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Corn fortification,a field demonstration model; final report,1971-1976

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9. ABSTRACT
PROJECT: To determine the effect of corn fortification with protein, lysine, vitamins, and iron on nutrition of pregnant women, fetal growth, growth and development of children, disease incidence and intestinal infection by Shigella. The project was also to study the management and economics of corn fortification at the community level and to evolve operational guidelines and economic data applicable to a regional or national program.
DATES: January 1, 1971 - March 31, 1976
DEVELOPMENT: Through the activities of this project it was shown that it is possible to fortify corn at the village mill level and it is possible to maintain the collaboration of a significant group of population. The intervention was beneficial in reducing infant mortality by fifty percent. Morbidity during weaning was reduced by thirty-three percent. A positive tendency for better growth increments in children three to five years old was found. The dietary intake in pregnant women was improved, however, no change in fetal growth was found. The two sections of this report deal with the implementation of the field methodology and acceptability of the intervention and with the biologic effect of the fortified corn. It is suggested that the consistency of the mixture be changed to pelletized form and that it be added to corn at ten percent level to obtain eight percent of final concentration in the corn dough. Additional field studies to show the effect of improvement of cereals should consider to increase the level of fortification, to enforce the fortification, to study the effect on a larger sample, and to include laboratory methods to assess the level of the host defense mechanisms. The report contains numerous tables illustrating the data gathered.

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CORN FORTIFICATION:

A FIELD DEMONSTRATION MODEL

FINAL REPORT

January 1, 1971-March 31, 1976

FINAL REPORT SUMMARY SHEET

CORN FORTIFICATION: A FIELD DEMONSTRATION MODEL
CONTRACT No. AID-CSD-3357

Project Title and Contract Number

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January 1, 1971-March 31, 1976 Contract Period (as amended) From-To	January 1, 1971-March 31, 1976 Reporting Period From-To
Total Expenditures and Obligations Through Previous Contract Year	$557,291
Total Expenditures and Obligations For Current Contract Year	

Narrative Summary of Accomplishments and Utilization:

Corn fortified with 8 percent soy bean flour (50% protein) and 0.125 percent L-lysine HCl is improved in its biological value. If persons living under natural conditions are fed with this corn, a positive biological effect on the growth pattern of children and on the morbidity and mortality would be observed. To test this hypothesis, the corn consumed by the villagers of Santa María Cauqué, Guatemala, was fortified during a period of 44 months, from June 1972 to January 1976.

Through the activities of this project, it was shown that it is possible to fortify corn at the village mill level and that it is possible to obtain and maintain the collaboration of a significant group of population. In relation to the biologic effect of the improvement of corn it was found that the intervention was beneficial in reducing the infant mortality by 50 percent. The second to fifth year mortality was also clearly reduced. Morbidity during weaning was reduced by 33 percent. These changes appear to be independent of socioeconomic class. Even if a significant effect on postnatal growth was not evident, a positive tendency for better growth increments was found in children 3 to 5 years old. No change in fetal growth was found; however, the dietary intake in pregnant women was improved, especially during the first six months of pregnancy.

B. PROJECT OBJECTIVES

The research objectives proposed in the original grant application are:

1. To determine the effect of fortification on nutrition of pregnant women and on fetal growth.

2. To determine the effect of fortification on the growth and development of children.

3. To determine the effect of fortification on disease incidence of children and on intestinal infection by Shigella.

4. To study the feasibility (management and economics) of corn fortification at the community level through the addition of a mixture containing protein, lysine, vitamins, and iron.

5. To evolve realistic operational guidelines and economic data applicable to a regional or national program of corn fortification.

C. ACCOMPLISHMENTS TO DATE

1. PRINCIPAL FINDINGS

This final report resumes the activities developed to carry out the corn fortification project during the period of 29th of May 1972 to the 31st of March 1976. The information on this report has been distributed into two sections, dealing first with the implementation of the field methodology and acceptability of the intervention, and second with the biologic effect of the fortified corn.

Section one:

Implementation of the field methodology and acceptability of the fortification

Santa María Cauqué was chosen as the experimental village. Another Indian village, Santo Domingo Xenacoj, located at 4 kilometers from Santa María Cauqué, was selected as a control. The variables to be studied in both villages were: fetal growth and

postnatal growth from birth to 5 years, as well as preschool mortality. In the experimental village, the effect of maize fortification on preschool morbidity, and on their dietary pattern was also to be assessed.

a. Social work previous to the implementation of the fortification project

The fortification project started on the 29th of May 1972, and ended unexpectedly on the 3rd of February 1976. Santa María Cauqué suffered the loss of 5% of its population and the destruction of all but one of its houses during the earthquake of the 4th of February. The only buildings left standing were: the town Hall, the health center, the school, and the only reinforced concrete house. Three months after the earthquake the village was completely rebuilt. Although the corn fortification could not be continued, the follow up of children was reinitiated two weeks after the earthquake; the studies on pregnant women started again at the middle of March.

The purposes and characteristics of the maize fortification project were explained to the villagers prior to the initiation of the field work. During a three months period several meetings were held with the village authorities and other village principles such as teachers and community leaders, to explain the project in detail. Besides, the field personnel carried out many home visits to explain to the housewives the purposes of the project, and especially the fortification methodology.

As maize is eaten in form of tortillas, several trials of taste differentiation with fortified and unfortified tortillas, were practiced with male and female adults, as well as with adolescents. The observation was carried out in 154 subjects with a total of 274 observations. The comparisons between fortified and unfortified tortillas were done utilizing the triangle method. The trials were conducted either at the health center, or at the Municipality building. The percent of correct answers was 32.5, which was not statistically significant. It was concluded that villagers could not differentiate between fortified and unfortified tortillas.

b. Installations and equipment for fortification

First of all it was necessary to obtain the collaboration of the mill owners. At the beginning of the project, there were two mills in the village. During the course of the project, two more mills became in operation. The same methodology that was applied to fortify the maize in the two existing mills, at the beginning of the project, was applied later on in the other two mills.

Considering that there was not any previous experience to fortify maize on daily basis at the village level, special simple equipment to be utilized by the millers had to be designed. The equipment consisted of a balance with a dial to read the number of pounds of cooked corn (nixtamal), and measuring cups of various sizes to deliver the corresponding amounts of fortifying mixture to the nixtamal at the level of 8%. For example: measure number 10, delivered the amount of flour needed to fortify 10 pounds of nixtamal (see Figure 1). Printed forms with the number and names of the housewives of the village families were used to keep on a control of the daily fortification. To identify the family at the mill when different members of the families carried the nixtamal, it was necessary to mark the family number on the containers utilized to carry the nixtamal. This was done by the INCAP staff before the project started.

The procedure for corn fortification was as follows: women or female children carried the nixtamal to either one of the mills, at the mill the nixtamal of all the customers was weighed. Then they were asked if they wanted the fortification. When the answer was affirmative, the proper measuring cup was utilized to deliver the mixture (Table 1) into the nixtamal (Figure 2). A record of the number of nixtamal pounds, and of the number of the measure utilized was registered on the precoded form. Thereafter the nixtamal plus the fortifying mixture was placed into the hopper of the mill for grinding. During the process of grinding, the nixtamal and the fortifying flour were mixed with a wood spatula (Figure 3). Then the women collected the maize dough and carried it to prepare the tortillas at home. In the process, the only intervention was the weighing of the corn and the adding of the flour; no other modifications were introduced in the traditional process of cooking maize or preparing tortillas.

c. Studies on pregnant women and preschool children

To assess the biologic effect of the improved maize on fetal growth and on the health of preschool children, 90% of the pregnant women and a cohort of 70 children from 0 to 3 years of age were followed up. Intrauterine growth was determined in 189 cases by measuring at birth weight, height, and head and chest circumference. The maternal variables affecting fetal growth, plus the dietary intake and morbidity during pregnancy were also determined.

The cohort of children 0 to 3 years of age was formed at the beginning of the study by 63 children distributed as follows: 13 children between 0 to 3 months of age, and by five groups of 10 children each, representing the age periods of 3 to 6, 9 to 12, 15 to 18, 21 to 24 and 27 to 30 months. The follow up of children stopped at the third birthday. All babies born after the 29th of May 1972, were included in the cohort until April 1973, when it was decided to stop the collection of newborn for the cohort; by then, the number of the study children was 70.

The health of the preschool children, 0 to 3 years old, was determined in the cohort children by a weekly surveillance of the morbidity and dietary intake. Growth of these children was determined by measuring weight, height, chest and head circumferences biweekly during the first year of life, and every four weeks during the second and third year of life. Besides, growth records of children, other than the cohort group, were also available through measurements every 3 months of the same parameters in children from birth to 10 years of age.

In the control village, pregnant women were followed only for anthropometrical examination. Newborns were examined at birth, as described for the experimental village. Records of growth from 0 to 3 years of age were obtained at 3 month intervals. A general record of natality and mortality was kept for both villages.

d. Cooperation of the villagers

During the first two days of fortification, 95% of the families accepted to fortify their maize. At this time, many villagers began complaining about foul odor and bad taste in

the fortified tortillas, that were overleft from the previous meal. After few days cooperation dropped to about a 30%. The problem was promptly investigated in the field and in the laboratory. It was found that the water content was higher in the fortified tortillas, due to the high water solubility of the fortifying mixture. Besides, the millers were adding a greater amount of water in order to facilitate the grinding of the maize plus the mixture. Furthermore, the storage of tortillas in closed and not well ventilated baskets, a common practice in the village, favored bacterial proliferation. It was found that fortified tortillas had greater number of Bacillus, coliforms and cocci. The logical practical solution was to remove part of the water from the nixtamal. For this purpose, holes were drilled in the balance tray (this removed from 5 to 10% of the total weight), and to favor water evaporation housewives were told to leave the tortillas a little longer on the hot dish (comal), where tortillas are cooked as well as to store them in a well ventilated basket.

These recommendations plus intensive field work, resulted in a better cooperation, but the percentage of regularly fortifying families, dropped to 40%. The problem of high water retention was never solved satisfactorily as it will be seen later.

e. Reasons for accepting or not accepting the fortifying flour

A survey aimed to determine the concepts villagers had about the fortifying flour was carried out at the end of 1974 (more than two years after the project had started). Thirty nine collaborator and 46 non-collaborator families were investigated.

In Table 2 are presented the reasons for accepting the fortifying flour. The majority of them (59%) expressed that they had accepted the fortification because it was advised by the clinic personnel. Forty-one percent mentioned that they were accepting it because the mixture gave them strength and it was good to prevent illnesses. Ten percent said that they were obtaining more tortillas because the flour increased the volume of the dough.

The concepts about the fortifying flour in the collaborator families are presented in Table 3. It can be seen that

82% of the families believed that the flour was good to avoid illnesses, and was acceptable for everybody, except pregnant women, because fortified tortillas caused them nausea.

The reasons for not accepting the fortification in the sample of non-collaborator families are presented in Table 4. The main reason was that tortillas could not be stored for next day. A noticeable change in flavor was reported by 37% of the families, mentioning that this change became stronger when tortillas were mixed with coffee. Twenty percent said that fortified tortillas produced them stomachache and/or diarrhea.

Finally, the reasons given by the collaborator families for not fortifying maize on daily basis are shown in Table 5. The main reasons were related to either change in flavor or to problems related to storage of tortillas. It was also mentioned, the preparation of corn tamales or tamalitos. This is related to the problem of the high water solubility of the soy flour. They also mentioned that flour increased the sticky consistence of dough made from unriped maize or maize destroyed by insects and consequently tortillas could not be easily prepared.

f. Level of fortification (control of fortification)

The level of fortification of the families was determined on weekly basis in accordance to the information collected in the daily records of attendance to the mills. A weekly index of fortification of the family (family weekly fortification index: FWFI), was determined as presented in Table 6. From this index, the average family fortification index (FI) or the average child FI, could be calculated for any specific time. As the indexes were cumulative, permitted the classification of the families in accordance to their level of fortification. The FI for one specific week was equal to the sum of the weekly indexes since the beginning of the fortification project, divided by the number of added weeks. A special index was prepared for each child born since February 1964 when the previous study in Santa María Cauqué started. To be able to compare children born at different periods, the time of gestation was considered. In this manner the child fortification index at birth, was equal to the family fortification index corresponding to the 39 weeks previous to delivery (average duration of pregnancy).

In the children who were born before the onset of the corn fortification project, the index corresponding to the date of any of the anthropometrical, dietary or morbidity surveys, was calculated taking the sum of the weekly family indexes at the moment of the survey, divided by the child age in weeks, plus the 39 weeks of gestation.

An analysis of the frequency distribution of the weekly family indexes, permitted to classify the families in accordance to the levels of cooperation. The lower fortified group had a FI less than 20 and it was constituted by 51% of the families. The FI for the medium fortified group oscillated between 20 to 39, and corresponded to 13% of the families. The highly fortified group had a FI of 40 and more; 36% of the families belonged to this group. The consistency in the collaboration of the highly and medium fortified group is shown in Tables 7 and 8. It can be observed that the highly fortified group was very consistent in the fortification. However, there were two periods when the collaboration dropped. The first period corresponded to the sixth trimester of observation, when their corn stocks became attacked by insects. The second period corresponded to the trimesters 10th and 11th, when two new mills became in operation in the village. About one third of the families decided to mill their maize in these two mills. It took about six months to convince the mill owners to participate in the program; after this period the collaboration began to increase.

On the other hand, the medium fortified group, started with a FI between 42 to 47 during the first three trimesters. However, during the fourth trimester their FI began to drop steadily. During the twelfth trimester half of the families of this group did not fortify their maize at all.

The intense campaign to convince the families to fortify their maize, was done only during the first three months of the study. Later on, it was found that the families were fortifying with a definitive pattern, and it was decided to stop the enrollment campaign. However, the fortifying mixture was available free of charge in the four mills. Any family could decide whether they wanted to fortify their maize or not.

g. Socioeconomical characteristics of the collaborator and non-collaborator families

With the data collected through the census of 1971, it was determined the socioeconomical characteristics of the collaborator and non-collaborator families. The following variables were considered: land tenure, cattle and poultry possessions, material utilized for house construction (floors, walls, roofs), water availability, fecal and waste disposal, literacy, scholarity and shoe wear. Each variable was given a maximum value of 3 points and a minimum of 1. The highest value was assigned to the families who had better conditions. The socioeconomic index was formed by the sum of these variables. The lower and maximum values were 12 and 36 respectively.

The analyses of this information did not show differences among the three groups of families classified in accordance to the fortification index. The socioeconomic index of the families with children less than 10 years old is presented in Table 9. Three main variables (land tenure, scholarity and shoe wear) were analyzed independently in the three groups of families. Table 10 shows that there were no differences.

Besides, a study of attitudes toward care of children and utilization of health facilities among two groups of mothers did not show any significant differences. Finally, a survey of the village clinic record of attendance, did not show differences in the number of consultation by preschool children, between the families with a high and low fortification index (see Table 11).

These data show that the tendency to fortify the corn was not related to social or economical class.

Monitor of the fortification project

Monitoring was done at two levels. First, as explained previously, the level of fortification per family was determined daily. Second, tortillas were examined in the chemistry laboratory to determine total free lysine and protein. Random sampling of tortillas were obtained for 100 families every month The results of these determinations may be observed in Table 12 It was found that although fortified tortillas had a larger content of protein and total free lysine and the differences

were highly significant, the amount of protein in the enriched tortillas, was only half of the expected value. Besides, the PER of fortified tortillas was between 1.90 to 2.19 and did not reach the expected value of 2.76. In this manner, it can be concluded that the fortification was done at a level of 4 to 6% and not at 8% as it was planned.

Several explanations have been found for this partial failure in the fortification procedure. First of all, it was found that it was difficult to compress the flour into the measuring cups due to the fluffy consistence of the fortifying flour (mesh 150). Besides, due to the large volume of flour plus the amount of water added during the milling process, the volume of the dough was increased reducing the final concentration of the fortifying mixture, in the cooked tortillas.

i. Discussion of the implementation of the field methodology and acceptability of the fortification

This field project was the first attempt to fortify maize at a village level, utilizing a technology devised to be applied as an industrial process. Although the fortification started successfully, several problems were immediately identified during the first two days of fortification.

The majority of the reasons for not accepting the maize fortification were related to the quality of the fortifying flour, especially because of its high water solubility. Housewives claimed that because of the big amount of the flour to be added, fortified tortillas could not be stored for more than 12 hours. Furthermore, people began detecting changes in flavor, which became more noticeable when tortillas were mixed with coffee. An important aspect of the flavor change, was that the fortified tortillas were a cause of nausea in pregnant women. Besides, due to the finess of the fortifying flour, it was not possible to fortify the maize at the desired concentration of 8%. In conclusion it can be said that the main causes for failure in the study were related to the quality of the flour that was utilized and not to the fortification per se.

The fortification technology devised for industrial purposes, requires of previous research at the field level, previous to the introduction of any food fortification program. For instance, the acceptability tests of fortified tortillas

showed that villagers were unable to identify the differences in flavor. However, when fortified tortillas were consumed daily, flavor differences were easily found.

It can be said, that the implementation of the maize fortification methodology was a success, considering that people allowed an intervention in their staple food. The fact that in spite of the problems identified with the fortification procedure 36% of the village families accepted regularly the fortification of their maize, is a positive aspect of the study. The achievements and failures of the maize fortification methodology are summarized in Table 13.

The identified problems can be solved by changing the characteristics of the fortifying flour. Recent experience at INCAP has shown that when a different flour is used, it is possible to add the required volumen of the mixture and less water is retained.

Section two:

Biologic effect of the maize fortification

In accordance to the design of the project, the fetal and postnatal growth rates, the morbidity in children 0 to 3 years old, and the preschool mortality observed during the period of fortification in Santa María Cauqué, were to be compared with the basal data collected in the same village from 1964 to May 1972. The data collected in the control village on fetal and postnatal growth as well as on preschool mortality were to be compared with changes observed in the experimental village. It was also to be utilized to determine secular changes occurring in the area during the period of the project.

The information collected in the control village, showed that the birth weight as well as the pattern of growth from birth to 3 years of age were similar to the growth pattern of the experimental village before fortification (Table 14). The mortality pattern in preschool children was also found to be similar to the one prevailing in Santa María Cauqué before the fortification.

However, it was decided that the most valuable comparison to detect changes induced by the maize fortification, should be by analyzing the differences between the pregnant women and preschool children of the experimental village with different levels of

fortification. This was decided after it was found that the tendency to fortify maize was not related to socioeconomical class.

The effect of maize fortification on fetal growth was assessed in the children who were born during the length of the project. This was determined by studying at birth all the babies born during the fortification. Information on dietary intake, morbidity and anthropometry was also obtained in about 90% of all pregnant women. Changes induced by the improvement of maize on growth from birth to 10 years of age, were determined in the village children of these ages. The studies on dietary intake and morbidity during the first three years of life, were conducted in the cohort of 70 children, as described in the first section of this report.

The records of natality and mortality, kept by the INCAP personnel, were utilized to determine the preschool mortality rate.

a. Effect of maize fortification on the dietary pattern of preschool children

Dietary intake was measured utilizing the weekly recall method. Tables 15 and 16 show that there were no differences in the intake of calories and protein of preschool children in relation to their fortification index during the first three years of life.

This finding points out that the fortification did not change the amount of food consumed by the children, but it is important to consider that the group of fortified children received a better protein during a critical period of their lives.

b. Effect of maize fortification on fetal growth

Fetal growth was determined in accordance to the anthropometrical characteristics of newborns. Data on weight, height, head and chest circumferences at birth were available for 189 cases which represented 95% of the babies born in the village during the fortification project. Weight was recorded into the first hour of life by a nurse. Height, head and chest circumferences were measured by the physician during the first 24 hours of life. Several maternal variables such as birth order and mother's height were also obtained. For the analyses of the effect of maize fortification on fetal growth, the fortification index for each newborn, was calculated as explained previously.

The relationship between birth weight, height, head circumference, birth order and mother's height with the fortification index for all full term babies born during the length of the project was analyzed. Table 17 shows these results. There was no apparent impact of the intervention on birth weight. Table 17 also shows that this finding was not due to differences in birth order of the child or maternal height. Moreover, similar analyses with height, and head circumferences of the newborn did also fail to show an effect. Lastly it was found through regression analyses that the fortification index was not related to growth in the newborn, either before or after controlling for the influence of the potentially confounding factors already mentioned (Table 18). Therefore, it was concluded from these analyses that the maize fortification program had no impact on fetal growth.

c. Effect of maize fortification on postnatal growth

Growth records for all village children born since the year 1964, were available. Measurements of weight, height, head and chest circumferences, were obtained at three month intervals for children under 6 years of age, and at six month intervals for children older than 6 years. The measurements were collected by an anthropometrist, following procedures already established for the long term interventions being carried out in Santa María Cauqué since 1964.

The analysis on the relationship between the fortification index and attained height from birth to 8 years of age is shown in Table 19. None of the correlation coefficients was significant. A similar analysis with weight gave similar results suggesting that there was not apparent relationship between fortification and postnatal growth. In order to control for the influence of factors constant to the family, such as socioeconomic status and level of collaboration with the program, it was carried out the following analysis. Sibling pairs were selected in families where growth information was available for both siblings at any of the following ages: birth 6, 15, 24, 36 and 60 months, and where the older sibling had reached the age in question before the fortification project, while the younger sibling reached the same age during the course of the project. Thus, for every age the older sibling had no opportunity to benefit from the maize fortification. The analyses consisted of comparing the height and weight of both siblings; the expectation being that the younger sibling

would be taller and heavier on account of fortification. The results of these analyses are shown in Table 20. None of the comparison between sibling pairs either for height or weight, at the various ages revealed differences. Therefore, it was concluded that even after controlling for constant factors in the family, the maize fortification did not seem to have had an impact on physical growth.

The analyses shown in Table 21 relates the increment in physical growth with the increment in fortification index, from 3 to 5 years of age. Although the correlation coefficients were not statistically significant, they do indicate a strong tendency for growth increments in both weight and height to be related to changes in the fortification index.

Finally, an analysis of the effects of the fortification of maize on maturation was done, utilizing bone development as an indicator of maturation. Table 22 shows that no correlation was found between the number of hand and wrist ossification centers and the fortification index from 6 to 96 months of age. An analysis of variance of the number of the carpal ossification centers in relation to the fortification index was also done. No differences were found in the three groups of children as can be seen in Table 23.

A correlation analysis between the cortical thickness of the second metacarpal and the fortification index, also did not show any relationship, as presented in Table 24.

In summary the analyses carried out suggest that maize fortification had had no significant effect upon physical growth and bone development.

d. Effect of maize fortification on the morbidity by infectious illnesses

In order to test the effect of maize fortification on the morbidity of infectious illnesses, a subsample of 70 village children collected at random as explained in section one, were carefully monitored through weekly home visits by the field physician. Their health status was determined every week on each visit. The date of onset and duration of every illness were determined. The severity of the symptomatology was assessed by the number of days of fever and in the diarrhea cases, by the number of days with 4 to 6, 7 to 9, and 10 or

more stools per day. The presence of vomits and of mucus and/or blood in the feces was also recorded.

The results of the morbidity analyses are presented for disease incidence, duration and severity, in relation to the fortification index. No differences in morbidity in the three groups of children were found during the first year of life. However, a significant reduction in morbidity was found in the children with high fortification during the second and third year of life.

The size of the cohort of children for the morbidity study, as well as the number of episodes of infectious illnesses observed in the children per category of the fortifiçation index are presented in Table 25. A total of 1539 episodes of illnesses were observed; these were utilized for the analysis of the effect of maize fortification.

No differences in the number of episodes of illness were found among the children with low, middle and high fortification index, as shown in Table 26. This indicates that children of the three categories were subjected to the same force of infection. The relationship between the fortification index and various morbidity items are presented in Tables 27 to 31. In these analyses, the morbidity information is expressed in terms of percentage of the time ill per semester of life. For example, 10% of the time ill with diarrhea is equivalent to 18 days with diarrhea in a six month period. The results of the analyses of the morbidity data are expressed as the percent of time ill in the three groups of children classified in accordance to the fortification index. Tables 27 and 28 show that the group with low fortification index, was nearly twice as sick with upper and lower respiratory tract infection as the high fortification group during the second and third year of life. The differences in duration of diarrhea, between the two groups of children were even larger (Table 29). Table 30 suggests that maize fortification also leads to fewer days ill with associated illnesses, that is to say, association of respiratory and diarrhea illness, or also respiratory or diarrhea illness associated to conjunctivitis and/or stomatitis. These differences were noticeable during the second and third year of life. This trend was not found for other disease, such as skin infections, conjunctivitis and stomatitis alone. Table 31 shows that there is a negative correlation between the corn fortification index and the percentage of the time ill with any infectious illness.

It was also found a significant reduction in the severity of disease manifestation. Tables 32 and 33 show that the children highly fortified suffered less days of fever and of diarrhea with 7 or more stools per day (severe diarrhea).

As a way of summary, Tables 34 and 35 present the differences between the high and low fortification groups (high-low) and the total reduction in number of illness days and of days with less severe manifestation of illness respectively. Clearly children in the high fortification group suffered less days of illness. The total reduction of disease duration during the two years period, amounts to 87.3 days (Table 34), 28.0 days less of fever and 17.2 days less of diarrhea with 7 and more stools per day (Table 35). This corresponds to a reduction of 31% in relation to disease duration during the second and third years of life in the groups of children with low fortification.

e. Effect of maize fortification on intestinal infection by Shigella in children

For the identification of Shigella in the feces of the cohort children, fecal weekly cultures were collected from each cohort child. The fecal samples were processed in accordance to the procedures utilized in the Santa María Cauqué studies since 1964.

In Table 36 are shown the number of cultures processed per semester of life. No marked differences in the incidence of the Shigella infections in the three groups of children were found. The duration of the Shigella infections is presented in Table 37. There were no differences between the groups.

The previous findings provide evidence that the frequency and duration of intestinal infections by Shigella, was not different in the three groups of children.

These data do not coincide with the morbidity findings, which showed that the duration and severity of diarrheal disease was reduced in the group of children with a higher fortification index. In regard to this, it must be mentioned that the methodology, to measure the duration of an infectious process is different in both circumstances. For example, the presence of clinical manifestations of disease can be recorded day by day, while in the case of an intestinal infection, the duration can be determined only by the isolation of the agent.

f. Effect of maize fortification on infant and 1 to 4 years mortality

Since the beginning of the field operations in Santa María Cauqué in 1964, preschool mortality data have been continuously collected. The causes of death were determined either by premorten diagnosis done during the course of the disease, or by interrogations to the child's parents on the characteristics of the final episode of the fatal disease. In more than 90% of the cases either the physician or the nurses had the opportunity to examine the child during the course of the fatal disease.

All births and deaths were recorded; in this manner it was possible to determine the number of newborns and inhabitants for each specific age from 1 to 4 years of age.

The mortality rate during the maize fortification project of 3 sets of families grouped according to the family fortification index were compared. Because of the long term data available it was possible to calculate in the same families the infant mortality rates during the period before corn fortification (January 1964 to May 1972). This baseline mortality data is presented in Table 38. Though, the low fortified group appears to have the highest mortality rates, the differences are not statistically significant.

The infant mortality rate for the period of corn fortification is presenced in Table 39. The rates are expressed per 1000 deliveries, in each of the three fortification groups. The highest infant mortality rate corresponds to the low and medium fortified group. These figures are not significantly different from the baseline rates shown in the same groups of families before the fortification period ($P > .05$). On the other hand, the infant mortality rate for the group of children with high fortification was reduced to nearly 3 times lower than that of the other two groups. In comparison to the baseline values, the high fortified group experienced a 50% reduction in mortality.

Table 40 shows that this reduction in infant mortality was not due to a decrease in the proportion of low birth weight babies. First of all, the proportion of low birth weight babies was similar across all three groups. Secondly, the relationship between corn fortification and infant mortality was still evident within the range of low birth weight babies. The mechanism involved, therefore, appears to be independent of birth weight.

The relationship between corn fortification and mortality during the second, third, fourth and fifth year of life is shown in Table 41. The rate for the second year of life was similar in the low and the high fortified groups. However, during the third to the fifth year of life only one death was observed for the group of children with a fortification index of 40-100. The total number of deaths were 11, 7 and 4 for the low, medium and high groups of fortification respectively. The rate of mortality for the whole village corresponding to the second to fifth year of life before the corn fortification project (see Table 42) was not significantly reduced; but it is important to notice that the mortality for children with high fortification was reduced to a third, and that only one death was observed after the age of two years in this group of children.

In summary it could be stated that corn fortification has had an effect on infant mortality and on the third, fourth and fifth year of life mortality.

g) Relationship between the dietary intake and morbidity during the second and third year of life

In this section are described the analyses carried out to find the influence of the infectious illnesses on dietary intake in preschool children during the second and third year of life. On table 43 are shown the correlation values between caloric, vegetal as well as total protein intake and diarrheal disease, respiratory disease and total infectious illnesses. In general it was found that all the correlation values were negative, meaning and adverse effect of infectious illnesses on the dietary intake. A significant correlation was found between dietary intake and diarrheal disease, as well as with total infectious illnesses during the third semester of life. However during the fourth semester of life the only significant correlation was found between diarrheal disease and vegetal protein intake. During the fifth semester none of the variables was found to be correlated, but during the sixth semester of life a significant correlation was only found between diarrheal disease and dietary intake.

From these analyses it can be concluded that diarrheal disease produced a negative effect on dietary intake probably mediated by the anorexia associated to this disease. A similar association was found in the group of 45 children studied in Santa María Cauqué before the corn fortification.

On the other hand, no relationship was found between the Fortification Index and dietary intake as it was shown in Tables 15 and 16, and also by the lack of correlation between these variables as shown in Table 44.

In accordance to this information, it could be concluded, first that diarrheal disease produced an immediate negative effect on dietary intake during the course of the illness and that the maize fortification did not change the dietary intake. Second that the effect of corn fortification on morbidity was independent of the dietary intake during the illness. This effect was probably due to the improvement of the host defense mechanisms through the provision of a better protein on daily basis.

h) Relationship between the Fortification Index and morbidity during pregnancy

This section describes the analyses of the morbidity during pregnancy done on the data collected since the beginning of the project. As soon as a pregnancy was detected, the field nurse began the weekly morbidity surveillances to determine the health status of the women during pregnancy. The clinical diagnosis was confirmed by the field physician. The duration and the severity of the infectious diseases were found out by daily visits of the nurse. She inquired about the presence of symptoms, the number of stools per day in the diarrhea cases; also, she recorded the temperature of the ill pregnant women. The physician visited them every two or three days, independently of the nurse visit to confirm the diagnosis and prescribe the treatment. A urine culture for the determination of significant bacteriurias (a count of $\geq 10^5$ bacteria per ml of urine), was carried out every 4 weeks.

The incidence and duration of infectious diseases was calculated for all the pregnant women, in order to establish the basal information on morbidity during pregnancy. The number of episodes of infectious illnesses per trimester of pregnancy is shown in Table 45. Respiratory infections were the most frequent; the upper respiratory tract was affected three times more frequently than the lower tract. Diarrheal disease was the second in frequency. Clinical symptoms of urinary tract infections were found in a fourth of the women while significant bacteriurias were identified in 21 percent of the pregnant women. It was observed that the disease

incidence was higher during the second and third trimester, which indicate a higher susceptibility during the last months of gestation.

The duration of the illness is presented in Table 46. Respiratory tract infections showed the longest duration. Although diarrheas were frequent, their course was short. The duration of urinary tract infections which was determined clinically by the symptoms persistence was short; however, the duration of bacteriurias was longer; preliminary information has shown that the mean duration of bacteriurias was around 8 weeks. As it was observed with the incidence, it was found that the disease duration was longer during the last part of gestation. As an average the women showed a total of 21 days of infectious illnesses during pregnancy.

It was determined that only 17 percent of women were free of infectious illnesses during pregnancy. On the other hand 52 percent suffered 1 or 2 episodes of illness; 22 percent had 3 or 4 episodes, and 9 percent had 5 or 6 episodes of illness.

The previous information shows that pregnant women in the rural area are subjected to a very intense force of infection and that they are ill during an average of 8 percent of the pregnancy duration.

A comparison of the incidence of infectious diseases during the first trimester of pregnancy in women with abortion and term pregnancies is presented in Table 47. There were no differences in the incidence of respiratory infection, diarrheal disease, conjunctivitis, stomatitis and skin infection. However, twenty five percent of the women with abortions had significant bacteriuria, compared to only six percent in the women with term pregnancies.

After establishing the incidence of infectious diseases for the pregnant women population, a comparison of the morbidity by infectious diseases during pregnancy per categories of the corn fortification index was carried out. A similar relationship was found between morbidity during pregnancy and weight of the conceptus. On Table 48 is presented the frequency of infectious illnesses in pregnant women in relation to newborn's weight. The significant bacteriuria was the only disease found to be more frequent in women delivering infants with low birth weight.

No difference in the incidence of episodes of infectious illnesses was found between the three groups of pregnant women. In Table 49 is presented the analysis aimed to determine differences in disease duration in accordance to corn fortification. As it can be seen, no differences were found.

These data show that no effect of corn fortification on morbidity was found in pregnant women as it was determined for preschool children. However it should be considered that the duration of illnesses in the adult population of Santa María Cauqué is shorter than that observed in children. Having this fact in mind it could be concluded that it would be difficult to determine an effect on morbidity during pregnancy by the improvement of corn. This effect could better be measured by determining changes in the cellular and humoral immunity in fortified and unfortified pregnant women.

i) Relationship between the Fortification Index and the dietary intake in pregnant women

The dietary intake of the women during pregnancy was determined by the method of one week daily record. Three dietetic surveys were carried out corresponding to each trimester of pregnancy. Each survey covered a period of seven days; the interviews were done during the morning and evening of each day from Monday to Friday. The early visit was to find out about the women's breakfast and to observe the preparation of foods served at noon. The second visit was to determine the amount of food eaten at lunch by the pregnant women. With this purpose the interviewers weighed the tortillas, the raw vegetables and fruits available in each home. Furthermore, the recipes of the mixed dishes were obtained as well as the number of servings of each preparation. It was also determined the weight of the servings of some cooked foods of frequent use such as black beans, rice, etc. Besides, the interviewers found out what the family was going to have for supper, and in the following morning visit the amounts of food eaten by the pregnant women at supper time was determined; this was repeated daily. The diets corresponding to Saturday and Sunday were obtained the following Monday by the recall method.

Dietary surveys were practiced in a total of 174 pregnant women. The analyses were done in the diets of 105 women, who were followed up during the three trimesters of pregnancy. The rest either had dietary surveys in one or two trimesters or did not have a complete prenatal record.

To establish the relationship among the level of fortification and the dietary intake some correlations were done (see Table 50). It was found a positive correlation between the fortification index and protein from corn, protein from soy, total vegetal protein, total protein, and protein from fortified tortillas. Based on these findings, an analysis of variance was done to find differences among the three fortified groups. The findings are shown in Table 51. It can be seen that the consumption of tortillas in the highly fortified group of women was significantly higher than in the other groups.

Since the calories produced by fortified and unfortified tortillas were alike (214 and 212 calories per 100 g of tortillas respectively), it can be concluded that the increase in the intake of calories, vegetal and total protein was due to a higher consumption of tortillas. The difference found in the intake of vegetal protein in the two extreme groups of fortification was of 9.5 g; 5.3 g of this protein were provided by the soy added to corn.

The relationship between the corn fortification index and the mean daily intake of calories and protein per trimester of pregnancy is presented in Tables 52, 53 and 54. Obviously the corn fortification produced an effect in the sense that the highly fortified group consumed more calories during the first and second trimesters of pregnancy (Table 52). The consumption of vegetal protein showed a direct relationship with the fortification index. The differences within groups are shown in Table 53. However, the intake of animal protein was the same in the three groups of women, see Table 54. As the consumption of this nutrient in the rural areas is determined by the economic condition, this finding can be considered as evidence that the socioeconomic condition of the families was similar in the families of the three groups of pregnant women.

In summary it can be concluded that corn fortification produced an increase in the daily intake of tortilla in the women who fortified their corn at high level. The differences were clearly noticeable in the daily intake of calories during the first and second trimesters and also in the intake of vegetal protein during the length of pregnancy. The highly fortified women had a mean daily intake of 244 calories higher than the non fortifying women during the first trimester of pregnancy. During the second and third trimesters the mean

daily intake was of 260 and 78 calories more respectively. The intake of vegetal protein for the fortifying women was 9.6, 5.9 and 6.5 g more during each trimester of pregnancy respectively. It was found that the lowest intake of calories and vegetal protein in the unfortified women corresponded to the first trimester of pregnancy. This finding shows that corn fortification had an effect during the period of pregnancy when the food intake is reduced due to the nausea and anorexia of pregnancy. As a consequence, corn fortification was a positive factor in improving the diet of the women during the first six months of pregnancy.

2. OPERATIONAL SIGNIFICANCE

The significant differences in the morbidity, between children with high and low fortification, during the second and third year of life, as well as the significant reduction in preschool mortality in the group of children highly fortified, indicates a good effect of the improvement in the quality of the maize protein. No change in the morbidity during the first year of life was observed, but, the reduction in the infant mortality is a strong indicator of the effect of maize fortification during that period. As children during their first year of life do not eat tortillas in significant amounts, the effect of the maize fortification could have been mediated through an improvement in the quality of the mother's milk. Besides, it must be considered that children less than one year old do not get ill as frequently as they do when they are two or three years old.

The fact that the intervention had a positive effect during the weaning period (12 to 30 months of age), when the infectious illnesses are more frequent, more severe, and have a longer duration, is of great importance in public health. During this period of life, children are not only growing inadequately, but the infectious illnesses have been identified as an important factor in the causality of malnutrition. A reduction in the duration and severity of the illnesses, results in a decrease of the nutritional damage induced by these diseases.

Corn fortification did not produce any change in the dietary pattern of children, and as a consequence the caloric deficit of the diet of children was not corrected; this could be the reason why no effect on growth was observed. However, the positive effect on morbidity and mortality, is showing that the nutritional status

of children was improved by increasing the host defense mechanisms, which are reduced in malnourished children. Since highly fortified children received a protein of better quality, the cellular immunity could have been improved as it has been shown to occur when acutely malnourished children receive an adequate dietary therapy.

In dealing with the subject of prevention of malnutrition, it has not been clarified the relative importance of improving food intake as opposed to controlling the infectious environment. These results show that a good measure to enhance resistance to infections is to improve the quality of children's diets during the first three years of life. These facts should be taken into account when deciding which kind of intervention should be done in countries with a high prevalence of protein-calorie malnutrition and a contaminated environment, since changes in the environmental conditions will take a long time to occur.

An aspect to be considered in any nutritional intervention during the weaning period is that the food to be offered should be processed with locally available foods, and prepared in a suitable form to be consumed easily by the weanling.

The results of this research project showed that the methodology to evaluate the effect of nutrition improvement programs in children should include besides growth, a very detailed morbidity surveillance, and the determination of the host defense mechanisms by measuring humoral and cellular immunity before and after the intervention.

3. SIDE EFFECTS OF THE WORK

The information here reported is in the scope of the project objectives. For the application of the findings, an approach consisting in the distribution of the fortifying mixture at the community level, through cooperatives or other community associations should be utilized. The experience gained through the research activities in the addition of the fortifying mixture at the mill level, assures an easy handling in similar settings. Besides, the demonstration of the biologic effect of the improved corn in the morbidity and mortality of preschool children, should be considered for advising the improvement of cereals.

4. RESEARCH DESIGN

No changes in the research designs were made during the development of the project. However, due to the fact that the fortifying mixture currently being added to the corn, increases the final volume of the corn dough making it difficult to reach the expected 8% level of fortification, the consistency of the mixture should be changed to a pelletized form. It also should be added to corn at 10% level to obtain 8% of final concentration in the corn dough.

Based on the experience of the study here presented, any field study aimed to show the effect of improvement of cereals should consider: a) to increase the level of fortification; b) to enforce the fortification of corn, in order that people should fortify their corn on daily basis; c) to study the effect of fortified corn on morbidity and mortality on a larger sample; d) to include also laboratory methods to assess the level of the host defense mechanisms.

D. DISSEMINATION AND UTILIZATION OF RESEARCH FINDINGS

1. PROJECT OUTPUT

a) Mata, L.J., J.J. Urrutia, B. García, R. Bressani, P. Lachance, and M.A. Guzmán. A model for maize fortification with soy bean flour, lysine and other nutrients in a low socioeconomic rural community. Nutritional Improvement of Maize, Institute of Nutrition of Central America and Panama (INCAP), Bressani, R., Braham J.E. and Béhar M. (Eds.), 1973.

b) Urrutia, J.J., L.J. Mata, F. Trent, J.R. Cruz, E. Villatoro, and R. Alexander. Infection and low birth weight in a developing country. Am. J. Dis. Child., 129:558-561, 1975.

c) Capparelli, E., and L.J. Mata. Microflora of maize prepared as tortillas. Applied Microbiol., 29:802-806, 1975.

d) Urrutia, J.J., B. García, L.J. Mata, and R. Bressani. Reporte preliminar del efecto biológico de la fortificación del maíz con harina de soya y lisina. In: Memorias de la Primera Conferencia Latinoamericana sobre la Proteína de Soya, México, 1975. (in press).

e) Urrutia, J.J., and L.J. Mata. Infección en la mujer embarazada y su influencia en el producto de la concepción. In: Aspectos Perinatales del Parto Prematuro y del Retardo de Crecimiento Intrauterino, Montevideo, Uruguay (in press).

f) Urrutia, J.J., B. García, R. Bressani, and L.J. Mata. Report of the maize fortification project in Guatemala. Presented at: Cereal Breeding and Fortification Workshop. Boulder, Colorado, 12-17 September, 1976 (in press).

2. DISSEMINATION

The research findings have been included in the Annual Progress Report of INCAP every year since 1973. This information has been circulated into the Public Health authorities of Central America.

A final report of the study was presented at: Cereal Breeding and Fortification Workshop held in Boulder, Colorado, September 1976 and will be published in the proceedings of that meeting.

The paper entitled "Preliminary report of biological effect of the corn fortification with soy flour and lysine" was presented at the First Latin American Conference on Soy Protein in November, 1975 and will be published by the American Society of Soy about June 1976. The recent findings about the effect of corn fortification on morbidity and mortality will be presented at the National Congress of Pediatrics of Guatemala in March 1977.

E. WORK PLAN FOR THE COMING YEAR

The project finished on the 31st of March 1976.

F. INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN

Four persons were in charge of adding the fortifying flour to the corn and keeping the records of daily assistance at each of village mills. The four were Indians from Santa María Cauqué. Three of them were minors: two women and one boy. The fourth person was a woman. They worked for the project on contractual basis.

Other women working for the project were: four auxiliary nurses; one dietary technologist and two dietary assistant; one

immunology technician, one laboratory helper, one data clerk and one secretary. All of them were Guatemalans, non Indians. With the exception of one nurse and one dietary assistant, who live in Santa María Cauqué, all lived in Guatemala City.

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Table 1

Fortifying mixture for maize*

Santa María Cauqué

Ingredient	Composition of supplement %	Content in 8% added to corn, g
Soybean flour	97.5000	7.800000
L-lysine HCl	1.5000	0.120000
Thiamin	0.0268	0.002144
Riboflavin	0.0162	0.001296
Niacinamide	0.1930	0.015440
Ferric orthophosphate**	0.6000	0.048000
Vit. A 250-SD***	0.0313	0.002504
Corn starch	0.1327	0.010616
Total	100.0000	8.000000

* Developed by R. Bressani, unpublished data.

** Contains 28.1% Fe.

*** 75,000 mcg Retinol/g.

Table 2

Reasons for accepting the fortifying flour
in 39 collaborator families
Santa María Cauqué, June 1972-January 1976

Reasons	Number of cases and percent
Advice of the clinic personnel	23(59)
Own decision (to increase body strength to resist illnesses)	8(21)
Were convinced by other persons from the community, because it gives strength	4(10)
Volume of dough is increased (produces more tortillas)	4(10)

Table 3

Concepts about the fortifying flour in 39 collaborator families
Santa María Cauqué, June 1972-January 1976

Concepts	Number of cases and percent
It is good and avoid illnesses	22(56)
It is good, avoid illnesses and has good flavor	10(26)
They did not have a concept	7(18)

Everybody expressed that the fortified tortillas has good flavor, but were not accepted by pregnant women, because fortified tortillas caused them nausea.

Table 4

Reasons for not accepting the fortifying flour in 46 non-collaborator families Santa María Cauqué, June 1972-January 1976

Reasons	Number of cases and percent
Tortillas cannot be stored for next day	20 (43)
Change in flavor	17 (37)
Stomachache and/or diarrhea	9 (20)

Table 5

Reasons for not fortifying the maize on daily basis in the collaborator families
Santa María Cauqué, June 1972-January 1976

Prepare tortillas for two or more days*
Feed other persons**
Preparation of corn tamales or tamalitos
Pregnancy (early months)**
Maize destroyed by insects
Maize not completely ripe

* Related to: tortillas cannot be stored.

** Related to: change in flavor.

Table 6

Calculation of fortification index (F.I.)

$$\text{Family weekly FI} = \frac{\text{Days of attendance to the mill}}{\text{Days of the week (6)}} \times \frac{\text{Amount of fortifying mixture added to cooked maize}}{\text{Pounds of cooked maize}}$$

$$\text{Average family FI} = \frac{\text{Sum of family weekly F.I.}}{\text{Sum of weeks of observation}}$$

$$\text{Average child FI} = \frac{\text{Sum of family weekly F.I.}}{\text{Age of child in weeks} + \text{39 weeks of gestation}}$$

Table 7

Variability in the fortification frequency in the highly fortified group* (FI: 40-100) Santa María Cauqué, June 1972-May 1975

Trimesters of observation	Fortification index	Trimesters of observation	Fortification index
1	64±22**	9	78±22
2	69±20	10	55±26
3	71±21	11	51±31
4	75±19	12	60±34
5	79±17	13	66±26
6	55±13	14	70±20
7	71±17	15***	74±16
8	75±16		

* 94 families.

** Mean ± one standard deviation.

*** From December 1st. 1975 to February 3rd. 1976.

Table 8

Variability in the fortification frequency
in the medium fortified group* (FI: 20-39)
Santa María Cauqué, June 1972-May 1975

Trimesters of observation	Fortification index	Trimesters of observation	Fortification index
1	42±27**	9	27±31
2	47±27	10	14±19
3	42±27	11	17±25
4	37±23	12	23±31
5	27±33	13	22±30
6	26±20	14	21±29
7	32±27	15***	24±32
8	24±24		

* 23 families.

** Mean ± one standard deviation.

*** From December 1st, 1975 to February 3rd. 1976.

Table 9

Frequency distribution of the family socioeconomical index in the families with children (<10 years old) in accordance to the fortification index
Santa María Cauqué, June 1971

Fortification index	Number of cases	Socioeconomical index				
		≤19	20-23	24-27	28-31	≥32-36
0-19	108	9(8)*	24(22)	38(35)	32(30)	5(5)
20-39	22	0	8(36)	5(23)	9(41)	0
40-100	93	7(8)	17(18)	38(41)	28(30)	3(3)

$X^2 = 8073$ P = Not significant

* Number of cases (rounded percentage).

Table 10

Family socioeconomical index of three variables in the families with children (<10 years old) in relation to the family fortification index
Santa María Cauqué, June 1971

Fortification index	Number of cases	Socioeconomical index		
		Land tenure	Scholarity	Shoe wear
0-19	108	1.98±0.83*	1.94±0.67	2.24±0.98
20-39	22	2.05±0.84	1.73±0.63	2.09±1.02
40-100	93	2.06±0.76	1.88±0.64	2.17±0.98

* Mean ± one standard deviation.

Table 11

Medical consultation of preschool children in relation to maize fortification
Santa María Cauqué, June 1972-December 1975

Groups of fortification*	Child-months of observation (number of children)	Number of consultations	Mean number of consultation per 100 child-months
0-19	4339(203)	1243	28.6
40-100	3930(165)	1171	29.8

* Classified by Fortification Index.

Table 12

Protein and total free lysine in a sample of 918 tortillas
Santa María Cauqué, June 1972-May 1975

Variables	498 fortified tortillas	420 unfortified tortillas	t value	P
Protein (g%)	10.7±1.2	8.7±1.1	26.45	<.001
Total free lysine (mg%)	55.9±23.2	19.7±13.1	28.31	<.001

Table 13

Achievements and failures of the maize fortification methodology
Santa María Cauqué, June 1972-January 1976

1. It was possible to develop methodology to fortify maize.

2. It was possible to keep on the operation at mill level.

3. It was possible to maintain a surveillance on the frequency of fortification.

4. It was possible to obtain the initial collaboration of 95% of the families.

5. It was possible to maintain the collaboration of 36% of the families.

Table 14

Anthropometry of children from Santo Domingo Xenacoj
25 May 1972-31 May 1975

Age (months)	Number of cases	Parameters	
		Weight (g)	Height (cm)
0	362	2562±410*	46.1±2.1
3	319	5140±815	56.5±3.2
6	281	6260±1104	61.6±3.6
9	252	6875±927	65.3±3.6
12	224	7205±1051	68.4±3.7
15	198	7510±1187	69.0±3.9
18	160	7902±1304	70.1±4.2
21	131	8261±1416	72.7±4.1
24	112	8845±1627	74.3±5.6
27	86	9136±1915	75.7±5.9
30	68	9823±2004	77.6±6.8
33	39	10028±2227	78.2±7.1
36	18	10254±2582	78.8±7.4

* Mean ± one standard deviation.

Table 15

Relationship between the fortification index and the mean daily intake of calories in children from 18 to 36 months of age, Santa María Cauqué, June 1972-May 1975

Age (months)	Fortification index	Number of children	Calories
18th	0-19	23	405±194*
	20-39	7	488±229
	40-100	29	459±272
	Total	59	453±250
24th	0-19	28	712±289
	20-39	5	485±113
	40-100	32	733±360
	Total	65	705±319
30th	0-19	22	966±283
	20-39	6	1004±318
	40-100	33	903±258
	Total	61	936±271
36th	0-19	15	1121±349
	20-39	6	1131±494
	40-100	24	1019±273
	Total	45	1068±329

* Mean ± one standard deviation.

Table 16

Relationship between the fortification index and the mean daily intake of protein in children from 18 to 36 months of age, Santa María Cauqué, June 1972-May 1975

Age (months)	Fortification index	Number of children	Animal protein (g)	Vegetal protein (g)	Total protein (g)
18th	0-19	23	1.2±1.8*	7.5±3.1	8.7±4.5
	20-39	7	4.5±4.0	7.8±3.6	12.2±6.7
	40-100	29	3.6±3.6	8.8±5.0	10.4±7.1
	Total	59	1.8±3.2	8.2±4.3	10.2±6.3
24th	0-19	28	2.7±2.5	13.8±6.2	16.5±7.3
	20-39	5	1.5±1.0	10.1±2.4	11.6±1.9
	40-100	32	3.0±5.1	14.8±7.3	17.8±10.8
	Total	65	2.7±4.0	14.0±6.7	16.8±9.0
30th	0-19	22	2.4±2.4	19.5±5.0	21.9±6.2
	20-39	6	2.6±0.8	22.5±7.5	25.0±7.3
	40-100	33	2.3±3.1	20.6±6.8	22.9±7.3
	Total	61	2.4±2.6	20.4±6.2	22.7±6.9
36th	0-19	15	3.7±2.3	23.1±7.9	26.7±7.9
	20-39	6	3.1±1.3	24.5±10.5	27.6±10.3
	40-100	24	2.2±1.4	24.1±7.4	26.3±7.3
	Total	45	2.8±1.8	23.8±7.8	23.8±7.8

* Mean ± one standard deviation.

Table 17

Correlation between fortification index, and birth order, mother's height, and newborn weight, height and head circumference
Santa María Cauqué, June 1972-May 1975

Variables	Number of cases	Correlation coefficient (r)
Birth order	189	.153
Mother's height	189	.094
Newborn weight	189	-.115
Newborn height	189	.030
Newborn head circumference	189	-.051

Table 18

Relationship between birth weight and the fortification index in full term infants,* Santa María Cauqué, June 1972-May 1975

Variables	Fortification index		
	0-19	20-39	40-100
	$\bar{x} \pm$ S.D.	$\bar{x} \pm$ S.D.	$\bar{x} \pm$ S.D.
Birth weight (grams)	2643±324	2702±285	2571±314
Fortification index	4±6	29±5	65±13
Birth order	4.1±3.1	4.2±2.9	4.8±3.6
Mother's height (centimeters)	143±4.2	145±5.3	144±4.7
Gestational age (weeks)	39.3±1.2	39.3±1.1	39.1±1.5
Number of cases	124	27	71

* Premature babies (< 37 weeks of gestational age) excluded.

Table 19

Correlation between fortification index and child height from birth to 8 years of age, Santa María Cauqué, June 1972-May 1975

Age (years)	Number of cases	Correlation coefficient (r)
0	214	.045
1	168	-.118
2	167	-.045
3	153	.000
4	139	.010
5	126	.057
6	109	.021
7	108	.091
8	109	.021

Table 20

Mean and standard deviations ($\bar{x} \pm$ S.D.) of heights and weights in sibling pairs, Santa María Cauqué, June 1972-May 1975

Age (months)	Number of sibling-pairs	Height (centimeters)		Weight (grams)	
		Sibling 1*	Sibling 2**	Sibling 1	Sibling 2
0	76	45.7±1.8	46.3±1.6	2569(307)	2634(380)
6	76	59.6±2.3	58.9±0.9	6242(687)	6351(857)
15	76	68.0±2.7	67.5±2.6	7320(893)	7210(878)
24	64	74.4±3.8	74.1±3.6	8586(1004)	8641(998)
36	64	79.9±3.9	80.2±4.3	10304(1276)	10389(1253)
60	66	92.2±4.4	92.7±4.1	13509(1498)	13615(1580)

* Sibling 1 born before corn fortification.

* Sibling 2 born after corn fortification.

Table 21

Relationship between changes in the fortification index and growth increments from 3 to 5 years, Santa María Cauqué, June 1972-May 1975

Variables	Number of children	Correlation coefficient (r)
Weight	56	.169
Height	55	.100

Table 22

Correlation between the number of hand and wrist ossification centers and the fortification index, from 6 months to 8 years of age
Santa María Cauqué, June 1972-December 1975

Age (months)	Number of cases	Number of ossification centers	Correlation coefficient (r)
6	76	2.4±1.8*	.060
12	114	3.3±2.6	-.051
18	139	4.9±3.9	.018
24	158	7.0±4.9	-.019
30	137	9.9±5.8	-.001
36	135	13.9±5.7	.000
42	124	16.5±4.9	-.095
48	121	18.0±4.6	.013
54	121	20.5±3.3	.045
60	109	22.1±3.5	.079
72	86	23.9±2.2	.106
84	42	25.4±2.3	-.139
96	19	26.6±2.0	-.250

* Mean ± one standard deviation.

Table 23

Analysis of variance of the number of the carpal ossification centers of children in relation to the fortification index
Santa María Cauqué, June 1972-December 1975

Age (years)	Fortification index 0-19	20-39	40-100	P
1	2.00* (67)	2.00 (23)	2.14 (23)	N.S.**
2	2.08 (102)	2.05 (19)	2.03 (37)	N.S.
3	2.17 (72)	2.22 (23)	2.20 (40)	N.S.
4	2.47 (75)	2.50 (16)	2.50 (30)	N.S.
5	3.09 (58)	3.33 (12)	3.41 (39)	N.S.
6	4.03 (38)	4.26 (19)	4.50 (30)	N.S.
7	5.64 (22)	5.30 (8)	5.05 (19)	N.S.

* Mean (number of cases).

** N.S. = Not significant

Table 24

Correlation between the cortical thickness of the second metacarpal and the fortification index from 6 months to 8 years of age, Santa María Cauqué, June 1972-December 1975

Age (months)	Number of cases	Cortical thickness (mm)	Correlation coefficient (r)
6	76	0.92±0.19*	-.066
12	114	0.95±0.24	.176
18	139	0.99±0.26	-.055
24	158	1.12±0.25	-.156
30	137	1.18±0.28	-.018
36	135	1.18±0.30	-.082
42	124	1.21±0.28	-.067
48	121	1.25±0.29	.099
54	121	1.38±0.31	-.081
60	109	1.41±0.33	.140
72	86	1.54±0.32	.041
84	42	1.68±0.34	.008
96	19	1.82±0.35	-.271

* Mean ± one standard deviation.

Table 25

Morbidity analysis, size of the sample
(number of children and episodes of illness)
Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months											
	0-5		6-11		12-17		18-23		24-29		30-35	
0-19	19**	38***	26	112	35	189	40	216	42	218	33	129
20-39	7	13	9	35	11	49	11	47	14	67	12	54
40-100	7	11	8	35	14	73	16	85	19	93	22	75
Total	33	62	43	182	60	311	67	348	75	378	67	258

* Classified by Fortification Index.

** Number of children.

*** Number of episodes of illness.

Table 26

Episodes of infectious illnesses per categories of the fortification index
Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	2.0**	4.3	5.4	5.4	5.2	3.9
20-39	1.8	3.9	4.5	4.3	4.8	4.5
40-100	1.6	4.4	5.2	5.3	4.9	3.4
P***	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

* Classified by Fortification Index.

** Average number of episodes of infectious illnesses per child.

*** Analysis of variance.

Table 27

Percent of the time will with upper respiratory tract infection
Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	11.0**	8.5	10.9	9.1	9.5	9.8
20-39	8.8	9.4	10.1	7.6	8.3	6.7
40-100	15.9	10.0	6.8	5.3	6.5	5.3
P*** 0-19/40-100	N.S.	N.S.	<.005	<.005	<.005	<.005

* Classified by Fortification Index.

** Rate per 100 child-days.

*** Chi-square test.

Table 28

Percent of the time ill with lower respiratory tract infection
Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	10.4**	8.5	8.3	7.4	8.8	4.0
20-39	16.7	10.1	6.8	5.4	2.9	3.7
40-100	15.9	8.9	5.7	3.1	4.6	4.6
p*** 0-19/40-100	N.S.	N.S.	$<.005$	$<.010$	$<.005$	N.S.

* Classified by Fortification Index.

** Rate per 100 child-days.

*** Chi-square test.

Table 29

Percent of the time ill with diarrhea

Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	10.2**	11.9	16.8	13.6	15.8	9.5
20-39	12.0	9.8	12.1	7.2	9.8	8.6
40-100	11.7	17.1	7.6	9.9	6.9	8.4
p*** 0-19/40-100	N.S.	N.S.	$< .005$	$< .005$	$< .005$	N.S.

* Classified by Fortification Index.

** Rate per 100 child-days.

*** Chi-square test.

Table 30

Percent of the time ill with associated illnesses*

Santa María Cauqué, June 1972-January 1976

Groups of fortification**	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	6.4***	6.5	7.3	6.5	6.7	3.5
20-39	7.3	6.5	6.0	5.7	4.9	2.6
40-100	9.5	9.1	4.6	2.7	2.9	2.4
p**** 0-19/40-100	N.S.	N.S.	$<.005$	$<.005$	$<.005$	$<.025$

* Respiratory plus diarrhea; respiratory plus conjunctivitis and/or stomatitis; diarrhea plus conjunctivitis and/or stomatitis; conjunctivitis plus stomatitis; respiratory plus diarrhea plus conjunctivitis and/or stomatitis.

** Classified by Fortification Index.

*** Rate per 100 child-days.

**** Chi-square test.

Table 31

Percent of the time ill with infectious illnesses

Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	28.6**	27.8	33.3	29.6	32.8	20.7
20-39	36.7	31.4	32.8	24.5	21.1	20.2
40-100	40.8	32.1	22.8	19.5	17.8	19.8
P*** 0-19/40-100	<.005	N.S.	<.005	<.005	<.005	N.S.

* Classified by Fortification Index.

** Rate per 100 child-days.

*** Chi-square test.

Table 32

Percent of the time ill with fever

Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	3.8**	6.9	9.2	7.8	10.4	5.1
20-39	5.6	7.6	7.4	4.8	5.8	5.5
40-100	3.5	5.3	4.0	4.3	3.7	5.6
p*** 0-19/40-100	N.S.	N.S.	$< .005$	$< .005$	$< .005$	N.S.

* Classified by Fortification Index.

** Rate per 100 child-days.

*** Chi-square test.

Table 33

Percent of the time ill with diarrhea of
7 or more stools per day
Santa María Cauqué, June 1972-January 1976

Groups of fortification*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	3.1**	3.2	4.8	4.6	4.6	1.9
20-39	2.0	2.7	5.0	2.2	2.7	2.7
40-100	2.2	4.0	1.4	1.8	1.3	2.1
p*** 0-19/40-100	N.S.	N.S.	$<.005$	$<.005$	$<.005$	N.S.

* Classified by Fortification Index.

** Rate per 100 child-days.

*** Chi-square test.

Table 34

Reduction in number of illness days in the highly fortified compared with the low fortified children, during the second and third year of life, Santa María Cauqué, June 1972-January 1976

Diseases	Age intervals, months				Total
	12-17	18-23	24-29	30-35	
Total diarrhea	16.7*	6.7	16.2	2.0	41.6**
Upper respiratory tract infections	7.5	6.9	5.5	8.2	28.1
Lower respiratory tract infections	4.7	5.3	7.6	0.0	17.6
Total days of infectious illnesses	28.9	18.9	29.3	10.2	87.3

* The figures given show the reduction of illness days per semester of life between the highly fortified and low fortified groups.

** Reduction of illness days during the second and the third year of life.

Table 35

Reduction in number of days with fever and diarrhea with 7 and more stools per day in the highly fortified compared with the low fortified children during the second and third year of life
Santa María Cauqué, June 1972-January 1976

Symptoms	Age intervals, months				Total
	12-17	18-23	24-29	30-35	
Total days of fever	9.4*	6.4	12.2	0.0	28.0**
Days of diarrhea with 7 and more intestinal movements a day	6.1	5.1	6.0	0.0	17.2

* The figures fiven show the reduction of illness days per semester of life between the highly fortified and low fortified group.

** Reduction of illness days during the second and the third year of life.

Table 36

Number of fecal cultures done at 6 month intervals in 3 groups of children observed from birth to 3 years of age, corn fortification project, Santa María Cauqué, June 1972-May 1975

Groups of children*	Age intervals, months					
	0-5	6-11	12-17	18-23	24-29	30-35
0-19	529**	485	624	889	930	784
20-39	198	200	195	258	280	259
40-100	182	176	242	313	397	379

* Classified by Fortification Index.

** Number of cultures.

Table 37

Duration of *Shigella* infection, carriers and cases 3 groups of children observed from birth to 3 years of age, corn fortification project, Santa María Cauqué, June 1972-May 1975

Groups of children*	Duration in weeks**		
	1 %	2-4 %	5-8 %
0-19	58	37	4
20-39	38	51	9
40-100	61	32	7

* Classified by Fortification Index.

** Two isolations were considered independent infections if separated by more than 2 weeks.

Table 38

Infant mortality before corn fortification

Santa María Cauqué, January 1964-May 1972

Groups of fortification*	Number of deliveries	Number of deaths			Rate
		Stillbirths	0-11 months	Total	
0-19	255	8	26	34	133**
20-39	43	0	5	5	116
40-100	206	8	14	22	107
Total	504	16	45	61	121

* Classified by Fortification Index.

** Rate per 1000 deliveries.

Table 39

Infant mortality during corn fortification

Santa María Cauqué, June 1972-January 1976

Groups of fortification	Number of deliveries	Deaths			Rate
		Stillbirths	0-11 months	Total	
0-19	166	6	15	21	127*
20-39	23	0	4	4	174
40-100	115	2	3	5	43
Total	304	8	22	30	99

Rate per 1000 deliveries.

Table 40

Infant mortality in low birth weight babies*

Santa María Cauqué, June 1972-January 1976

Groups of fortification	Number of deliveries	Number of LBW babies	Percent of all deliveries	Number of deaths	Rate
0-19	166	64	38.6	11	172**
20-39	23	9	39.1	3	333
40-100	115	43	37.4	2	47

* <2500 g birth weight.

** Rate per 1000 deliveries.

Table 41

Second to fifth year mortality during corn fortification

Santa María Cauqué, June 1972-January 1976

ortality (years)	Groups of families by Fortification Index											
	0-19			20-39			40-100			Total		
	No. of children	No. of deaths	Rate	No. of children	No. of deaths	Rate	No. of children	No. of deaths	Rate	No. of children	No. of deaths	Rate
Second	163	5	31*	24	4	167	126	3	24	313	12	38
Third	143	3	21	24	0	0	118	1	8	285	4	14
Fourth	103	2	19	18	3	167	88	0	0	209	5	24
Fifth	89	1	11	15	0	0	81	0	0	185	1	5
al 2nd-5th	498	11	22	81	7	86	413	4	10	992	22	22

Rate per 1000 children of that age.

Table 42

Second to fifth year mortality
before corn fortification
Santa María Cauqué, January 1964-May 1972

Mortality	Number of children	Number of deaths	Rate
Second year	454	26	57*
Third year	389	13	33
Fourth year	376	5	13
Fifth year	357	1	3
Total	1576	45	29

* Rate per 1000 children of that age.

Table 43

Correlation between dietary intake and percent of time ill during the second and third year of life
Santa María Cauqué, June 1972-January 1976

Semester of life	M	Variables								
		DD/CAL*	DD/VP	DD/TP	RD/CAL	RD/VP	RD/TP	TID/CAL	TID/VP	TID/TP
Third	52	-.348**	-.366**	-.344**	-.033	-.080	-.077	-.302***	-.348**	-.297***
Fourth	65	-.153	-.209****	-.195	-.029	-.078	-.008	-.131	-.194	-.166
Fifth	70	-.015	-.034	-.061	-.010	-.060	-.053	-.040	-.122	-.105
Sixth	46	-.503**	-.444**	-.478**	-.037	-.165	-.159	-.190	-.168	-.184

* DD = Diarrheal disease; RD = Respiratory disease; TID = Total infectious disease; CAL = Calories; VP = Vegetal protein; TP = Total protein.

** $P < .01$

*** $P < .05$

**** $P < .10$

Table 44

Correlation between fortification index and dietary intake during the second and third year of life
Santa María Cauqué, June 1972-January 1976

Semester of life	Variables			
	FI/CAL*	FI/VP	FI/AP	FI/TP
Third	.071	.136	.066	.129
Fourth	-.023	.021	-.042	.002
Fifth	-.096	-.032	.052	-.009
Sixth	.039	.125	-.163	.079

* FI = Fortification index; CAL = Calories; VP = Vegetal protein; AP = Animal protein; TP = Total protein.

Table 45

Incidence of infectious diseases during pregnancy[1]

Santa María Cauqué, January 1972-October 1975

Trimester of pregnancy	Respiratory tract infection		Diarrheal disease	Other illnesses[2]	Urinary tract bacterial infection	
	Upper	Lower			Clinical	Bacteriuria[3]
1	58(28)[4]	11(5)	12(6)	9(4)	7(3)	12(6)
2	78(38)	21(10)	20(10)	9(4)	16(8)	15(7)
3	83(40)	30(15)	41(20)	18(9)	28(14)	17(8)
Incidence per 100 pregnancies	219(106)	62(30)	73(36)	36(17)	51(25)	44(21)

1 Data obtained from 209 pregnant women observed prospectively from conception to delivery.

2 Conjunctivitis, otitis media, stomatitis and skin infections.

3 $\geqslant$100,000 bacteria per milliliter of urine.

4 Number of episodes (rounded percentage).

Table 46

Days of illness due to infectious disease[1]

Santa María Cauqué, January 1972-October 1975

Trimester of pregnancy	Respiratory tract infection		Diarrheal disease			Other illnesses[2]	Urinary tract infection[3]
	Upper	Lower	Without mucus	With mucus and/or blood	Total		
1	2.8[4]	.9	.2	.0	.2	.4	.4
2	3.5	1.3	.5	.0	.5	.4	.8
3	4.0	2.3	.9	.3	1.2	1.1	1.5
Mean	3.2	1.5	.6	.1	.7	.6	.9

1 Data obtained from 209 pregnant women observed prospectively from conception to delivery.

2 Conjunctivitis, otitis media, stomatitis and skin infections.

3 Based on symptom's duration.

4 Mean days of illness per 100 days.

Table 47

Comparison of the incidence of infectious diseases during the first trimester of pregnancy in women with abortion and term pregnancies
Santa María Cauqué, January 1972-October 1975

Pregnancy	Number of subjects	Respiratory tract infection		Diarrheal disease	Other illnesses	Urinary tract bacterial infection	
		Upper	Lower			Clinical	Bacteriuria
Abortion	56	15(27)*	3(5)	4(7)	4(7)	3(5)	14(25)
Term	209	58(28)	11(5)	12(6)	9(4)	7(3)	12(6)
	X^2	0.012	0.000	0.134	0.680	0.450	13.870
	P	N.S.	N.S.	N.S.	N.S.	N.S.	<0.005

* Number of cases (rounded percentage).

Table 48

Relationship between the incidence of infectious diseases during pregnancy[1] and the newborn's weight
Santa María Cauqué, January 1972-October 1975

Weight of newborns (g)	Number of mothers	Respiratory tract infection		Diarrheal disease	Other illnesses[2]	Bacteriurias[3]
		Upper	Lower			
≤2300	44	36(82)[4]	14(32)	11(25)	9(21)	12(27)[5]
2301-2700	78	89(114)	20(26)	26(33)	12(15)	10(13)
≥2701	75	86(115)	23(31)	28(37)	15(20)	9(12)
Total	197	211(107)	57(29)	65(33)	36(18)	31(16)

1 Data obtained from 209 pregnant women observed prospectively from conception to delivery.

2 Conjunctivitis, otitis media, stomatitis and skin infections.

3 ≥100,000 bacteria per milliliter of urine.

4 Number of episodes (rounded percentage).

5 Differences statistically significant ($X^2 = 3.89$ $P<0.05$).

Table 49

Percent of the time ill with infectious diseases during pregnancy per categories of the corn Fortification Index, corn fortification project, Santa María Cauqué, January 1972-October 1975

Groups of fortification*	Number of women	Infectious diseases				
		Upper respiratory infection	Lower respiratory infection	Diarrheal disease	Urinary tract infection	Other illnesses**
0-19	97	2.9***	1.7	0.7	0.8	0.8
20-39	24	3.7	0.8	0.5	0.3	0.1
40-100	65	3.4	1.4	0.6	1.3	0.7
P		N.S.	N.S.	N.S.	N.S.	N.S.

* Classified by Fortification Index.

** Conjunctivitis, otitis media, stomatitis and skin infections.

*** Rate per 100 person-days.

Table 50

Correlation between fortification index
and some variables in 105 pregnant women diets*,
corn fortification project,
Santa María Cauqué, June 1972-May 1975

Variables	Correlation coefficient (r)	P
Protein from corn	.327	<0.01
Protein from soy	.683	<0.01
Vegetal protein other than corn or soy	-.011	
Total vegetal protein	.256	<0.01
Animal protein	-.079	
Total protein	.222	<0.05
Protein from fortified tortilla	.710	<0.01
Protein from unfortified tortilla	-.584	<0.01
Grams of tortilla	.154	
Calories not derived from tortilla	-.075	
Total calories	.153	

* Mean daily intake, derived from three, one week daily record surveys, corresponding to each trimester of pregnancy.

Table 51

Analysis of variance of the diets of three groups of 105 pregnant women* corn fortification project, Santa María Cauqué, June 1972-May 1975

Variables	Fortification Index			P
	0-19 (37)**	20-39 (16)	40-100 (52)	
Tortilla (g)	479	476	574	<0.010
Calories not from corn	741	732	766	N.S.
Total calories	1801	1745	2024	<0.005
Total protein (g)	46.1	46.3	55.3	<0.005
Animal protein (g)	6.9	7.6	6.6	N.S.
Vegetal protein (g)	39.2	39.0	48.7	<0.005
Protein from corn (g)	21.6	22.5	30.6	<0.005
Protein not from corn (g)	17.6	16.5	18.1	N.S.
Protein from soy (g)	0.0	2.0	5.3	<0.005

* Mean daily intake, derived from three, one week daily record surveys, corresponding to each trimester of pregnancy.

** Number of cases.

Table 52

Relationship between the corn Fortification Index and the mean daily intake of calories during pregnancy corn fortification project, Santa María Cauqué, June 1972-May 1975

Fortification index	Number of women	Trimesters of pregnancy		
		First	Second	Third
0-19	41	1687±486*	1742±485	1840±432
20-39	24	1783±423	1835±462	1742±474
40-100	40	1931±450	2002±472	1918±444
t test:	0-19/20-39	1.30	1.38	1.50
t test:	0-19/40-100	2.35**	2.45***	0.80

* Mean ± one standard deviation.

** $P < 0.05$

*** $P < 0.02$

Table 53

Relationship between the corn Fortification Index and the mean daily intake of vegetal protein during pregnancy corn fortification project, Santa María Cauqué, June 1972-May 1975

Fortification index	Number of women	Trimesters of pregnancy		
		First	Second	Third
0-19	41	36.1±12.2*	41.8±11.8	40.2±9.8
20-39	24	39.4±10.6	42.3±11.3	38.9±11.6
40-100	40	45.7±13.1	47.7±13.3	46.7±12.1
t test:	0-19/20-39	2.00**	1.66	2.54***
t test:	0-19/40-100	3.42*****	2.12**	2.66****

* Mean ± one standard deviation.

** $P < 0.05$ *** $P < 0.01$

*** $P < 0.02$ ***** $P < 0.001$

Table 54

Relationship between the corn Fortification Index and the mean daily intake of animal protein during pregnancy corn fortification project, Santa María Cauqué, June 1972-May 1975

Fortification index	Number of women	Trimesters of pregnancy		
		First	Second	Third
0-19	41	7.5±4.2*	6.5±3.5	7.1±3.6
20-39	24	8.0±4.0	6.4±3.9	7.4±4.8
40-100	40	7.0±3.9	7.3±4.3	6.5±3.4
t test:	0-19/20-39	-0.98	0.84	-0.88
t test:	0-19/40-100	-0.56	0.92	-0.77

* Mean ± one standard deviation.

FIGURES

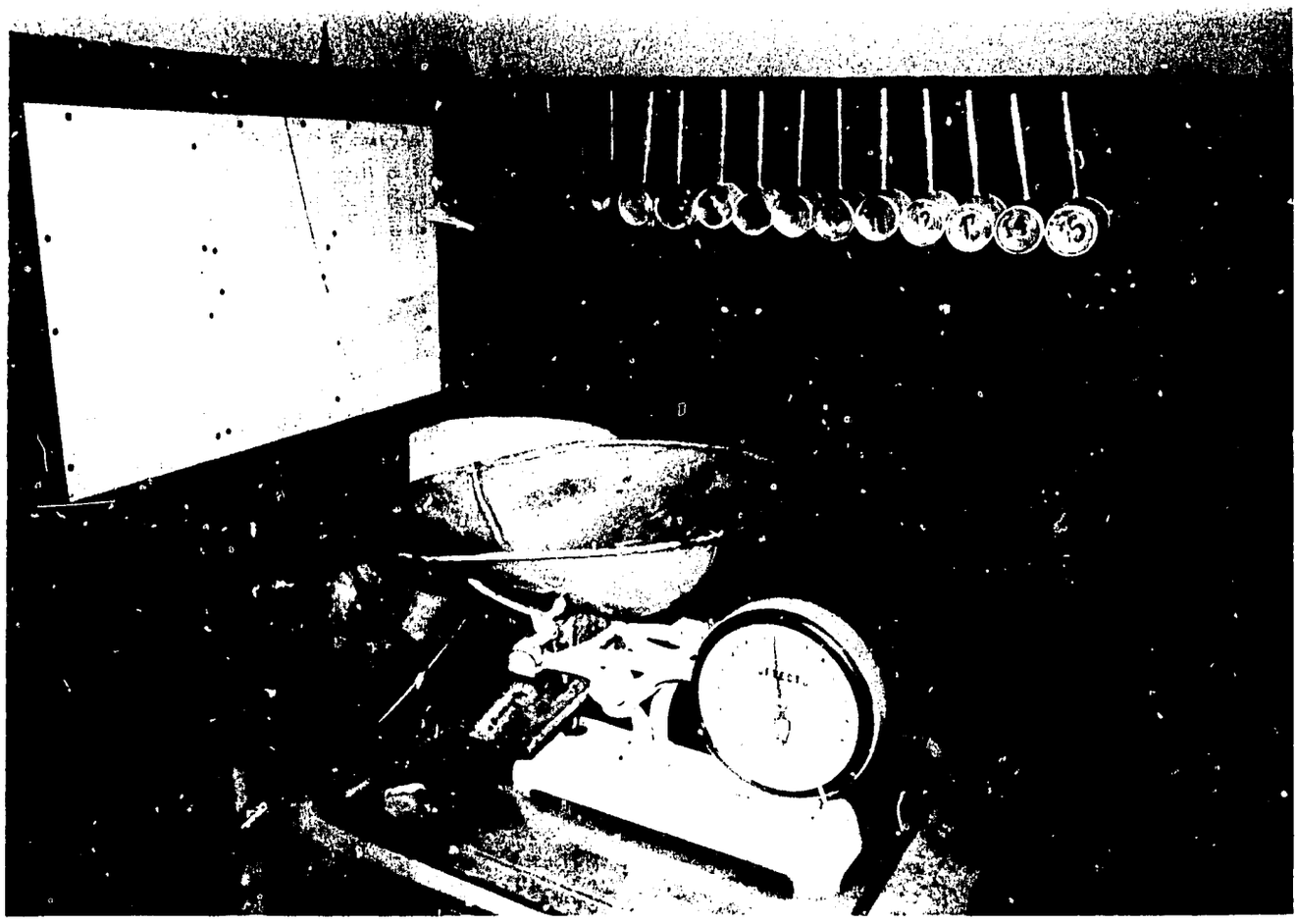

FIGURE 1

FIGURE 2

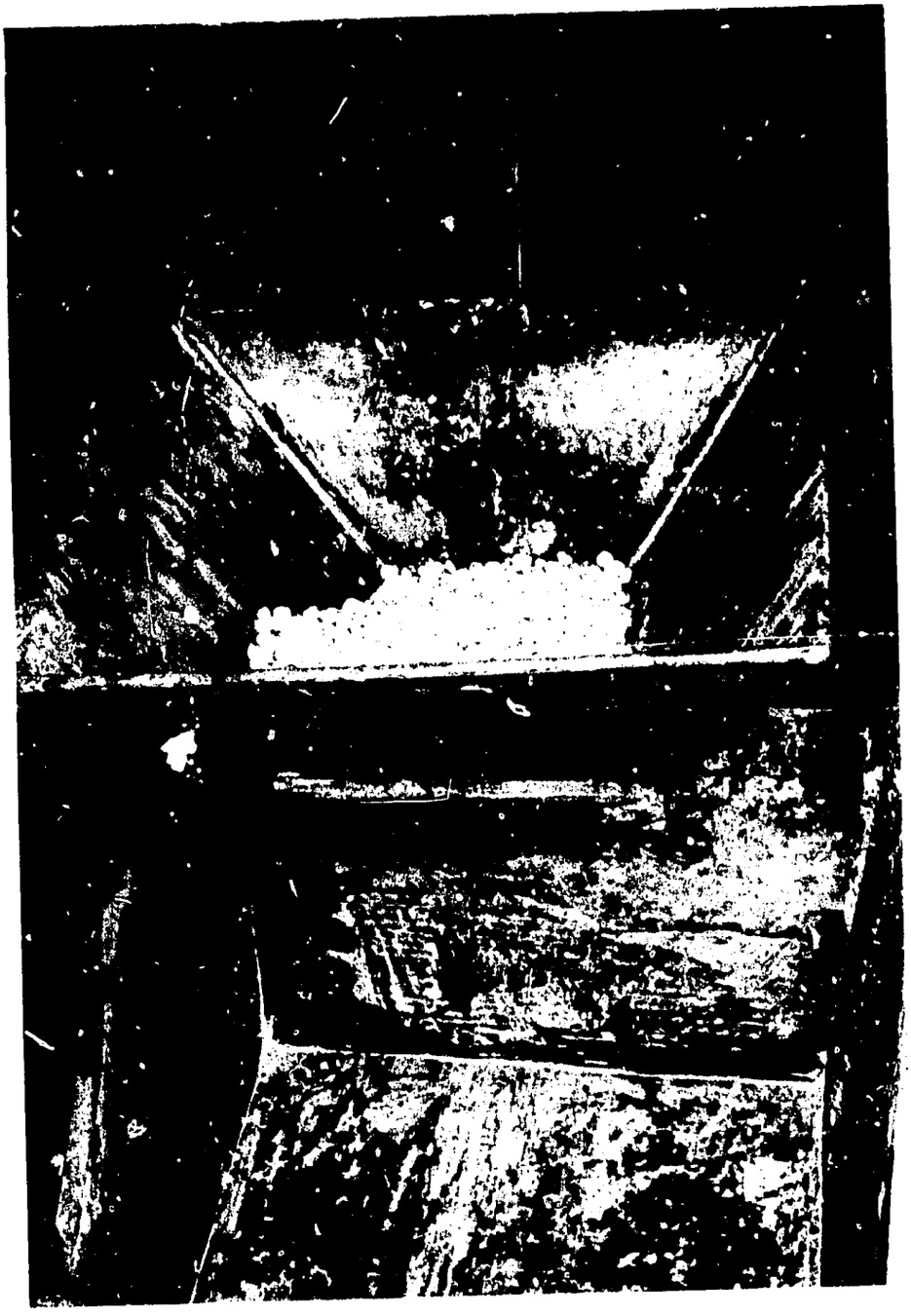

FIGURE 3