

## SUGGESTED RESEARCH ON EATING BEHAVIOR IN CHICKENS

For the sake of convenience the topic may be broken down into three categories:

- A. Physical properties of the feed,
- B. Feeding conditions,
- C. Properties of the chicken.

A. Physical properties of the feed. How does a chicken discriminate between feeds? How do they discriminate between feed and non-feed (saw-dust, rocks, etc.)? There is considerable experimental evidence to show that if the senses of taste and smell exist at all in chickens, they are poorly developed.<sup>1</sup> There are, however, other physical properties on the basis of which discriminations could be made:

1. Specific gravity (density)
2. Hardness
3. Surface texture
4. Color (hue, saturation, and intensity)
5. Light reflecting properties
6. Size
7. Combinations of these

After isolating the controlling factors, one would hope to be able to give to a manufactured feed such physical properties as to cause greater consumption. By an optimal combination of physical properties it may be possible to make a less "palatable" feed as desirable as the most preferred feed. Also, it may be possible to improve on nature by developing a feed that is more attractive than any natural feed.

### B. Feeding conditions.

1. Intermittent feeding. Our experiments have shown that a hen may consume her full daily ration at one time when fed once a day. On the other hand, it is common practice to let chickens eat ad libitum. How would food consumption vary for intermittent feeding schedules between these two extremes?
2. Variable pay-off. What would be the effect of having an automatic hopper deliver less than a full round of feed (i. e., with a group of, say, 12 hens, the hopper would deliver on the average only 8 pellets or grains)? Such a set-up should promote competition for the available food. Would this result in greater food consumption? What would happen to the more submissive chickens?
3. Self-operated feeder. What would be the effect of a feeder which the chicken operated by some simple response such as pulling a string? (Training could be automatic.)
4. Stimuli correlated with presentation of food (discriminative stimuli).

- a. Stimuli which regularly precede the presentation of food eventually exert a marked influence on responses associated

with feeding. By the proper arrangement of such stimuli it may be possible to elicit greater than normal eating behavior.

- b. Are there stimuli which innately elicit eating responses? Two possibilities occur off-hand: rattling sounds such as grain falling on a resonating surface, and movement of the feed such as bouncing or scattering grain. Perhaps such movement might elicit the natural pursuit responses, as when a chicken chases a grasshopper. Would this increase eating responses? These two types of stimuli could be easily arranged by means of an elevated hopper which dropped the feed onto an inclined board whence it would fall into the eating trough.

5. Presentation of one type of food contingent upon eating another type of food. What would happen if a chicken were required to eat a pellet (or two) of mash in order to get a piece of grain?

- C. Properties of the chicken. What makes a chicken cease eating? This is perhaps a more cogent question than "Why does the chicken start eating?" for if a set of conditions can be found which will postpone the "cease-eating stimulation," the chicken may consume more feed in the usual eating situation.

As we know, a chicken may fill its crop and cease eating in a few minutes. Since it is unlikely that the digestion could have progressed far enough in this time to change the basic physiological condition of the body, the "cut-off" mechanism must be associated with the state of the crop after feeding. There are experimental studies of the pigeon showing that the crop behaves (in a motivating sense) like the human stomach in that it exhibits rhythmical contractions beginning 30 to 45 minutes after feeding and increasing in frequency up to 6 hours. Filling the crop causes cessation of contractions in the part filled but not in the unfilled part.<sup>2</sup> Contractions of the human stomach have been shown to be correlated with hunger pangs.<sup>3</sup> The inhibitions of eating responses arising from a full crop might result from several conditions:

1. Pressure caused by feed,
2. Weight of crop contents,
3. Chemical action of food on the walls of the crop.

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<sup>2</sup> Warden, C. J., Jenkins, T. N., Warner, L. H., Comparative Psychology, Vol. III., p. 207-208.

<sup>3</sup> Wada, T., Arch. Psychol., 1922, no. 57.

## PRELIMINARY EXPERIMENTS ON EATING BEHAVIOR IN CHICKENS

The experiments described below are purely exploratory in nature, and are not to be regarded as final in any sense. They have, however, suggested some interesting possibilities for more extensive research.

### Open Crop Experiment

The chicken used in this experiment had been on a daily feeding schedule of 80 grams ( $2\frac{2}{3}$  ounces) of pellet mash and 20 grams ( $\frac{2}{3}$  ounces) of growing grain, fed once a day for 6 months. On the day of the experiment she was fed, at the usual time, 80 grams ( $2\frac{2}{3}$  ounces) of whole corn. Her crop was then slit at the bottom, and the corn was removed. She ate immediately the corn which fell from her crop; there seemed to be no pain or disturbance of any kind, and very little bleeding. When placed in a wire-bottomed cage with a large pan of corn, she ate about 60 grams (2 ounces), then slowed down and began merely to peck at it and throw it around. However, when supplied with growing grain, she ate a full pound between 3:30 P.M. and dusk (7:00 P.M.), all of which, of course, dropped out of her crop and through the screen floor. The following morning, she consumed another 90 or 100 grams (3 to 4 ounces) between daylight (about 7:30 A.M.) and 8:30 A. M. She then stopped eating, but when presented with pellet mash, she ate 160 grams ( $5\frac{1}{3}$  ounces) during the course of the day. The chicken was killed at the conclusion of this experiment.

The implication is that the mechanism which leads a chicken to stop eating lies chiefly in the crop; if the crop fails to fill up, the chicken will continue to eat. Eventually, of course, the chicken will stop because of weakness or thirst (at least we know that in an intact animal a strong thirst drive will inhibit eating). There is some indication that some sort of extinction of the eating reflexes may take place--i. e., when the eating responses fail to be reinforced by later members of the chain of reflexes (filling of the stomach, passage of the food to the gizzard, etc.), the eating responses weaken. Here the eating responses connected with growing grain apparently weakened in some such fashion, but those concerned with eating mash had not yet been thoroughly extinguished; hence the chicken consumed some mash. This hypothesis, of course, must be considered tentative until it is tested on other chickens.

### Weight of Crop Contents as a Variable in Food Consumption

A chicken weighing  $3\frac{7}{8}$  pounds, which had had nothing to eat for 48 hours, was first tested for strength of eating behavior by presenting pellet mash and corn, both of which she ate avidly (only a few grains of each were given). No. 4 lead shot was then poured into her crop  $2\frac{1}{2}$  ounces at a time; after each dose, she was again tested on mash and corn. At each presentation, she ate both types of feed avidly; little, if any, slackening was noticed as her crop became heavier with shot. Later in the experiment it was noticed that corn was preferred to mash, and that this difference was accentuated as the experiment progressed. The injection of shot was

stopped after the chicken had been given 1 1/4 pounds, as she was beginning to have difficulty in keeping her balance. She was then placed in a cage with 500 grams (1 pound, 2/3 ounces) of pellet mash, of which she ate 160 grams ( 5 1/3 ounces).

This experiment indicates that weight of the crop contents as such is not the variable which leads the chicken to stop eating. Other factors such as distention of the crop or chemical action of the crop walls must be considered (we hope to deal with these in the near future). The 1 1/4 pounds of shot did not occupy in the crop anywhere near the space that a similar weight of food would require (specific gravity of lead = 11  $\frac{1}{2}$ ), and apparently, as long as there is room for food, the chicken will eat.

### Feeding to Satiation

Eight chickens, on a feeding schedule which gave them once a day 80 grams (2 2/3 ounces) of pellet mash and 20 grams (2/3 ounces) of growing grain, were allowed at their usual feeding time to eat to satiation. Four (Group A) were allowed to eat all the pellet mash they would consume; then their food cups were cleaned out and they were given growing grain. The other four (Group B) were given all the grain they would consume, then pellet mash. All had water available all through the experiment. Under these circumstances, Group A ate an average of 167 grams (5 1/2 ounces) of pellet mash and 12 grams (2/5 ounces) of growing grain. Group B ate an average of 292 grams (9 2/3 ounces) of grain and 5 grams (1/6 ounces) of mash. There is very little difference in the weight per volume of these two types of feed. It should be noted that the number of chickens in each group is quite small and not too much importance can be attached to the difference between them in amount of feed consumed. Group A averaged 39 minutes, Group B 47 minutes to eat to satiation.

This experiment indicates that a chicken is capable of eating more than the usual daily ration (1/5 to 1/4 pound, or 100 to 120 grams) and under proper circumstances will eat more. There were no instances of harmful results in any of the chickens. Other side phenomena were observed: every time fresh feed was added to the cup, the chickens ate with more vigor. The chickens which had had mash to start with ate the grain quite avidly, even though their crops were considerably distended. Those who had been fed grain first were considerably less eager about the mash; they had, of course, on the average, eaten more feed at this point. The grain eaters became quite selective as they neared satiation, picking out certain grains and leaving others.



## Experiments on Eating Behavior in Chickens

### Crop Pressure

As previously reported in the lead shot experiment, weight of crop contents is apparently not the factor which inhibits eating responses. The following exploratory experiment was conducted in order to test the hypothesis that pressure in the crop exerts the inhibiting action.

The chicken used in this experiment had been without food for 48 hours. Water had been available at all times.

An automobile inner tube valve stem was fitted into the orifice of an ordinary rubber balloon, and the hose of a bicycle pump was screwed into the valve. The balloon was then inserted into the crop of the chicken through the esophagus and was inflated by means of the bicycle pump until the crop was quite taut. The hose connection was then unscrewed and the hose removed, leaving the crop inflated with the balloon.

The chicken's eating responses were then tested by presenting it with a box of feed, including Larro pelleted mash, Larro growing grain,<sup>1</sup> and whole corn. At the sight of the feed, the chicken showed a brief flash of excitement, approached the feed in an eager manner, and for a moment it seemed that the eating responses might be at their normal strength. However, the instant that the hen began to emit a pecking response, the eating reflexes were completely inhibited so that the chicken seized one grain but released it without eating. Rattling the grain in front of the chicken caused the eager approaching response to be emitted again but the responses were so inhibited that the actual eating reflexes would not occur.

The chicken was then placed in her home cage with 80 grams of growing grain. The stimuli of the home situation where the chicken was usually fed were apparently sufficient to strengthen the response so that half a dozen pecking responses to the feed were emitted. However, this was the extent of all eating behavior, and after two hours in the cage the chicken still had consumed none of the grain.

The chicken was then removed from the cage and placed upon the experimental table. Grain was again offered, but no responses at all were made. A small penknife was inserted through the crop, puncturing and deflating the balloon. This required about 10 seconds. The hen was then placed on the table with the growing grain, where she ate energetically at once. This was a striking phenomenon: one moment, no eating responses at all; ten seconds later, very strong eating behavior, just as if a switch had been turned on. The hen was then returned to her home cage where she consumed her normal daily ration.

It appears, then, if we can trust these experiments employing only one chicken each, that the inhibiting mechanism for eating behavior is not the weight of the crop contents but the pressure exerted in the crop by the contents. It is true that there may be an interaction factor in which weight and pressure combine to effect an inhibition. We have not as yet tested this.

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<sup>1</sup> This chicken is normally fed a ration of growing grain and pelleted mash.

### Specific Gravity

In order to test the chicken's acceptance of pellets of increased specific gravity, a special die was constructed by means of which it was possible to fabricate reasonable facsimiles of the ordinary Larro hen size pellets. The pellets were fabricated by filling the female die partially full of Larro broiler mash and then with one stroke of the press partially compressing this. Then one No. 2 lead shot 1/8 inch in diameter was added, a small bit of mash placed on top of this, another stroke of the press, then another shot added. The remaining portion of the mash was put into the female die and the whole squeezed into a unit pellet.

With the press used it was not possible to squeeze the pellet as firmly as is done in the factory operation. However, because of the addition of the lead shot, the specific gravity of these pellets ranged from about 2.5 to 4.3, depending on their length. Except for the fact that these pellets were square on the ends and did not have as high a gloss on the side due to the low pressures involved, they were not unlike the ordinary Larro pellets.

When the experimental pellets were offered to the hens they accepted them readily, showing no hesitation whatsoever except when, occasionally, a pellet would break and the shot would come out, the hen would investigate the shot, picking it up in the beak but always rejecting it. Otherwise they swallowed the pellets just as they do the standard Larro pellets.

It thus appears that the tolerance for increased specific gravity in the hen is well beyond any range of density attainable by compression.

Prior to the construction of this die I talked to Mr. James of the Mechanical Division with regard to the problems involved in the compression of Larro egg mash into pellets of increased density. Mr. James was of the opinion that the pellet now fabricated by the Larro mills is a fairly dense pellet and that the pressures involved are considerable already. He doubted the possibility of further compressing the pellets beyond 10 per cent. or so.

X The experiment, thus far, of course, only shows that chickens will accept pellets of increased specific gravity. We have no indication that chickens will actually eat a greater weight of such pellets. This can be tested only after fabrication of enough pellets of increased density to run feeding experiments for a period of time. With the die we now have it is not possible to attain the required pressures or volume output for this kind of test.

### Surface Properties

X A number of exploratory experiments have been carried out on the surface properties of the feed in order to determine a starting point for more elaborate and better controlled experimentation. We have fed chickens pellets painted black, corn

painted black, corn painted partially black, wooden pellets made from hardwood dowel, air rifle shot coated with wax, pellets coated with wax, pellets wrapped in tin foil, pellets coated with Duco cement, pellets coated with shellac, pellets coated with shellac and dipped in flour, and capsules filled with mash.

To date no pattern has evolved from this experimentation, and we are at the moment thoroughly confused. Consequently, I am withholding detailed reporting on these experiments until next month, at which time we hope that some unifying principle will have revealed itself.

The only suggestion of a principle at the present time has to do with the learning theory of eating behavior. This is indicated by two results which we have obtained.

First, the capsule experiment: when the hens were presented with the capsules filled with Larro mash, they seized the capsules in an exploratory way, rattling them in the bill, and striking them on the floor of the cage as if trying to break them open. However, they did not eat the capsules until one was opened and the egg mash eaten separately. After that the chickens began to swallow the capsules without further exploration.

Secondly, in order to test the unlearned strength of behavior for various physical stimuli with regard to eating responses, a dozen day old chickens were obtained. Numerous substances were glued to identical pieces of plywood and presented to the chicks one after another, on the theory that we would get the native strength of response here, without the factor of reinforcement entering in. There were numerous things on the boards: air rifle shot, Larro pellets, corn, various grains from a package of canary feed, cake decorations, various colors and shapes. All in all the whole experiment was a simple exploratory study to try to determine if there was any strong native behavior to any particular type of stimulus pattern.

This experiment was going along smoothly and we had just presented the whole corn board, to which the chickens made no pecking responses at all. We then put in the board which bore the small canary seeds. The chicks made a few lackadaisical pecks at these seeds, in the course of which some of the seeds came off. These were seized by the chicks and eaten. All the chickens then became greatly excited and started pecking frantically at the seeds. All the seeds were finally dislodged from the board and eaten. There was a very marked increase in the activity of the chickens.

Now we reinserted the board with the whole corn on it, and we must remember that no responses were made to this board previously. The chickens now became greatly excited and pecked frantically at the grains of corn. This board was left in for 10 minutes during which time several thousand responses (too fast to count) were made to the grains of corn. An extinction process took place in which the chickens gradually pecked with less and less frequency and with ever diminishing energy at the grains.



This strong pecking behavior to the corn must presumably be due to some effect from the experience with the canary seeds. Some of the reinforcing effect from eating the seed apparently generalized to the corn through similarities in the two stimulus patterns. Similarly in the capsule experiment, the chicken's eating behavior was so strengthened by the mash that the capsules also became adequate stimuli and were eaten. These interpretations are, of course, tentative.

### Conditions of Feeding

Background. It has been found in previous experiments that chickens will eat up to 50 per cent. more feed when, after having been satiated in isolation, they are placed in the environment with another hungry chicken which is eating. This is presumably due to some sort of competition factor in the chicken. It is also generally known in behavioral experimentation that any stimulus which is consistently associated with the presentation of a reinforcing state of affairs comes to have in itself considerable control over the elicitation of the response normally tied up to the reinforcement. The following experimental situation represents an attempt to utilize both of these principles simultaneously to make the chicken eat more feed per unit of time.

The food was presented in a series of small amounts, never enough so that there was enough to go around. In this way it was hoped that the competitive aspects of the chickens' behavior would be augmented. At the same time a definite stimulus was given just prior to the presentation of the food or simultaneously with it. This, it was hoped, would take on the characteristics of a discriminative stimulus and strengthen the eating behavior.

The Animals. The animals used in this experiment were 23 White Rock chickens obtained from the Hartmann Poultry Farm, Wayzata, Minnesota, on March 11, 1949. They had been hatched February 3<sup>1</sup> and had been raised on the new Larro broiler mash under battery conditions. They were apparently in good health, although we have had to isolate one bird because of a suspected fowl paralysis and another died at the time of writing this report, after the data had been collected and analyzed.

The Experimental Situation. Eleven birds were assigned to the control group and 12 to the experimental group. The birds were placed in adjacent pens 4' x 4', 30" high, with wire mesh covering the sides and the top. Special hovers were constructed for them, electrically heated to about 70° and thermostatically controlled. They were equipped with standard waterers and feed troughs. A 40 watt light bulb was placed in each pen and was on at all times.

These pens were located in a basement barn where the temperature during the early part of the experiment occasionally fell to 20° or 25° so that the waterers froze during the night. A tarpaulin was spread over the pens for extra warmth. Equal amounts of warm water were given each morning, of sufficient warmth and quantity to last throughout the day.

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<sup>1</sup> These chickens, I was told by Mr. Hartmann, were 3 weeks old on the purchase date. However, we discovered later, much to our chagrin, that they were nearer 5 than 3 weeks old.



For the first week after the chickens were purchased, they were fed on straight Larro broiler mash. At the end of this time they were weighed and leg-banded. The control group was continued on the same program with the exception that a half cup of Larro chick size pellets was spread over the mash each morning and another half cup at night.

A special feeder and timing device was constructed for the experimental group. The feeder consisted of a solenoid driven device which delivered, when an electrical contact was made, a small quantity of pellets from a hopper standing two feet from the floor, in such a manner that the pellets rolled down an inclined plane of plywood and spread out into the trough below. The timing device consisted of a synchronous motor actuating an inverted pendulum with a mercury switch attached. A screw adjustment made possible the delivery of a range of 5 to 10 impulses in a closely grouped pattern, so that when the timer was running, every 2 1/4 minutes a series of electrical contacts was made with the feeder solenoid, causing it to click sharply from 5 to 10 times, at the same time releasing small quantities of pellets which fell into the feeder below.

The number of hours per day during which the feeder was allowed to operate was determined largely by the behavior of the chickens. An effort was made to prevent the chickens from hearing the sound of the feeder when they were no longer eating. Thus an attempt was made to turn the feeder off when the chickens ceased to eat the pellets which it delivered. The actual length of time during which the feeder operated then varies somewhat from day to day, but the general pattern was 3 to 4 hours in the morning and 3 to 4 hours in the afternoon.

The results of this experiment are presented below.

Table I  
Feed Intake

Date	Group		Mash	Control	
	Experimental N = 12			N = 11	
	Grams of Pellets			Grams of Pellets	
3-21-49	928		.	160	
3-22-49	1208		.	160	
3-23-49	1008		.	160	
3-24-49	1125		.	160	
3-25-49	1475		.	160	
3-26-49	1000		.	160	
	<u>6744</u>		<u>8.75 lbs.</u>	<u>960</u>	
	(14.85 lbs.)			(2.11 lbs.)	
				(10.86 lbs. total)	
Total lbs. per bird	1.24			.99	
Lbs. per bird per day	.21			.16	

Table II  
Weight Gains

Experimental Group N = 12				Control Group N = 11			
Bird No.	Init. Weight	Final Weight	Diff.	Bird No.	Init. Weight	Final Weight	Diff.
8	12(oz.)	21(oz.)	9(oz.)	4	20(oz.)	24(oz.)	4(oz.)
42	18	26	8	11	16	19	3
3	18	25	7	33	19	25	6
1	19	24	5	49	17	19	2
31*	14	16	2	22/	14	16	2
24	18	25	7	21	22	28	6
40	20	25	5	29	22	27	5
20	19	25	6	12	18	23	5
17	18	23	5	43	15	19	4
15	19	25	6	38	22	25	3
41	22	28	6	23	22	28	6
28	20	28	8				
Sum	217	291	74		207	253	46
Mean	18.1	24.3	6.2		18.8	23.0	4.2

Difference between mean gains: 2.0 ounces

$$\text{Significance of difference: } k = \frac{\text{mean difference}}{\text{standard error of mean difference}} \\ = \frac{2.0}{.64} = 3.1$$

The probability (obtained from tables of the normal curve) is less than 2 in 1000 that a difference this large would be obtained solely through sampling errors.

\* Bird isolated shortly after experiment because of suspected fowl paralysis.

/ Bird died soon after experiment.

From Table I, we see that the food intake of the experimental birds was considerably greater than that of the controls. Also, from Table II, the weight gains of the experimental birds were considerably greater. This difference, as seen from the table, is statistically significant. The number of birds used did not really warrant use of normal curve tables (generally speaking, N should be 20 or above) and a t test would have been more appropriate. However, we were not able to obtain tables of the probability integral of t in time for this report. The probability integral of the k obtained is so low that there is a good chance that we are dealing with a real difference.

The experimental birds were by and large much better feathered than the control birds. This is probably due to the fact that they spend more time out from under the hovers where the temperature was considerably lower. It is possible, of course, that the lower temperatures to which these birds were exposed also

account for the greater food intake.

All things considered, the results of this experiment up to the time of preparation of this report seem to warrant further investigation. The experiment is being continued with some minor variations, and we expect that more significant data will emerge as the conditions approach the optimal.



# CONDITIONS OF FEEDING

## Part 1

The first part of this report describes the continuation and conclusion of the experiment reported under this heading in the progress report of 4-1-49.

As will be recalled from this earlier report, two groups of chickens, 10\* in the control group and 11\* in the experimental group, housed in adjacent pens which were illuminated with 40 watt light bulbs and provided with thermostatically controlled hovers, were fed on different schedules: the control group was fed ad lib. according to the method described in the Larro Broiler Book. The experimental group was fed by a special mechanical feeder, described in the previous report, which delivered every 2 1/4 minutes small quantities of pellets in such a fashion as to encourage the chickens' competitive behavior toward the feed.

Table I gives the daily intake of feed in grams for the experimental birds, the amount of mash supplied the control birds (in pounds), and the totals for each group in pounds, pounds per bird, and pounds per bird per day.

Table I Feed Intake Group		
Date	Experimental (in grams)	Control (in pounds)
3-27	500	7.00
28	1375	
29	1375	
30	1125	8.00
31	1125	
4- 1	1500	10.50
2	1000	
3	1000	
4	1250	
5	1250	
6	1000 x	
7	1000	
8	1000	10.00
9	1250	
10	1187	
11	1250	
12	1250	11.00
13	1687	
14	1625	
15	1500 x	
16	1250 x	10.00
17	1125	
18	1375	
	27999 gms.	56.50 lbs.
		Less 1.75 lbs. left in trough
		54.75 lbs. consumed
Pounds per bird	5.61	5.48
Pounds per bird per day	.244	.238

\*Numbers remaining in the groups after the death and illness previously reported.

From these results it appears that the experimental group maintained a slight edge over the control in food consumed but the difference is very slight and no doubt statistically insignificant.\*

On the days ~~stead~~ in the table, the feeder clogged in such a way that it made its usual sound but delivered no pellets. Hence some extinction of the eating responses conditioned to the sound of the feeder took place. The effects of this are most apparent following April 16, after two days of such mishaps. These unfortunate occurrences are of course an inherent weakness of any mechanical means of feeding.

Table II presents mean weights in ounces and average gains for the two groups from the beginning to the end of the experiment.

Table II  
Mean Weights and Gains in Ounces for  
Both Groups from Beginning to End of  
Experiment

	Mean Weight in Ounces		Mean Gain in Ounces		Diff. (E - C)
	Control	Experimental	Control	Experimental	
Initial	19.3 <sup>X</sup>	18.5 <sup>X</sup>			
3-26	23.7 <sup>X</sup>	25.0 <sup>X</sup>	4.4	6.5	2.1
4- 6	36.0	38.2	12.3	13.2	0.9
4-17	46.8	48.7	10.8	10.5	- 0.3

<sup>X</sup> These means exclude the sick birds noted in the previous report. The means including the rejects were slightly lower. See Table II of report dated 4-1-49, Conditions of Feeding.

From this table it can be seen that although the experimental group maintained its advantage in average weight, its rate of gain steadily dropped until the control group finally surpassed it in gain.

Because of the difficulties involved in the mechanical features of this experiment (clogging, and the inability of this particular feeder to deliver the hen-size pellets), and the failure of the experimental birds to maintain their advantage in weight gain over the control group, it was decided to abandon this experiment and put the birds on a different schedule. However, the early marked differences between these two groups suggest that this experiment should be repeated with new birds and an attempt be made to iron out some of the problems encountered.

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\* Since no individual food consumption records were kept for each bird, it was, of course, impossible to test the significance of this difference.

Part 2

On April 19, 1949, the two groups used in the experiment just reported were switched to a new feeding schedule. The experimental group was fed Larro Broiler Pellets (Hen Size) once a day. The amount to be fed was determined by estimating first how much they might reasonably eat in a day (based on their previous rate of consumption and the amount eaten by the control group), then later in the experiment boosting this amount in an effort to make them eat more. At the end of the day, any unconsumed feed was removed from the trough. The control group, meanwhile, was fed ad lib. on the hen-size pellets. The feed consumption data are presented below in Table III and the weights and gains in ounces on April 28 in Table IV.

Table III  
Amounts of Feed Consumed by Experimental  
Group Fed Once a Day and Control Group  
Fed ad Lib., on Larro Broiler Pellets (H)

Date	Group	
	Experimental (in grams)	Control (in pounds)
4-19	998	13.75
20	1237	
21	1500	
22	1500	
23	1500	
24	1562	8.38
25	1562	
26	1562	
27	1562	11.00
28	1000	
29	750	
Total	14733 grams 32.45 lbs.	33.13 lbs.

Table IV  
Mean Weights and Gains in Ounces for Both  
Groups at Beginning and End of Feeding  
Schedule Experiment

Date	Weight	Group		Weight	Experimental Gain
		Control	Gain		
4-17	46.8			48.7	
			13.1		9.1
28	59.9			57.8	

The results of this experiment are very inconclusive. On April 28, it will be noted from Table III, the food consumption of the experimental group suddenly dropped by a considerable amount. On the 29th it dropped still further.



On subsequent days not recorded in this table the birds were put on an ad lib. schedule but ate very little. Similarly, from Table IV it can be seen that their weight gain was small compared to that of the control group, whose rate of gain jumped considerably once they were switched to hen-size pellets.

The reasons for these results were not determined. The experimental birds were not obviously sick, although they did appear lackadaisical. The bird isolated because of suspected fowl paralysis was from this group. (This bird is still alive, and has apparently recovered from its motor symptoms, but is much stunted in growth.) By examining Tables II and IV in the two parts of this experiment, it can be seen that the advantage in rate of gain of the experimental group has been steadily dropping at every weighing from the first, and the absolute rate of gain decreasing since the second weighing. This also suggests that the health of at least some of the experimental birds may have been failing. The sudden drop in food consumption noted in Table III also suggests such an explanation.

At any rate, this experiment will also have to be repeated in order properly to evaluate the once-a-day feeding schedule.

## THE INFLUENCE OF COLOR ON FOOD PREFERENCE

The Animals. The chickens used in these experiments were eleven White Rocks of mixed sex, hatched March 16, 1949. Prior to the start of these experiments they had been fed on Larro Broiler Mash. Their housing was a floor pen with sawdust litter.

Method. Test feeds were presented to the chickens in their pen in a twelve-cup muffin pan fitted with guard wires to prevent scratching. Test feeds were presented simultaneously in the pan and were assigned to cups in varied order to preclude the formation of position preferences. Each type of feed was weighed on a gram scale before and after feeding, the difference in the weights being taken as the amount eaten. All uneaten feed was discarded and fresh feed was used in each experiment in order to prevent any accumulation of undesirable pellets or extraneous substances. There was little wasting or mixing of feed and the method is probably accurate within 2 or 3 grams.

### Experiment 1

Age of chickens: 33 days.

As a beginning in this series, Larro Broiler Mash, Larro Broiler Pellets (Chick Size) and Larro Growing Grain were tested against each other. 100 grams of each were presented to the chickens on a twelve-hour hunger drive. The feeds were assigned to the cups in the pattern shown below. The pan remained in the pen until the chickens were satiated.

#### Presentation Pattern

P	G	M	-	P = pellets
M	-	-	P	M = mash
P	G	M	G	G = growing grain

#### Amounts Eaten

Growing grain:	88 grams
Mash:	50 grams
Pellets:	5 grams

This experiment indicates a distinct preference for growing grain on the part of chicks who had previously experienced only mash. The chicks ate the grain first, moving to the mash only after the choice grain was exhausted. At the end of the experiment their crops were packed tight.

### Experiment 2: Color

Age of chickens: 33 days.

After considerable trial and error experimenting, a suitable colored feed was developed by using spaghetti and ordinary water-

soluble food coloring.\* The spaghetti sticks were placed in a pan of dye water until a desirable saturation of color was obtained (usually 2 to 3 minutes). Then they were removed and air-dried, after which they were broken to suitable length. After developing a shearing machine for the breaking operation which did not work too satisfactorily, it was discovered that an ordinary food chopper did an excellent job if the spaghetti was thoroughly dry and brittle.

The first experimental batch of colored spaghetti was presented to the chicks seven hours after completion of Experiment 1. The manner of presentation was the same as that described in Experiment 1. The results are given below:

<u>Feed</u>	<u>Amount In</u>	<u>Amount Left</u>	<u>Amount Eaten</u>
Yellow spaghetti pellet	68 grams	49 grams	19 grams
Red spaghetti pellet	43 g "	42 "	1 "
Green spaghetti pellet	29 "	29 "	0 "
Broiler pellets (chick)	50 "	48 "	2 "

Thus the chickens appear to show a distinct preference for the yellow spaghetti.

### Experiment 3

Age of chickens: 3 1/4 days.

This is essentially a replication of Experiment 2 with the exception that the amount of each feed presented was the same (50 grams) for all feeds except the yellow spaghetti. Since it was anticipated that the chickens might eat more than 50 grams of this, 75 grams were given.

The chickens had had no food during the night preceding the experiment. At 9:00 A.M., they were given 150 grams of mash. The experiment was started at 2:30 P.M. The chickens were thus on a moderate drive. The results are as follows:

<u>Feed</u>	<u>Amount In</u>	<u>Amount Left</u>	<u>Amount Eaten</u>
Yellow spaghetti pellet	75 grams	25 grams	50 grams
Green spaghetti pellet	50 "	49 "	1 "
Red spaghetti pellet	50 "	46 "	4 "
Broiler pellets (chick)	50 "	46 "	4 "

Again a clear preference was shown for the yellow spaghetti.

### Experiment 4

Age of chickens: 3 1/2 days.

This is a duplication of Experiment 3 except that the chickens, having been without feed overnight, were fed 100 grams

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\* Samples of this feed are being forwarded.



of mash just before the experiment began. The results are given below:

<u>Feed</u>	<u>Amount In</u>	<u>Amount Left</u>	<u>Amount Eaten</u>
Yellow spaghetti pellet	75 grams	6 grams	69 grams
Red spaghetti pellet	50 "	48 "	2 "
Green spaghetti pellet	50 "	47 "	3 "
Broiler pellets (chick)	50 "	50 "	0 "

Here again the preference is clearly for the yellow spaghetti pellet. Taking all three color experiments together, it seems safe to say (within the limits of these experiments) that chickens raised on Larro Broiler Mash show a clear preference for yellow pellets of spaghetti over red and green pellets similar except for color. Similarly, they seem to prefer the yellow spaghetti to the Larro Broiler Pellet (Chick Size), although in this case there are differences between the pellets with respect to many properties, most notably, size.

#### Experiment 5: Yellow Spaghetti vs. Broiler Pellet

Age of chickens: 37 days.

The chickens were satiated on mash and then presented with equal quantities of Broiler Pellets (Chick size) and yellow spaghetti pellets. The results are as follows:

<u>Feed</u>	<u>Amount In</u>	<u>Amount Left</u>	<u>Amount Eaten</u>
Yellow spaghetti pellet	75 grams	26 grams	49 grams
Broiler pellet (chick)	75 "	74 "	1 "

#### Experiment 6

Age of chickens: 42 days.

This experiment is the same as Experiment 5 except that the feeds were not presented together. Instead, the Broiler Pellets were presented first and only after satiation on these were the yellow spaghetti pellets presented.

<u>Feed</u>	<u>Amount In</u>	<u>Amount Left</u>	<u>Amount Eaten</u>
Yellow spaghetti pellet	75 grams	0 grams	75 grams
Broiler pellet (chick)	75 grams	58 grams	17 grams

Here the Broiler Pellet was given the advantage by being presented first and alone, yet the yellow spaghetti pellet maintained its advantage, not, however, by as wide a margin as before.

#### Experiment 7: Yellow Spaghetti vs. Cracked Corn

Age of chickens: 41 days.

After we discovered the high acceptability of the yellow pellet, the question naturally arose as to how it might compare

corn. This comparison was made by presenting the two together after satiating the chickens on mash. The corn particles were slightly larger on the average than the spaghetti pellets.

<u>Feed</u>	<u>Amount In</u>	<u>Amount Left</u>	<u>Amount Eaten</u>
Cracked corn	100 grams	20 grams	80 grams
Yellow spaghetti pellet	100 grams	40 grams	60 grams

#### Experiment 8: Corn of Different Colors

Age of chickens: 40 days.

Cracked yellow corn was dyed (samples are being forwarded) by soaking overnight in dye water made from food coloring. In this manner samples of red, green, and natural colored corn were produced. The natural colored corn was put through the same process except that no dye was added to the water. The corn was then presented in the usual manner to chicks satiated on mash, with results as shown below:

<u>Feed</u>	<u>Amount In</u>	<u>Amount Left</u>	<u>Amount Eaten</u>
Natural colored corn	50 grams	0 grams	50 grams
Green dyed corn	50 "	50 "	0 "
Red dyed corn	50 "	50 "	0 "

It appears then that for these chickens, at least, the color of the corn is an important variable determining its acceptability.

#### Summary

The experiments conducted so far reveal that color of feed may be a very important variable for the chicken in determining the selection of its feed. These experiments do not reveal whether the response to specific colors is an innate characteristic or one acquired through a specific ingestion history. We are setting up experiments on this aspect of the problem.