It must come as no small surprise that tobacco, whose current worldwide use as a smoking material kills some three million people every year, "may in time become one of the world's principal sources of protein for human consumption and livestock feed." So stated no less an authority than the World Health Organization's Farm and Agriculture Organization in 1981. Nevertheless, tobacco as a protein source has received so little publicity over the years that most of us are still largely unaware of its potential to feed a hungry world.

**Protein From Tobacco**

Among the protein extracts that were prepared from a variety of green plants and forage crops, those originating from the leaves of the tobacco plant, *Nicotiana tabacum*, according to Wildman, a leading protein chemist, had "properties which make them uniquely desirable as sources of edible leaf protein".

Tobacco was the only plant from which the Fraction-1-protein (F-1-p a single, large, homogenous protein that makes up half of the plant's soluble protein) could be obtained in pure, crystalline form. It has no taste or odor, is colorless and non-allergenic and exhibits an optimal amino acid composition which lowers cholesterol. Its functional characteristics (e.g. solubility, stability, foaming, gelling and emulsifying ability) are superior to those of egg white, casein and soy protein. In feeding experiments, tobacco F-1-p significantly exceeded casein, soy, corn and other cereal proteins in protein efficiency, i.e., the weight increment of growing rats per gram of protein ingested. All in all, tobacco F-1-p may be the best nutritional and functional food protein. It has also been recommended for a variety of medical uses (e.g., for kidney dialysis patients and as artificial milk for infants).

F-2-proteins (a mixture of low molecular weight soluble proteins) from tobacco also have favorable characteristics and could be added to soups and beverages to boost nutritional quality. The insoluble proteins, could be used to enrich solid foods for human consumption or used as feed for poultry and non-ruminants.

**Can It be Done?**

Leaf Protein International (LPI) was founded in 1979 as a joint venture between the North Carolina Farm Bureau Federation and General Foods (prior to its incorporation into Philip Morris Industries). In spite of severe budgetary limitations, LPI built and operated a pilot plant in North Carolina's tobacco region. During 1981 and 1982, LPI demonstrated that the extraction process for obtaining crystalline F-1-p and other raw materials from tobacco was commercially feasible. The yield of F-1-p was estimated at 530 lbs/acre (600 kg/hectare).

LPI's goal was to transform tobacco into a commodity used on a large scale for human food as
well as for smoking. Cigarettes made from the fibrous residue remaining after protein extraction (more than 5 tons per acre) would produce much lower amounts of toxins and carcinogens during burning than conventional cigarettes. The residue could also serve as ruminant feed.

Grown for food, tobacco plants could be more densely spaced and generate about four times as much protein per acre as soybeans or corn and about five times as much smoking material as conventional tobacco crops. At the same time, labor input could be halved. The total yield value could exceed $6,000 per acre as compared to $2,500 per acre for conventional tobacco. In comparison, corn brings $100-150 per acre.

In 1983, the U.S. Office on Technology Assessment convened a workshop on protein extraction. The general tenor regarding protein extraction from tobacco is reflected in the preface of the proceedings:

The risk involved in investment in this technology is perceived to be high, and a considerable concern exists that products would have limited marketability because of:

* the health concerns that some (italics added) attach to tobacco, and
* the changed character of cigarettes and chewing tobacco made from protein-extracted tobacco may not satisfy consumers.

In due course funding for the protein project dried up, the pilot plant ceased operating and LPI was disbanded.

**Why Not?**

Paradoxically, the project suffered defeat at the very juncture when one would have expected the green light for a large-scale trial. The negative arguments cited in the OTA Proceedings must have existed before the pilot study began. However, they were only brought to bear when the project was proving successful. The language used unmistakably betrays its provenance. Obviously, the powerful tobacco lobby is jealously guarding the *status quo*, for conventional cigarettes are still the most lucrative commodity sold on world markets.

Realistic constraints, however, do exist. The need for prompt processing of harvested leaves to forestall loss in F-1-p will require duplication of equipment which raises initial investment cost. Tobacco, unable to utilize atmospheric nitrogen, is hard on soils, demanding more fertilizer than legumes. However, since tobacco has recently become a favorite object of biogenetic manipulation, it is conceivable that a nitrogen-fixing variety can be created.

Consumers in developed nations may be surprised when offered protein supplements from tobacco, which *most (not some)* view as a killer weed. The protein extracts are, of course, freed of poisons. Nicotine is present in a concentration of 20 ppb, many times lower than that normally found in tomatoes, potatoes or green peppers. Nevertheless, a painstaking scrutiny of both food and pharmaceutical products from tobacco would precede the Food and Drug Administration's approval for marketing. (The prospect of FDA involvement with tobacco is anathema to an industry that has successfully kept it out of the agency's grip). While the market for protein supplements might be disappointing in affluent countries which thrive on meat, the benefit to the protein-starved third world may be considerable.
Tobacco for a Hungry World

For over 25 years tax-supported tobacco was dispatched to hungry nations under the auspices of America's Food for Peace program. When mounting criticism prompted the suspension of this practice in 1980, the ground was already prepared for the transnational tobacco corporations’ onslaught of third world markets. Nicotine addiction spread, inflated profits lured farmers away from tending food crops, and ravaged forests provided new land for planting and fuel for curing tobacco. The maxim "Whenever tobacco is grown, food is not" has become the grim characterization of the third world's current predicament.

Today we know that there is another side to the coin. With projections based on North Carolina's pilot study, the third world's almost 4.5 million hectares under tobacco cultivation could deliver over 2.5 million tons of high quality F-1-p, about half as much F-2-p and 20 million tons of insoluble protein, leaving another 60 million tons of deproteinized residue for use in cigarettes and/or ruminant feed. Indeed, this may just be the beginning, because tobacco could later replace some food crops with lesser yields of high quality protein.

Tobacco is Not the Enemy

It may be unrealistic to expect tobacco's complete elimination, the avowed goal of a smoke-free society. However, the prospect of turning a deadly harvest into one which supports life would preserve, if not enrich, the livelihood of tobacco farmers and win them over as allies in the just cause of the pro-health forces.

It's ironic that the same plant which has killed millions of people should also possess the potential to feed a protein-starved world. Tobacco is not inherently evil, nor for that matter is anything else in our environment. In the final analysis, it depends on what we, individually and collectively, make of it.

K.H. Ginzel, M.D., is Professor Emeritus of Pharmacology and Toxicology at the University of Arkansas. Most of his work is in the area of nicotine and its effects. He wishes to acknowledge the invaluable input of Dr. Shuh J. Sheen, a leading authority in the field of protein extraction from tobacco.

Protein from Plants

Plants are the primary and most prolific manufacturers of proteins on earth. But, in order for us to enjoy animal food, plant proteins must first be converted into animal proteins at a substantial loss in food efficiency (20 pounds of grain produce one pound of beef). Most of the less developed countries cannot afford this luxury. They must depend solely on plant proteins which their dietary staples often fail to provide in adequate amount, composition or quality. Hence, protein deficiencies abound in the third world.
More than 40 years ago, Pirie first pioneered protein extraction. He insisted that the technique could offer a more efficient way than does the ruminant to convert leaf protein into food suitable for human consumption with equivalent nutritional value to meat. During the following decades great progress was achieved by different research teams toward extracting, purifying and characterizing leaf proteins as well as developing technologies which promised practical commercial utility.

(From Priorities Vol. 4, No. 1, 1992)