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9. ABSTRACT

A status report of a corn-fortification demonstration project in the village of Santa Maria Cauque, Guatemala, during the second year of a five-year project. The purpose of the project is to make fortified corn flour for use in tortillas, persuade the villagers to use this flour, and assess the nutritional effects of its use by monitoring certain health characteristics of families who have been using the fortified flour and those that have not been using it. What the corn flour is fortified with is not stated. However, the fortified and non-fortified tortillas are being randomly sampled each month and analyzed to determine how much protein, total free lysin, and nitrogen they contain. The fortified tortillas are reported to contain 10.5 grams of protein and 497.8 mg percent of free lysin, compared to 8.4 grams of protein and 139.5 mg percent of free lysin in the non-fortified tortillas. Many village families are reluctant to use the fortified corn flour. After 73 weeks of the fortification program, about 40% of the families are using it, and 45% are not collaborating at all. (The other 5% are evidently confirmed vaccillators.) The measurement of effects of the fortified corn flour is focused on pregnant women, newborn infants, and small children. Newborn infants of mothers with good consumption of fortified tortillas have averaged 200 grams more in weight. Work is also proceeding in a study of the anthropometry and mortality in the control village of Santo Domingo Xenacoj.

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CORN FORTIFICATION:

A FIELD DEMONSTRATION MODEL

PROGRESS REPORT

Oct. 16, 1972 - Oct. 15, 1973

REPORT SUMMARY

A. 1. Corn Fortification: A Field Demonstration Model. Contract No. AID-CSD-3357.

2. Principal Investigator: Dr. Leonardo J. Mata
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Institute of Nutrition of Central America and Panama (INCAP)
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3. Contract Period: October 1, 1971 - September 30, 1976.

4. Period covered by report: October 16, 1972 - October 15, 1973.

5. Total AID funding of contract to date: $278,700.00

6. Total expenditures and obligations through previous contract year: $194,675.00 (June 30, 1973).

7. Total expenditures and obligations for current year: $84,025.00 (To March 31, 1974).

8. Estimated expenditures for next contract year: $139,050.00 (To April 1, 1974 - June 30, 1975).

B. During the period of the report the collaboration of about 40% of the families has been assured. Another 45% are not collaborating at all. These groups have remained essentially the same, and will be considered as the experimental and control groups. The fortification has been done without any interruption for a length of 73 weeks. The record attendance to the mill is kept every week. Besides that, the amount of protein, total free lysin and nitrogen in fortified and non-fortified tortillas is determined. The fortified tortillas had increased values when compared with the non-fortified tortillas. An increase of 200 grams in the average birth weight of children being born from mothers having had a good consumption of the fortified tortillas was observed. Mortality in children older than 1 year of age was observed more frequently in the non-cooperative families. A detailed analysis will be done when 2 years of fortification are completed (May 1974). For the future we are planning to increase also the caloric consumption at the village level, in order to compare the impact of an associated protein and caloric increment.

CORN FORTIFICATION MODEL IN GUATEMALA

PROGRESS REPORT

Oct. 16, 1972 - Oct. 15, 1973

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A Work in the Fortification Village: Santa María Cauqué

1. Field Personnel

The personnel presently working in this village consists of:

The Field Director (Dr. Juan J. Urrutia)

The Medical Officer (Dr. Luis A. Reynoso)

One Dietary Investigations Technician (Ms. Bertha García)

Two Laboratory Technicians (Mr. Raúl Fernández and Mr. Lorenzo García)

Two Mill Supervisors (Mr. Gustavo Linares and Mr. Edgar Vega)

Two Mill Operators (Mr. Javier Jitz and Mr. Manuel Cutzán)

Two Home Visitors (Ms. Enma Blanco Tobar and Ms. Elisa Juárez)

One Nurse (Ms. Leticia Juárez)

One Anthropometrist (Mr. Mario Sánchez)

All this staff is supported by the project; three additional nurses are in the payroll of the Direction of Health Services of Guatemala. It was necessary to increase the personnel in order to fulfill the increment in the field activities. The anthropometrist is in charge of the measurements of children other than the cohort children; the new home visitor helps with the dietary surveys of the cohort children plus the cohort of pregnant women.

The additional nurse was hired in order to improve the methodology for the early detection of pregnancies. The second

laboratory technician together with Mr. Raúl Fernández are in charge of the identification of the enteropathogenic bacteria. Dr. Reynoso, who was asigned to the control village, was also necessary in the fortification village in order to help the Field Director in the morbidity and anthropometrical control of the cohort children.

The field personnel has been able to maintain the collaboration of the population. The social work has been incremented in a large scale in order to maintain the collaboration in the corn fortification as well as in keeping the control of the cohort children and the pregnant women.

2. Installations and Equipment for the Corn Fortification

There have not been any alterations in the procedures already outlined in the Progress Report of last year.

3. Implementation of Fortification and Level of Cooperation

Since the 29th of May 1972 to the week starting on 22nd October 1973, the fortification has been done without any interruption for a length of 73 weeks. After a period of 3 months of fortification, during which the fortifying flour was offered to all the villagers, three groups of families were identified in accordance to the level of fortification. In table 1 is presented the level of fortification of the families during 34 weeks, from

the 26th of February to the 21st of October, 1973.

The field dietary investigation technician visits personally every week the families which are showing a tendency to reduce the level of collaboration, in order to encourage them to keep on and give them some advices to solve their fortification problems. The problem of increased water retention in fortified tortillas as well as the bacterial proliferation as was communicated in the Progress Report of last year, has been solved partially. Collaborative families are cooperating in keeping the overnight tortillas uncovered to facilitate dehydration. During the process of making the tortillas, they cooked them a little longer on the hot dish ("comal") to allow water evaporation. Besides that, a significant number of collaborative families go to the mill twice a day in order to have fresh tortillas in their meals. It can be seen that the percent of families not collaborating at all, oscillates from 36 to 48. Very few families are fortifying the "nixtamal" at the level of 1 to 74 percent. A good percentage of families between 35% to 42%, are collaborating on regularly basis every week (at the level of 75-100 percent). Overall, the amount of families in the group of 0-49 oscillates from 45 to 52 percent and the total of families fortifying from 50-100 percent oscillates from 39 to 47. A great effort is being done in keeping

the collaboration of the families at the level of 75 to 100 percent of fortification. This is a consistent group of families and has not shown any significant variation since the beginning of the study. This control of the percentage of fortification has been done through the weekly summaries.

The collaborative families have been helped with the provision of corn at a reduced price in two occasions, the first one around September 1972 to January 1973, when their stock of corn became attacked by insects. It was found that the fortified mixture could not be added to this corn, because the material became very sticky and was impossible to be worked out to make tortillas with it. The second time that corn has been provided to these families started in October 1973. The reason was the scarcity of corn and therefore the increase of the price of this grain, as a consequence of the drought observed last year. That effort will be continued till January 1974, when people will harvest their own corn.

It is important to note that at least 40 percent of the families are collaborating continuously at the level of 50 to 100 percent of the fortification. At the present no effort is being done in convincing the people to change from the non-collaborative to the collaborative group. However, when the Field Director considers that families with malnourished children should re-

ceive the benefit of the supplement, they are visited, to be convinced to accept the fortification; but those families have been reluctant to change.

4. Monitor of Fortification Project

Monitoring is being done weekly by determining the level of fortification per family at the mill level, as reported last year. Besides that, from 100 families selected at random, one tortilla is collected every month to determine protein, total free lysin and nitrogen. In table 2 it is shown the amount of protein and total free lysin on a sample of 87 tortillas obtained during the month of April, 1973. The fortified tortillas gave 10.5 grams of protein against 8.4 in the non-fortified tortillas. The difference is very significant ($p < 0.001$). The amount of total free lysin was also very high in the fortified tortillas, giving a figure of 497.8 mg percent against 139.5 in the non-fortified tortillas. The difference was also very significant ($p < 0.001$).

The results for the chemical and biological assays made on tortillas collected every 4 months are not yet available.

5. Biological Impact of Fortification

Starting on the 29th of May, 1972 a cohort of 50 children of ages ranging from 0 to 26 months, was integrated to observe the

effect of the cohort fortification on the pattern of postnatal growth, morbidity, diet and colonization of the intestinal tract by enteropathogenic bacteria. Besides that, all babies born after the 29th of May, 1972, were also included in the cohort. On the first of July, 1973 a definitive cohort of 70 children was selected. Half of the children belong to families that are collaborating with the corn fortification. The age range of this cohort is from 5 to 73 months. The surveillance of them will be kept until they become 42 months old (3 1/2 years). They are subjected to the frequent dietary investigation, anthropometric measurements, interviews and fecal cultures as it is described in the original Grant Proposal.

Besides that, all babies born in the village are being measured at birth; daily for one week; every week for the first month; every 4 weeks for the first 6 months and then every 3 months. As it is described on the methodology of the Grant Proposal, all children who were born after February, 1964 are still being measured in the following system: Children from 6 months to 7 years every 3 months; children from 7 years and older are measured every 6 months. Radiographies of hand and wrist are taken every 6 months, to determine bone development.

Cohort of Pregnant Women: A total of 182 pregnant women has been identified since the prenatal control was strengthened

in December 1971. The field methodology has been very well established in such a way that the great majority of pregnant women are being identified at about the 7 week of amenorrhea. A total of 121 children has been born since 29th of May 1972, and 62 children have been born from mothers who became pregnant after the first of June, 1972.

An annual bleeding is being done on preschool and school age children to draw comparison between several hematological, biochemical and immunological parameters before and after fortification. Three blood samples have been collected in about 70% of pregnant women, and in about 20% of the other women there is at least 1 blood sample. Every single cord blood sample has been taken. Dietary investigations in the cohort children are being done on weekly basis and every 3 months in the pregnant women, for a total of three interviews.

6. Birth Weight and Other Biological Variables

Two parameters were selected in order to identify any change produced by the fortification.

a) A total of 62 consecutive newborn babies, whose gestation started on the week or after the fortification began, was analyzed to observe any change in birth weight. The average birth weight for a total of the 62 babies was

2592 g ±, which is very similar to the average birth weight for the village before the fortification began. However, when the birth weight was compared in accordance to the level of fortification during the whole length of gestation, it was found that the products of conception from mothers having had a level of fortification from 0-24 percent, weighted 2469 ± 433 g. Children being born from mothers with a percent of fortification from 25 to 74, had an average birth weight of 2723 ± 375 g. And in the group of children whose mothers consumed from 75 to 100 percent fortified tortillas the average birth weight was 2681 ± 370 g. As no difference was found between the last two groups; a separated analysis was done between the birth weights of children born from mothers with 0-24 percent of fortification and in children with 25-100 percent of fortification. The results can be observed in table 3. The difference between both groups is significant at the level of 0.05. Another interesting data is that the amount of premature babies in the non-fortification group is 14%, against 3% in the fortified group.

Further analysis are needed to clarify this point. It is important to remember that there are other variables such as birth order, age and the physical characteristics of

the mother, length of pregnancy, and the synergistic effect of infections and diet. No efforts were done to study the effect of fortification in relation to the time of pregnancy. A detailed analysis will be done in May 1974, after two years of fortification.

b) The second variable analyzed to show the effect of corn fortification was mortality after the first year of life. There were six deaths in children older than one year: one death was observed during the second year, two diet during the third year, another two during the fourth year and one child died during the fifth year. All the children were suffering of second and third degree malnutrition. All the fatalities were observed after the corn fortification started. The lapse of time between the beginning of the program and the time the deaths were observed ranged from 43 to 69 weeks. The average level of fortification was between 0 to 18 percent in four cases; one family fortified at the level of 37 percent; only one case belonged to a family with a 96 percent of participation in the program. The causes of death were as follows: besides malnutrition, five children had diarrhea as the main cause of death, in one case it was a severe dysentery caused by Shigella A1. All those children belonged to the group, with a bad participation in the

program of corn fortification. The child that belonged to the family with a collaboration of 96 percent, was killed by an acute bronchopneumonia.

It is important to report these cases, because mortality after the first year is usually associated with malnutrition. Through an improvement in the diet this mortality could be reduced; however, it is very early to draw conclussions on this aspect. A detailed analysis of the impact of the improvement of nutrition through the program of corn fortification, on the mortality on the preschool children, will be done after two years of fortification.

B <u>Work in the Control Village: Santo Domingo Xenacoj</u>

1. The field personnel working in this village consists of:

   The field physician (Dr. Luis A. Reynoso)

   Two nurses

   One Mid-wife

Dr. Reynoso and the midwife are supported by the project. The two nurses are on the payroll of the Public Health Ministry of Guatemala. The field physician has been also in charge of several activities in Santa María Cauqué as described previously. Dr. Reynoso has been responsible for collecting the anthropometric and maturity characteristics of the new born in

the village. A total of 194 babies has been born since the beginning of the program. He has been also measuring the postnatal growth of children as well as keeping the mortality surveillance. He has trained the two nurses and the local midwife in the techniques for the assessment of fetal maturity and anthropometric measurements.

The two nurses were trained by Dr. Reynoso on the main aspects of the prevalent diseases in the area. So, the nurses are now able to deliver the medical care under the adequate supervision of the field physician. The midwife has been an excellent collaborator to the program. Her responsibilities are: attending the deliveries, collecting the cord blood samples and helping the physician in the anthropometrical and clinical evaluation of the newborn as well as in the postnatal growth. Recently, the midwife started a prenatal control. For this purpose she installed a prenatal clinic in her house with the help of INCAP budget and under the strict supervision of Dr. Reynoso. It is expected that in a very near future, home visits will be started in Xenacoj in order to identify pregnancies.

2. Results of the Study of Anthropometry and Mortality in the Control Village.

The anthropometric measurements of children from birth to

15 months of age are shown in table 4. The mean measurements are similar to those observed in the experimental village, before the fortification was started.

It was done a detailed analysis on the records of mortality and natality, kept by the civil register in Santo Domingo Xenacoj during the period of 15 years before the program started (July 1956-June 1971), as well as during the period of one year from July 1971 to June 1972. The field physician has been recording all deaths and births since July 1972.

A comparison for the birth and mortality rates during those three periods of time are presented in table 5 and 6 respectively. The infant mortality is shown in table 7. A complete analysis will be done in June next year, in order to compare the effect of medical treatment during the first two years of the study.

C Future Plans

An intense field work will continue in order to maintain the level of fortification in the village to optimize the testing of the hypothesis. In view of the increased average birth weight in infants born from mothers consuming fortified corn, but the lack of increase in the average of birth weight for the village as a whole, an intervention with calories is in line. This is very likely to accomplish by using a very similar product in

which soya flour will be substituted by full fat soya beans flour, thus providing a significant increase intake of oil. The expectation is that the new fortified mixture will be unnoticed in tortillas, and that it will be incorporated without difficulty into corn. At this moment we are discussing the possibility of having a trial allowance for various possibilities of corn fortification. It is very important that permission be granted to utilize the funds at a greater speed, in order to allow Dr. Bressani enough time to prepare the new mixture in Guatemala.

D Budget

Mr. Rodrigo Donoso, Administrator of INCAP, submitted a budget for the next period within the established ceiling as requested. However, it should be pointed out that there is a pressing need for the extra funds ($26,950) requested last year. We need this extra money to buy the pellet mill, as explained on pages 15 and 16 of last year Progress Report.

Table 1

LEVEL OF FORTIFICATION OF THE FAMILIES
IN SANTA MARIA CAUQUE
26 FEBRUARY-21 OCTOBER, 1973

Week	Families absent	Percentage of Fortification (P)*				Totals	
		0	1-49	50-74	75-100	0-49	50-100
39	10**	36	9	3	42	45	45
40	9	41	5	3	42	46	45
41	9	40	5	6	40	45	46
42	9	40	7	4	39	47	43
43	8	42	5	5	40	47	45
44	8	44	5	2	41	49	43
45	9	38	6	8	39	44	47
46	12	41	5	3	39	46	42
47	9	41	6	3	41	47	44
48	9	41	5	7	38	46	45
49	10	41	4	5	40	45	45
50	7	41	8	5	40	49	45
51	7	42	6	4	41	48	45
52	8	45	4	3	40	49	43
53	8	45	5	4	38	50	42
54	8	44	5	5	38	49	43
55	8	44	5	5	38	49	43
56	9	45	6	4	35	51	39
57	9	45	4	6	36	49	42
58	10	46	4	5	35	50	40
59	9	48	3	3	36	51	39
60	10	45	5	4	36	50	40
61	9	48	2	3	39	50	42
62	10	47	2	1	40	49	41
63	Not analyzed. "Feria" of Santa María Cauqué.						
64	9	48	4	2	37	52	39
65	9	48	3	1	39	51	40
66	10	46	3	4	37	49	41
67	10	43	3	5	39	46	44
68	11	45	4	3	37	49	40
69	10	45	3	1	41	48	42
70	9	47	2	2	39	49	41
71	11	46	2	3	38	48	41
72	9	45	5	3	38	50	41

* $p = \frac{\text{Total measurements of fortifying mixture}}{\text{Total pounds of nixtamal}} \times 100$

** Percent of families in categories

Table 2

PROTEIN AND TOTAL FREE LYSINE IN 87 TORTILLAS
IN SANTA MARIA CAUQUE
2 APRIL - 26 APRIL, 1973

Variables	42 fortified tortillas	45 unfortified tortillas	t value	P
Protein (g%)	10.5 ± 0.8	8.4 ± 1.0	11.33	<0.001
Total free lysine (mg %)	497.8 ± 194.5	139.5 ± 115.5	10.54	<0.001

Table 3

EFFECT OF CORN FORTIFICATION (P)* ON BIRTH WEIGHT
SANTA MARIA CAUQUE, 1972-1973

Level of fortification during pregnancy %	Birth weight M ± S.D.(g)	Number of cases	t test
0-24	2469 ± 433	29	
			2.278; $p < .05$
25-100	2700 ± 367	33	

$$* \quad p = \frac{\text{Total of fortifying mixture}}{\text{total pounds of nixtamal}} \times 100$$

Table 4

ANTHROPOMETRY OF CHILDREN FROM
SANTO DOMINGO XENACOJ

Age (months)	Number of cases	Parameters			
		Weight (g)	Height (cm)	Skull circumference (cm)	Chest circumference (cm)
0	194	2557 ± 413*	46.0 ± 2.2	32.7 ± 1.7	31.3 ± 2.2
3	119	5111 ± 836	56.7 ± 3.1	39.1 ± 1.5	40.1 ± 2.3
6	95	6235 ± 1072	61.9 ± 3.5	41.6 ± 2.0	42.6 ± 3.4
9	62	6900 ± 930	65.4 ± 3.8	43.1 ± 1.4	43.5 ± 2.3
12	31	7174 ± 1067	68.4 ± 3.6	43.7 ± 1.8	43.8 ± 2.7
15	5	7796 ± 916	72.0 ± 2.0	44.2 ± 1.5	45.1 ± 1.9

* Mean ± one standard deviation

Table 5

BIRTH RATE IN SANTO DOMINGO XENACOJ,
DURING THREE PERIODS OF TIME

Years	Number of inhabitants	Number of live births	Birth rate
56-71	2237	120	53.4
71-72	2760	133	48.9
72-73	2857	153	53.4

Table 6

MORTALITY RATES IN SANTO DOMINGO XENACOJ,
DURING THREE PERIODS OF TIME

Years	Number of inhabitants	Number of death*	Rate
56-71	2237	63	28.6
71-72	2760	41	14.9
72-73	2857	56	19.6

* Stillbirths not considered

Table 7

INFANTILE MORTALITY RATE IN SANTO DOMINGO XENACOJ, DURING THREE PERIODS OF TIME

Period of life	Years		
	1956-71	1971-72	1972-73
Neonatal			
0-6 days			
number of deaths	3	3	4
rate	21.2	22.6	26.2
7-27 days			
number of deaths	3	1	1
rate	26.2	7.5	6.5
0-27 days			
number of deaths	6	4	5
rate	47.4	30.1	32.6
Postneonatal			
28 days to 11 months			
number of deaths	11	7	8
rate	92.6	52.5	52.3
Infantile Mortality			
0 - 11 months			
number of deaths	17	11	13
rate	140.7	83.0	85.0