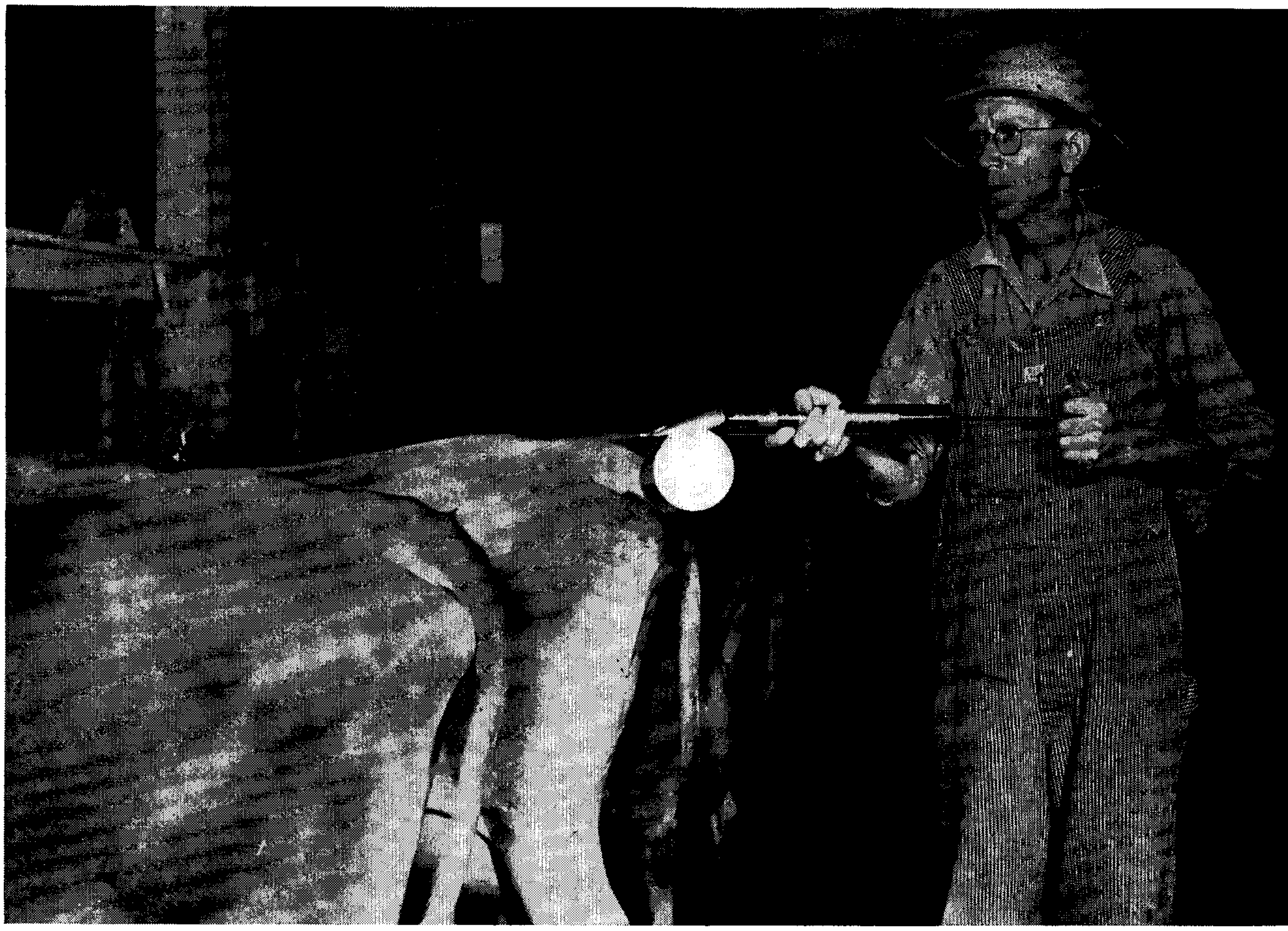

About 1948, USDA found out that milk would contain DDT if cows, their barns, or their feed were treated with it

Pesticide Residues in Milk

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The problems are complex and difficult, but there are heartening indications that they are not always impossible to resolve in a practical way

FIFTEEN or 20 years ago, the subject of pesticide residues in milk could probably have aroused interest only by reason of curiosity as to what peculiar circumstances might have brought the matter up. But there is today no mystery as to why the topic is frequently discussed. Developing knowledge of the improvement in dairy practice that can stem from pesticide usage has brought with it intense interest in the associated residue problem. Some aspects of that problem are among the most ticklish of all residue questions, particularly from the viewpoint of the regulatory agency.

Soon after DDT became available, it was introduced in the culture of feed crops, and as a fly spray for application in dairy barns, and to dairy cattle themselves. But about 1948, experiments conducted by the Department of Agriculture indicated that if cows were given feed bearing DDT, or if they were sprayed with it, or even if it were used in their barns, their milk would contain DDT.

This was something new. Good practice in use of the old line inorganic pesticides had not been found to contribute any residue to milk. The expectation had been that with proper precautions to protect foods from direct contamination, DDT would be a safe and effective pesticide to use in food production of every type. Quite evidently the facts were otherwise. Conferences between the Food and Drug Administration, the Department of Agriculture, and the Public Health Service resulted in warnings against use of DDT in dairy practice. Speaking in the light of comprehensive studies that had just been completed, dealing with the physiological effects of DDT, the then Commissioner of Food and Drugs declared that FDA would not and could not set up a tolerance for DDT in milk. He simultaneously commented on alternate and far less objectionable substitutes for DDT.

No facts have since come to light that would justify any change in the position then taken by the FDA respecting DDT. But that is not to say that tolerances are thereby necessarily precluded for all pesticide residues in milk. The Miller Amendment provides for establishment of *safe* tolerances for residues of *useful* pesticides in raw agricultural commodities, and this includes milk. Where the facts permit, residue tolerances for milk can properly be established. That such tolerances have not been announced, so far, is ascribable primarily to difficulty in ascertaining the residue level for milk that would be safe, and yet would not be exceeded in consequence of useful employment of pesticides.

Why does milk pose particular difficulty in this regard?

First, milk and its products are far more widely consumed, in greater quantity per capita, than are food items derived from any other single source, except water. Computations based on recent USDA data show that dairy products make up a little more than 29% of the average civilian diet in this country—fluid milk itself, at least 25%. No other commodity contributes so much as a third as large a proportion of the diet. Only a little more than 9% is represented in the products of wheat, including bread. Less than 8% consists of potatoes, the vegetable eaten in by far the greatest bulk. No single class of fruit contributes more than 3%; yet the pesticide residue problem was initially identified with fruit, particularly apples, which constitute less than 1.5% of the average diet. It may help to orient residue viewpoints to recognize that milk involves about 20 times as much food as that involved some thirty years ago when lead arsenate on apples first became a pressing problem in this country.

Now, certain of the prominent components of the diet—potatoes, for example—are less likely than others to incur residues from pesticide usage. With certain other sources of food—wheat, for example—processing measures, necessary to render them edible, often serve to minimize an incurred residue. And with a good many articles, usual culinary practice, while often not very effective, does unquestionably eliminate some of the residue. Once incurred in milk, on the other hand, a residue will ordinarily be consumed in its entirety.

Then it must be taken into account that milk constitutes not the average 25%, but a preponderance of the diet of that segment of the population to which potential for harm from pesticide residues is probably greatest. For the weak, the sick, the very young, and the aged, milk can represent close to 100% of the nutrient intake, and supplant most of the water intake as well. The residue this group may ingest, per unit of body weight, could be an entire order of magnitude higher than the residue in the milk component of the average diet.

Many modern pesticides tend to change identity under the influence of conditions to which they are exposed in the course of becoming residues—on plant surfaces, within plant tissue, or in the animal digestive or metabolic system

Presumably, these factors could be evaluated in reasonably quantitative degree. But what would be the magnitude of the further allowance needed to compensate for the probability that these people are relatively susceptible to effects of pesticide residues?

That is perhaps the most difficult of the questions connected with residues in milk—for the means available for obtaining an objective general answer to it are a good deal less than adequate. The reason for this is that gaging the toxicity of a substance must ordinarily be approached through observing the effects of graduated doses of it, administered to initially normal, well-fed, and well-cared-for laboratory animals. However satisfactorily such basis for conclusions may apply to the diet of average individuals, there is manifest room for doubt that the same would hold for food for infants, invalids, and the elderly. Nevertheless, it is not impossible that circumstances might lend themselves to practical resolution of this question, in at least some instances.

It is evident, in any event, that consideration of residue tolerances for milk must be focused upon substantially smaller concentrations than those which might represent safe levels in most other raw agricultural commodities.

This will usually raise another problem—that of analytical methodology. Not only need a tolerance be safe; it must be practical. And that means it must be met under conditions of useful employment of the pesticide. Ordinarily the only way to ascertain whether a given residue level will be met is through analysis. To be suitable for the purpose, the method of analysis must, of course, be capable of detecting and measuring the substance to be determined. A pesticide residue, particularly one in milk, is not necessarily identical with the parent pesticide. Many modern pesticides have a troublesome tendency to change their identities under the influence of conditions to which they are exposed in the course of becoming residues—on plant surfaces, within plant tissue,

A useful clue to the residue problem is in study of the bovine rumen, an active environment for chemical change

or in the animal digestive or metabolic systems. Moreover, changes within the animal may differ depending on whether the pesticide is absorbed through the hide or enters through the digestive tract, or even by way of the respiratory system.

As if this were not complex enough, it must also be remembered that in some instances the chemical identity of the original pesticide is not known, and that in others the product may contain a substantial proportion of impurities that may not act at all like the main component.

Metabolic changes often serve to reduce the toxicity of the residue, or even completely detoxify it. But, alternately, such changes could conceivably multiply toxicity, perhaps many fold, by the time the pesticide becomes residue in milk. There is no way to tell, beforehand, which may occur. Quite evidently, a suitable method for residue analysis cannot be selected or devised until the residue has been chemically characterized. And also, of course, a pertinent gage of its toxicity cannot be approached without knowing what it is. Basic to the whole problem, therefore, is a determination of the identity of the residue as it exists in milk, where its concentration, from the pesticide usage contemplated, may often be no greater than a fraction of a part per million. Once it is identified, there is the additional requirement of a means to isolate it from milk for analysis, and then to measure it with such delicacy, precision, and specificity as may be appropriate. To say that the obligation of the chemist is likely to be exacting would be an understatement.

But even if things worked out satisfactorily up to this point, solution of the over-all problem would be far from complete. The analytical method would provide a tool by which to proceed with experimentation designed to show what the amount of residue in milk would be when the pesticide is employed for a useful purpose. If it were a pesticide for use on feed crops, controlled applications thereto would need to be made under variant conditions expected in practice, and residue findings thereon would need to be gathered to establish tolerances on the feed itself. This would also be needed in order to relate feeding levels to residues that would occur in milk consequent to use of the feed. Parallel studies would need to be carried along to gage the associated residue in meat resultant from those feeding levels. And if the pesticide had usage directly on the animal, or on dairy premises, additional phases of experimentation would be required.

It is not necessary to go into the many details of such studies to realize that responsible establishment of a tolerance for milk can be an undertaking of very considerable scope, complexity, and difficulty.

In discussing any problem, particularly a general problem, without going into available devices or approaches to aid in specific solutions of it, one is likely to create an impression that the difficulties are invariably more imposing than may actually be the fact. While evidently this kind of problem is seldom likely to be simple, there has been enough success on some phases, in some instances, to suggest that other difficulties can probably be handled.

The case of methoxychlor, for instance, prominently illustrates the phenomenon of a threshold diet level, which must be exceeded before the cow transfers any of it to her milk. If graduated doses of methoxychlor well in excess of 100 p.p.m. are fed to a cow, residue *will* appear in her milk in amount related to the dosage. Extrapolation of the diet-to-milk residue relationship, so established, signifies that the milk residue diminishes to zero at a diet level well above 100 p.p.m. This device of establishing a relationship in a range well above the area of actual interest, and then extrapolating to the point pertinent to the objective of the study, has been useful in other instances.

Granted that extrapolation, within limits, is scientifically sound, this seems a good way to demonstrate the conditions under which a residue will be completely absent. It does not always give a pattern of results that will prove a particular point. Some pesticides appear in the milk in direct ratio to the level in the diet, with no threshold, and hence under no circumstances of ingesting such pesticide will the cow give completely residue-free milk. But even if there is no threshold, the relationship can be useful. For it permits employment of a relatively insensitive method to establish the relationship at levels high enough for determination, and the gaging therefrom of the quantity of residue in the milk, even though undetectably low, that would attend the contemplated usage of the pesticide.

Another potentially useful clue comes from tests of the effects on pesticides of bovine rumen contents, a notably active environment for chemical change. The rumen apparently is capable of destroying, rather promptly, the cholinesterase-inhibiting capacity of parathion and certain closely similar organophosphates. It does not do this with all such pesticides, but whether it does or not would seem a potentially useful fact to establish with any new ones.

This is not quite the same as saying that the rumen destroys parathion—it only reduces its nitro group. The reduced substance could still be a toxicant, even though not a cholinesterase-inhibiting one, or could change to a toxicant before it got to the milk, if it did. So, knowing the effect, if any, of the rumen is not likely to solve the problem completely. The point is that this and similar exploration of the fate of the pesticide in the cow's metabolic system could contribute to solution of the problem, at least in some cases.

During feeding studies it has generally been observed that at a given diet level, if residue transfers to the milk, it increases as the study progresses until, after an interval of from a few days to a few weeks, it levels off at a constant ratio to the dosage. When experimental use of radioactively tagged pesticide is contemplated, in order to test for the residue by radioassay, there is posed the very practical problem of the quantity of tagged material needed, to feed as large an experimental animal as the cow. This can sometimes be minimized by the simple device of pre-equilibrating the animal on untagged pesticide—feeding it untagged pesticide long enough for the milk-to-diet residue ratio to become constant. Then the feeding of tagged pesticide for a day or so may be sufficient for assays that will determine whether or not the residue will appear in the milk. This is not to be relied upon for a quantitative measure of the residue, if any, but could be advantageous in defining a diet-to-milk residue relationship that can be extrapolated to ascertain a diet threshold.

In summary, the circumstances surrounding milk and its use require critical consideration of pesticide residues in this commodity. The problems this situation raises are comparatively complex and difficult, but there are heartening indications that these problems are not always impossible of practical resolution.