opportunities for the crop seem unlimited in a world already scarred with famine. Yet no one is pursuing the research needs aggressively; no one is advocating that North Carolina become a leader in experimenting with this crop. With few exceptions, such as the UCLA findings and some USDA work, research seems to be motivated by fear more than by a sense of opportunity.

To the powerful anti-smoking lobby, protein offers an alternative for tobacco that is unassailable. To champions of tobacco, protein extraction could represent an important marketing option that complements – not replaces – the existing tobacco crop. Farms could remain small: A single acre could produce nearly four times as much protein as an acre of soybeans. And the federal tobacco program could probably be amended to accommodate the tobacco-for-protein crop.

Research needs to be done, certainly, to ensure that this alternative is a viable commercial enterprise. But what scientists have already demonstrated – in the laboratory and in the field – should assure even policymakers with very different views that harvesting tobacco for protein might well be an alternative for the flue-cured tobacco farmer, an alternative as attractive to the most strident anti-smoking voices as it is to the most provincial pro-tobacco spokesmen.□

"Deproteinized" tobacco that has passed through the homogenized leaf curing (HLC) process.