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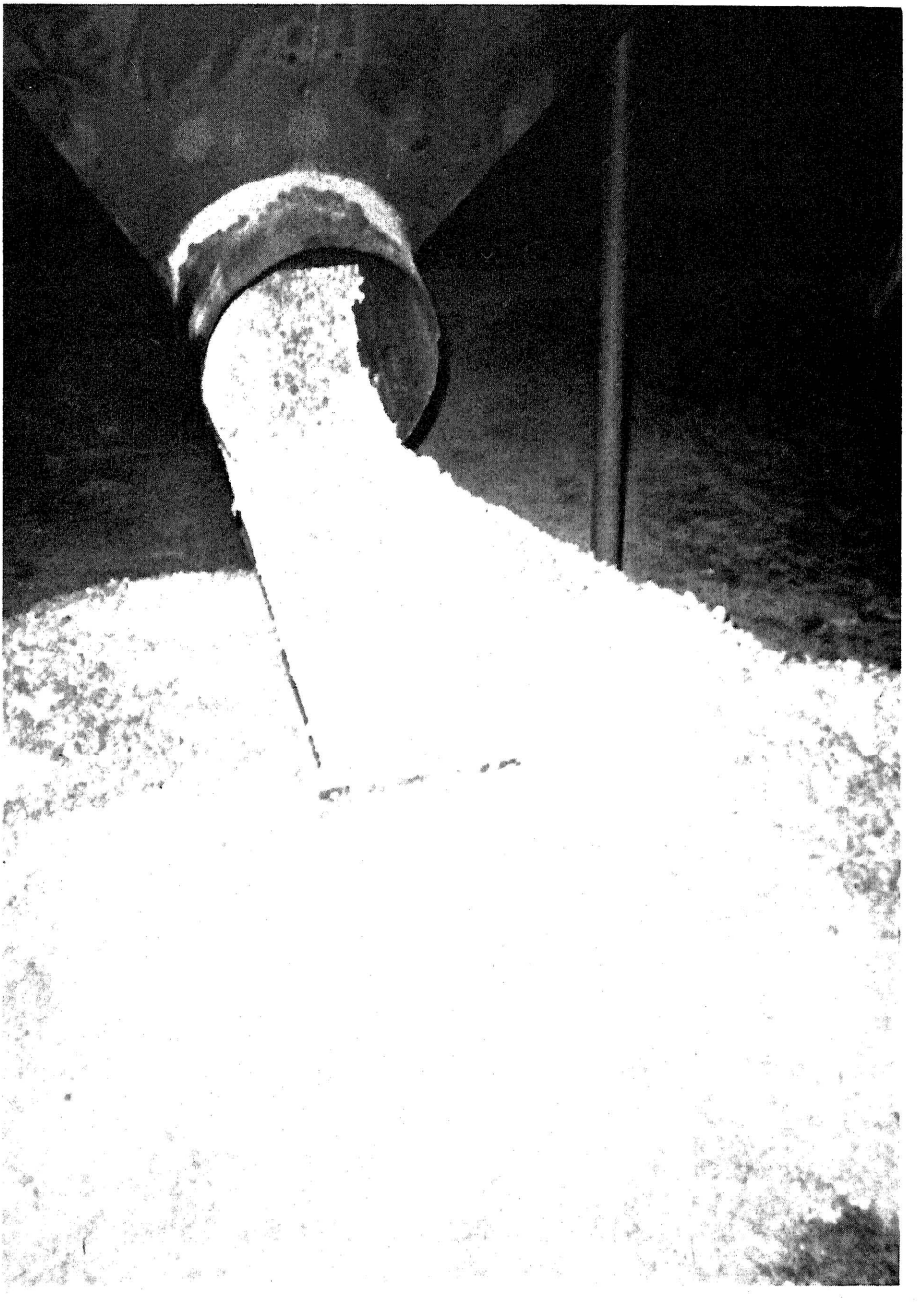
Proper controls on the processing equipment are essential to insure a quality product.

Dehydrated and heated hatchery by-product meal.



The Potential of Hatchery Waste as a Feed Ingredient

(Processed infertile eggs, dead embryos, chicks and poults, and shells of hatched eggs)

J. M. Vandepopuliere, L. A. Voss and Harold B. Jones*

The major components of the hatchery industry are egg-type chick hatcheries, broiler chick hatcheries, and turkey hatcheries. There are hatcheries for ducks and miscellaneous other domestic fowl and game birds but these are relatively unimportant. It is estimated that the hatchery industry for egg-type and broiler chicks takes about 6 percent of the total egg production of the United States annually. In the turkey and broiler industries eggs are produced only for hatching, whereas, in the commercial egg industry eggs are produced for hatching and human consumption.

In 1975 there were 797 chicken hatcheries operating in the United States with an egg capacity of 416 million eggs. There were 3,169 million chicks hatched in 1975 with 454 million being egg-type and 2,715 million broiler-type chicks. The 179 turkey hatcheries in the United States in 1975 had an egg capacity of 41.4 million eggs, and they hatched 137 million poults. The normal hatch for egg-type chicks is about 92 percent of all eggs set; thus about 493.5 million of these eggs were set last year. For broiler hatching eggs the hatch is normally about 85 percent; therefore, the number of eggs set was around 3,194 million. For turkeys, the hatch is low compared to chickens, about 70 percent. This indicates 195.7 million turkey eggs were set to achieve 137 million hatch for 1975.

Broiler and turkey hatchery waste consists of infertile eggs, dead embryos, dead chicks or poults, and the shells of the hatched eggs. The hatchery waste from the commercial egg-type hatchery contains all the components of broiler type hatchery waste plus the male chicks that are normally destroyed at the time of sexing.

PURPOSE OF REPORT

The purpose of this publication is to present in brief form:

1. Information on the volume, composition, and utilization of hatchery wastes.
2. The present status and developments in utilization of hatchery wastes.
3. General information on the economics of hatchery waste use and disposal costs.

There has been considerable research on the hatchery waste disposition and utilization problem. This publication is an effort to assess the current situation and provide a basis for further research.

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FEDERAL AND STATE REGULATIONS

The regulations governing the utilization of hatchery by-product meal in feed are contained in the Uniform State Feed Bill (1969) prepared and approved by the Association of American Feed Control officials and the American Feed Manufacturers Association (1). These are the standards used by the Food and Drug Administration for feeds moving in interstate commerce and most state regulations closely follow these guidelines. The Association of American Feed Control Officials used definitions developed by the National Research Council, the Research Branch of the National Academy of Sciences.

Hatchery by-product meal is officially designated as "poultry hatchery by-products", including "a mixture of egg shell, infertile and unhatched eggs, and cull chicks which have been cooked, dried, and ground with or without removal of part of the fat." [(Adopted 1957.) *NRC5-03-796.*] As an approved feed ingredient no special restrictions are placed on use of poultry hatchery by-products (2).

The Food and Drug Administration recognized the collective term "animal products" and poultry hatchery by-products may be listed alone or in combination with other animal products under this classification. State standards may vary on this point, so it is advisable to check state laws before offering products containing poultry hatchery by-products for sale. Feed containing poultry hatchery by-products must meet all applicable federal and state standards for wholesomeness. Further information on regulations regarding feeding poultry hatchery by-products may be obtained from the Food and Drug Administration of the United States Department of Health, Education, and Welfare, from the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture and various State Departments of Agriculture.

This publication is particularly relevant at this time because of the changing economic situation and waste disposal problems. Feed ingredient prices have increased sharply over the past several years, particularly feed ingredients purchased as protein sources, thus making it feasible to consider processing hatchery wastes into feed ingredients.

There is also increasing concern in our society with relation to waste disposal and pollution and related problems. There are ever-increasing regulations and demands for proper disposition of wastes, and encouragement of recycling and resource recovery where possible. In the years ahead there will be ever-increasing volumes of waste of all types and the demand for landfill for waste disposal will increase substantially. New regulations limiting the dumping of wastes are likely to be passed in some states and localities. Policy changes of this nature have the effect of changing costs of onsite or landfill disposal. Such changes may also affect the different sizes of hatcheries differently.

New regulations will probably favor firms which are able to utilize their wastes as production inputs over firms which must continue to dump these wastes. Stricter limitations on waste disposal methods may hasten the trend towards larger, integrated hatcheries.

REVIEW OF LITERATURE

Hammond, *et al.* reported on the effect of length of incubation period on the nutritional value of fertile eggs (4). Gladys and Smith prepared a publication on waste disposal by broiler hatcheries in Delaware (3). A limited number of trials feeding hatchery waste to pigs and chickens were conducted by Williman (8), *et al.*, Hammond, (4) *et al.*, Kempster (5), and Wisman (10), *et al.* These workers reported that in general, when properly processed, hatchery wastes could be used as a feedstuff in swine and poultry diets.

In a recent publication, Vandepopuliere (6), *et al.* discussed the feeding of broiler and egg-type chick hatchery by-products in linear programmed diets.

Both hatchery by-product meals produce satisfactory performance, egg production, and feed conversion when fed at 8 and 16 percent levels replacing wheat middlings and meat and bone meal, or soybean meal and ground limestone. No significant differences were obtained among the various treatments. This indicated that the availability of the limiting amino acids and calcium was equal to that in the ingredients replaced. The laying hens' dietary requirements for calcium are considerably higher than those of non-laying poultry. The work indicated that since hatchery by-products contained a relatively high level of calcium, laying diets appear to be a natural area to utilize the product. These feedstuffs can, however, be used in rations for all poultry species. The quantity should be restricted to a level that would meet dietary calcium requirements.

COMPOSITION OF HATCHERY WASTE

The nutrient profiles of the various types of hatchery waste differ due to the makeup of the raw product. Broiler and turkey hatchery wastes are somewhat lower in protein and higher in calcium than egg-type chick hatchery wastes because the male broilers and turkeys are used in the grow-out program while the males of the egg-type chick hatch are destroyed as soon as the chicks are sexed. In general, it is expected that hatchery-type product protein content will decrease and the calcium level will increase as hatchability increases.

While the turkey hatch is normally lower than the chicken hatch, for the same percentage hatch of broilers and turkeys the turkey hatchery waste would tend to be slightly higher in protein and a little lower in calcium as the turkey egg is larger and the amount of shell required to enclose a given volume of material is less with a larger sphere or oval.

Table 1 provides nutrient profiles to enable a general comparison of two types of hatchery wastes. Information is not yet available on the composition of turkey hatchery wastes. The original moisture content of the egg-type chick hatchery wastes is higher because of the destroyed male chicks that are included in the waste. Amino acid values are reported in the same paper.

Table 1

COMPOSITION OF HATCHERY WASTE

	Chick; Broiler		Chick; Egg-Type
	%		%
Original moisture	65.00		71.00
		Dried Basis	
Protein	22.20		32.30
Calcium	24.60		17.20
Phosphorus	0.33		0.60
Fat	9.90		18.00

Source: Vandepopuliere, J. M., *et al.* (7).

Additional chemical composition of hatchery wastes was reported by Wisman (9). The 26.0 percent crude protein observed would indicate a slightly reduced level of hatchability from what hatcheries are currently experiencing. It was assumed that this was from a broiler chick hatchery although the research paper did not specifically state this.

ESTIMATE OF TOTAL QUANTITY OF WASTE

Hatchability of the egg-type hatching eggs will range from 90 to 95 percent, broiler eggs, 83 to 87 percent and turkey eggs, 68 to 72 percent under normal hatchery conditions. Using these hatchability ranges, it is possible to estimate the hatchery wastes produced in the U.S. on an annual basis. Table 2 presents hatchery waste on a wet and dry matter basis.

Table 2

ESTIMATE OF HATCHERY WASTE PRODUCE ANNUALLY U.S. 1975

Species	Wet	Dry Matter
	Tons	Tons
Chicken broiler	56,000	22,000
Egg-type chick	20,000	6,000
Turkey	8,200	2,600

Source: Calculated from Chicks and Turkeys Produced - 1975. SRS-USDA.

The value of hatchery by-product as a feeding ingredient will vary according to the type of hatchery. The most valuable by-product will be produced from the commercial egg-type hatcheries with turkey hatcheries next and chicken broiler hatcheries last. The market value of hatchery by-products will vary also depending on the market value of the ingredients that they replace in the diet. If value of hatchery by-product meals is calculated, using ground corn at $106 per ton, soybean meal of 44 percent at $160 per ton, and ground limestone at $14 per ton, diets containing broiler-type hatchery by-product or egg-type chick hatchery by-product provide estimated values of $111 and $154 per ton respectively, air dry basis. These ingredient values provide guidelines as to limitations a hatchery would have in establishing maximum processing cost that would permit the production of a profitable product.

FACTORS IN THE CHOICE OF A DISPOSAL METHOD FOR HATCHERY WASTE

The hatchery industry has been in a continuous state of transition with small, independent hatcheries being replaced by larger, integrated operations. New approaches are needed in many areas. Waste disposal is one such area.

No one method of waste disposal is best for all hatcheries. Some factors which need to be considered in arriving at a choice of an optimal disposal method for any particular hatchery include the size of hatchery, both in terms of numbers of eggs hatched, and in land available for on-site waste disposal.

In years ahead there will be ever increasing volumes of waste of all types. In the absence of recycling or other waste recovery methods demand for landfill for waste disposal will increase substantially. New regulations limiting the dumping of waste are likely to be passed in most localities and states. Policy changes of this nature have the effect of changing the absolute cost of on-site or land fill disposal. Such changes also affect the different sizes of hatcheries differently.

Future regulations will probably favor firms which are able to utilize their waste as a production input over firms which must continue to dump these wastes. Stricter limitations on waste disposal methods may hasten the trend toward larger integrated hatcheries.

A plant section that recycles processed hatchery waste through poultry feeds can be a profit center for the larger hatcheries. For smaller hatcheries, recycling offers little opportunity due to the limitation of processing equipment. In an area where there are a number of small or medium-sized hatcheries, it is possible that they could pool their waste and collectively produce hatchery by-product meals. In such a cooperative project, a strict quality control program would be extremely important. The possibility of recycling will depend upon individual circumstances facing each firm.

The greatest economic return from hatchery by-product meal production can be realized by using it at the optimum level in all feeds that are manufactured at a given location. Since the ingredient supply is continually changing with respect to availability and price, the value of hatchery meal will change also.

Converting current hatchery waste products into high quality feedstuffs could result in a substantial additional income to the poultry industry. Why is recycling of hatchery waste not a general practice? The major reasons include: (1) most hatcheries lack sufficient volume of waste to justify the economic investment in equipment. Many are too small to process their wastes profitably; (2) processing procedures have not been worked out satisfactorily for the dehydrators that are available; (3) hatchery by-products have not gained wide acceptance because feed manufacturers are concerned with potential disease control problems or other factors related to quality control.

Although experimental trials show no evidence of increased disease or mortality in flocks fed processed hatchery by-products, such trials have been conducted under laboratory conditions. Similar results might not be obtained under field conditions. Quality control on hatchery waste from the time the chick is pulled until it is processed is an extremely important area. Research can demonstrate results under actual field conditions to help win wider acceptance of hatchery by-products. Ultimately, the decision to use hatchery by-product meal as feedstuff will depend on disposal costs, production costs, processing performance and net benefits.

One major factor limiting the production of hatchery by-product meal is the lack of processing equipment of small enough size (operating eight hours a day) to handle the quantity of products produced in small hatcheries that set up to 100,000 eggs per day. A small commercial dryer, available for use in hatchery operations, is rated at removing 1,000 pounds of water per hour. This dryer would accomodate a hatchery that could set 400,000 eggs a day. Smaller hatcheries could use this type of equipment, operating it a shorter period of time each day. However, the capital investment per ton of finished product would increase. This problem will be alleviated partially in the future by the trend to bigger hatchery sizes. Equipment manufacturers also could become more willing to produce small equipment as the interest in processing hatchery waste increases.

COST OF PRODUCING HATCHERY BY-PRODUCT MEAL

An economic analysis of dehydration of poultry waste has been prepared by H. V. Walton and J. M. Vandepopuliere at the University of Missouri-Columbia. Table 3 takes into consideration the various items in operating a dehydrating plant such as annual equipment depreciation, interest, maintenance, repairs, insurance, and taxes. The table also covers variable factors such as dryer costs, labor costs, and hatchery size. The larger volume of waste from the egg-type hatchery of the same size lowers the cost per ton. A 100,000 capacity egg-type hatchery has a cost of $58.03 per ton, versus $74.68 for the same size broiler hatchery. The table also shows the effect of higher labor costs and higher capital investment costs on the production of hatchery waste.

Table 3

CALCULATED PRODUCTION COSTS FOR DEHYDRATING HATCHERY [1] BY-PRODUCTS FOR EGG AND BROILER TYPE HATCHERIES

Dryer Capital Investment Costs	Labor Cost	Broiler Hatcheries		Egg-Type Hatcheries	
		Eggs Set per Day			
		100,000	150,000	100,000	150,000
($)	($ per hr.)	Air Dry Basis - $ per Ton			
25,000	3.00	74.68	54.79	58.03	46.48
	4.00	88.19	63.80	65.87	51.71
30,000	3.00	78.51	57.34	60.25	47.97
	4.00	92.02	66.35	68.10	53.20
35,000	3.00	82.35	59.90	62.48	49.45
	4.00	95.86	68.91	70.32	54.68

[1]Assumes daily operation for a five-day work week
Source: Walton, H. V. and J. M. Vandepopuliere, unpublished material.

A number of poultry operations have invested in manure dehydrating equipment. It might be possible to utilize some of this equipment to process hatchery waste. It is important, however, to recognize that the two types of products that are being processed are markedly different and require entirely different processing procedures.

COST OF HATCHERY WASTE DISPOSAL

The waste disposal process involves two stages: (1) removal of cull chicks, unhatched eggs, and shells from the incubators, and (2) transporting the material to a site for disposal. Incubator cleanout is the most costly phase of the hatchery waste disposal process. The cost of removing egg shells and cull chicks is incurred regardless of the use of the waste. In evaluating alternate systems, therefore, only costs incurred after incubator cleanout are relevant.

In the Gladys and Smith study (3), the cost of removal of material from incubators in Maryland accounted for 83.6% of the total waste disposal costs. Because of the labor-intensive nature of incubator cleanout, all available economies of scale were achievable at a relatively small level of hatchery output. However, costs observed were extremely variable, indicating that incubator cleanout is one area in which improved management practices may yield significant savings.

Table 4 shows the average cost of waste disposal, in Maryland, both on a per ton basis and on a chick hatch basis. As can be seen, average costs of waste disposal tend to decline as the hatch and volume of waste increase.

TABLE 4

COMPARISON OF COST OF WASTE DISPOSAL FOR TWELVE HATCHERIES

Annual Hatch (000) (eggs)	Total Waste (Tons)	Waste Disposal Cost ($)	Waste Disposal Cost per Chick (¢)	Waste Disposal Cost per Ton ($)	Disposal Method (1)
516	9.1	700	.1356	76.92	B
2,335	53.4	779	.0334	14.59	A
2,396	48.0	1,193	.0498	24.85	B
2,970	54.4	1,061	.0357	19.49	A
3,791	94.1	1,800	.0475	19.12	B
5,406	81.4	1,051	.0194	12.91	D
6,229	114.0	765	.0123	6.71	B
6,236	119.5	1,704	.0273	14.25	B
14,255	249.0	4,767	.0334	19.14	C
17,473	350.3	4,352	.0249	12.42	A
21,683	434.8	6,442	.0297	14.82	A
25,920	496.8	5,579	.0215	11.22	D

(1)A - disposal on own property.
B - pick up for disposal at landfill.
C - operator hauls own waste to landfill.
D - delivery to swine producers.
Source; Gladys and Smith (3)

The disposal costs incurred after cleanout varied from $0.63 to $3.00 per ton (3). The firms with the lowest per unit cost of waste disposal also tended to have the lowest ratios of cost incurred after cleanout to total costs.

The costs for firms disposing of waste on their own property are overstated because no fertility value is imputed to the waste. Real cost to these hatcheries will depend upon such diverse factors as distance to landfill, charge for use of landfill, degree of development in the area around the hatchery, property values near hatchery, legal restrictions on waste disposal, and other factors.

NEED FOR FURTHER RESEARCH

The data available suggest that with large integrated operations having both a hatchery and a milling operation in close proximity to each other, recycling hatchery waste through the feeding program is feasible. Yet various studies indicate that there are potential production and quality problems associated with attempting to convert hatchery waste to feedstuffs. The prospects for recycling hatchery waste as feedstuffs appear bright as additional research information becomes available.

Specific research is needed to determine the type of equipment and minimum size unit for which on-site processing of hatchery waste is feasible. There is also a potential for developing better equipment. An integrated firm drying manure from its laying or breeding operation may be able to use its dehydration equipment for processing hatchery waste. Research is needed to evaluate the effect of dehydrating equipment on product quality and to determine possible contamination resulting from drying manure and hatchery waste in the same dryer.

SUMMARY

Sufficient nutritional research has been conducted indicating that properly processed hatchery by-products can be utilized as a feed ingredient in poultry feed. Several factors such as available supply, processing costs, and utilization in relation to cost of disposal will determine the feasibility of producing a product at a given location.

While studies are available on the nutritional value of poultry and hatchery by-products and the results have been generally favorable to the use of these products, only limited data is available on cost associated with processing these products.

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