Anemia and Work Output

By

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Introduction

I. INTRODUCTION

By the end of the decade the developing countries' population will have increased from roughly three quarters to four fifths of the worlds' total population according to the estimates of Hulse (1984). The population of India has crossed the level of 68 crores and is now swelling at the rate of well over 10 lakhs a month as indicated by Agarval (1983). Consequently the per capita and possibly total food demand will increase with larger younger population. In addition to meeting the increased food demands it should be possible for India to make a headway in all other fields. But malnutrition and ill-health seem to be the debilitating factors in meeting with the various needs of our population. So there is an immediate need for good nutrition and good health to achieve sound man power which is the basis for the national development (Aujla et al., 1983).

Agarval (1983) points out that despite some growth of the economy and increase in the production of food articles, the food taken by most of the Indians is deficient in nutritive elements and which adversely affects the welfare of the people as also their work efficiency. Sadasivam and John (1979) warn that malnutrition leads to wastage of human resources and reduction of this loss would increase the social effectiveness of the population and contribute to economic development.

Spurr et al. (1983) state that poorly nourished populations have a lower work output and a lower working potential mainly due to reduced lean body mass. Sathyanarayana et al. (1978)

point out that both work capacity and work out-put are influenced by the nutrient uptake and the resulting nutritional status of those who perform the work. Childhood malnutrition may also affect the future capacity of individuals for work. It is generally believed that productivity among workers in developing countries is low. This has been attributed at least in part to their poor physique as a consequence of chronic malnutrition. The attempts to improve the nutritional status would thus not only be associated with better health but also with economic benefits in terms of increased productivity.

Physical work capacity can be defined as the potential of an individual to engage in activities involving muscle action. Such activities range from strenuous exercise of short duration to mild exercise of long duration. Individual performance in acute strenuous exercise leading to near exhaustion (maximum exercise) depends mostly on cardio-respiratory reserve, oxygen delivery and metabolic adaptation (such as with physical training) (WHO, 1975).

Iron deficiency anemia affects the physical capacity by reducing the availability of oxygen to the tissues which in turn affects cardiac output and the heart, eventually leading to death in severe cases (Vijayalakshmi et al., 1983).

Nutrition Reviews (1982) point out that among the nutritional deficiency diseases iron deficiency anemia is a major concern in many developing countries. Sjolin (1981) points out that in developing countries the incidence of iron deficiency anemia is often extremely high compared with that in the industrialised part of the world. It has been estimated that there are a total of 260 million anemic women in the developing world alone. The overall proportion of anemic women is highest in Asia, Oceania, followed in descending order by Africa and Latin America (Food and Nutrition Bulletin, 1979).

In developed countries the prevalence of anemia ranges from 7 to 20 per cent in non-pregnant women and upto 35 per cent in pregnant women. Assuming conservatively that 10 per cent of the non-pregnant women and 30 per cent of the pregnant women are anemic, this would make an additional 31 million bringing the world total (outside China) of anemic women between 15 and 49 years of age to 291 million (Food and Nutrition Bulletin, 1979).

Severe anemia is claimed to impair work capacity, learning ability and immune functions. Anemia also contributes significantly to the high rate of maternal mortality and marbidity and low birth weight in infants (Nutrition Reviews, 1982). Finch et al. (1983) through his studies had shown that there was a strong inverse relationship between economic development and prevalence of iron deficiency.

Iron deficiency anemia is more prevalent among young women than is generally supposed and is bound to interfere with health, preparation for pregnancy and work efficiency (Vijayalakshmi et al., 1983). Finch et al. (1983) opine that there is no question that a marked decrease in haemoglobin concentration reduces maximal work performance. Further studies of individuals engaged in hard physical labour suggest that productivity and therefore income are reduced in the presence of iron deficiency.

WHO (1975) brings to the notice of the public that a great deal of ill-health sapping energy and productiveness in many countries and causing tragedies in child birth is due to anemia which reveals that urgent steps are needed to prevent and control anemia.

Cook et al. (1984) have shown that nutritional iron deficiency is a major health problem in developing countries. The only proven way it can be alleviated is to increase iron intake, either by providing medicinal iron (supplementation) or by adding iron to the diet (fortification). Iron supplementation has the advantage of producing rapid changes in iron status. According to Nutrition Reviews, 1982 the incidence of anemia in rural communities of India was reduced by introduction of salt fortified with iron. Vijayalakshmi et al. (1983) by their studies had proved that the haemoglobin level of anemic subjects rose significantly after iron supplementation. Which resulted in an increased work capacity. Davidson et al. (1970) points out that the total cost of the medicinal iron therapy for anemia was less than the cost of the dietary supplement of iron rich foods for one day, while the mean or rise in haemoglobin level was 30 per cent.

Thus iron supplementation can be an effective way of combating anemia and helps in increasing the work output of population groups. This will indirectly help in increasing the gross national product (GNP).

Satyanarayana et al. (1984) state that a major proportion of rural population in developing countries is known to earn their livelihood on activities related to agriculture. Statistical data given by Chidambaram (1983-84) reveals that the percentage of labourers engaged in agriculture is 28.9 per cent of the total workers of Tamil Nadu. As per Spurr et al. (1983) in the less developed areas of the world where mechanization is at a minimum, human labour provides much of the power for economic productivity.

Having these points in mind the present study was designed with the following aims,

1. To find out the relationship between nutrition and work output with special reference to iron deficiency among farm women doing specific activities.

2. To supplement the anemic subjects with suitable doses of iron in the form of ferrous sulphate and observe the impact of supplementation.

It is hoped that the results of the study will be of interest to those involved in increasing the work capacity of population groups.

Review of Literature

II. REVIEW OF LITERATURE

The review of literature related to this study 'Anemia and work output' is discussed under the following sub-headings.

1. National development as related to the nutritional status
2. Prevalence of anemia
3. Anemia and work output
4. Importance of iron supplementation and
5. Effect of iron supplementation on work output

1. National development as related to the nutritional status

Devadas *et al.* (1981) observe that despite India's marvellous increase in food production her nutrition problems continue to be formidable. Malnutrition is still one of the critical issues detering national development.

Eswaran *et al.* (1976) and Luwang *et al.* (1981) state that malnutrition is widely spread in developing countries and is the cause of child mortality, physical and mental retardation. According to Faris (1966) adequate nutrition is an indispensable base for economic development. FAO (1976) warns that poor diet reduces the working efficiency by increasing absenteeism, decreasing resistance to disease causing lethargy and lack of drive.

Belli (1971) has remarked that productivity decreases when the workers do not eat enough.

Latham (1976) reported that there is an obvious link between poor nutrition and productivity, such as lack of calories, poor physical and mental development and anemia. Both work capacity and work output are influenced by the nutrient intake and the nutritional status of those who perform work, be they house wives, persons engaged in subsistence agriculture or wage earners in the labour force. There is no doubt that the sequelae of childhood malnutrition may also affect the future capacity of individuals for work.

Mohan Ram (1982) opined that nutrition research has brought to light several effects of malnutrition on human health. One aspect of far reaching socio-economic implications is the effect of chronic malnutrition in early life on the physical stature and working capacity of individuals.

Under nutrition prevailing in specific social classes in some urban areas and some over populated rural regions of the developing nations retard their work capacity and economic growth (Edmundson, 1979).

Food and Nutrition Bulletin (1979) quoted that malnutrition reduces the present and future potential of human beings by its effects on the physical and mental development of children and the working capacity of adults and it contributes substantially to the perpetuation of the hardships and misery they face.

Miller (1983) opined that the malnutrition survivors (children) are at risk of school failure and eventually are most likely to become 'school dropout'. This affects not only their capacity to learn, but specially to earn money and be productive in society.

A study conducted by Satyanarayana et al. (1977) on 57 male industrial workers engaged in the production of detonator fuses revealed that body weight, height and lean body mass were significantly correlated. Correlation coefficient being as high as 0.72 (P 0.001) with work output. The total daily output was significantly higher (P 0.01) in those with higher body weight and lean body weight. It was also observed that the rate of work increased after the provision of a meal. Sathyanarayana et al. (1979) through his another study on 96 rural Hyderabad boys aged between 14 and 17 years of age proved that impaired work efficiency in under nourished adolescent boys was perhaps the result of current under nutrition. Thus, we could see that the development of a nation will be seriously hampered by the poor nutritional status of its people. Among the deficiency conditions, anemia is very common which is discussed in the subsequent heading.

2. Prevalence of anemia

Sauberlich (1976) considered a Hb level less than 12 g/100 ml of blood as deficient in the case of males above 16 years while Hb values less than 10 g/100 ml as deficient in case of females above 16 years.

According to WHO (1975) haemoglobin concentration of less than 13 g/100 ml of blood in non-pregnant women of child bearing age is likely to indicate anemia.

Food and Nutrition Bulletin (1979) cited that in developed countries the prevalence of anemia ranges from 7 to 20 per cent in non-pregnant women and upto 35 per cent in pregnant women. Assuming conservatively that 10 per cent of the non-pregnant women and 30 per cent of the pregnant women are anemic this would make an additional 31 million bringing the world total (outside China) of anemic women between 15 and 49 years of age to 291 million.

Cook <u>et</u> <u>al</u>. (1980) stated that iron deficiency anemia affects 10-20 per cent of the world's population and Das <u>et</u> <u>al</u>. (1980) had reported that 15 per cent of college students are anemic in the United States of America.

According to Hereberg <u>et</u> <u>al</u>. (1981) nutritional anemia is estimated to affect 500 million to one billion people world wide, or around 10-20 per cent of the population. In Africa between 15 per cent and 60 per cent of children are affected. Rates are as high as 80-90 per cent for pregnant women in areas of India, Bangladesh and Pakistan. Levels of infant anemia in South America are estimated to range from 15 to 50 per cent. Frey (1978) pointed out that iron deficiency anemia is the commonest in all parts of the country. Even in developed countries like Britain, iron deficiency forms 92 per cent of the total anemias (including all types of anemia in female population).

Highest prevalence rates for preschool children were reported in the middle Caicas Islands (68.7 per cent) with 41 per cent and 42.7 per cent respectively in Guyana and Cayman Islands. In Jamaica 76 per cent of infants of one year old were affected. The highest percentage among school aged children was also found in the middle Caicas Islands, high levels were also observed among agricultural and road construction workers.

For this age group in Grenada 65 per cent and Guyana 41 per cent and 57 per cent in two studies, while the prevalence noted in Barbados was 9.3 per cent. Highest rates for pregnant females were found in Montserrat 100 per cent while the lowest was 22.2 per cent in Saint Lucia. Saint Lucia, however had the highest levels among adult men 46.3 per cent. The highest rate among non-pregnant, non-lactating females was 48 per cent in Grenada with the lowest 19 per cent in Barbados (Simmons et al., 1982). Baher (1978) stated that the incidence of anemia has been reported to vary from 10 to over 50 per cent and three fourth of the cases have been prescribed to iron deficiency even in developed countries.

Sjolin (1981) pointed out that prevalence of anemia in Ethiopia among the age group of 10-16 years was 35 per cent (urban) and 69 per cent (rural). In U.S.A. in the case of male aged 13-16 years the prevalence was 4.5 per cent (black) and 1.5 per cent (white) of low income and 0.5 per cent (black) and 0.2 per cent (white) of high income whereas in the case of females of 13-16 years it was 12.5 (black) and 3.6 (white) of low income and 7.4 per cent (black) and 1.0 (white) of high income. This shows that in developing countries the incidence of iron deficiency anemia is often extremely high compared with that in the industralised part of the world. Anemia thus ranks as one of the most serious maladies affecting mankind all over world.

3. Anemia and work output

Basta (1978) pointed out that the relationship between productivity and anemia was both stronger and more relevant to actual conditions of endurance such as the Harward step test as tread mill tests. Among sugarcane cutters there existed a direct relationship between haemoglobin concentration (or) packed cell volume and scores on the Harward step test which assured cardio respiratory reserve with near maximum exercise (Viteri and Torum, 1975).

Iron deficiency anemia affects the physical work capacity by reducing the availability of oxygen to the tissues which in turn affects the cardiac output and the heart eventually leading to death in severe cases (Vijayalakshmi et al., 1983). Basta (1977) and FAO (1977) reveal that World Bank has identified iron deficiency anemia among the possible factors limiting work output and physical capacity of male agricultural and road construction workers under tropical conditions.

Gopalan (1975) reported that studies on agricultural labourers had shown that using an acute severe exercise which measures cardiopulmonary reserves, differences in maximal physical efficiency can be demonstrated, even when the anemia is of a mild or moderate degree. Such findings have been reported among road construction workers and workers in rubber plantations. The changes due to anemia seem to have been corrected by raising the Hb level, according to reliable observations.

WHO (1975) pointed out that a great deal of ill health sapping energy and productiveness in many countries and causing tragedies in child birth was due to anemia. Anemia is a major complication of pregnancy in developing countries.as per Eswaran <u>et al</u>. (1981) and is believed to be a contributing factor in the increased incidence of genitourinary infections, still births, premature births and in the reduction of birth weight of the infant.

Balasubramanian (1975) pointed out that apart from causing a large number of deaths among pregnant women, anemia debilitates the farm and industrial workers, affects their working capacity and reduces their work output.

Nutrition Reviews (1980) state that adolescent boys who were under nourshied during childhood had impaired work efficiency. Anemia interferes with the sense of well being of the individual and reduces productivity and work capacity, it aggravates many other disorders, it contributes to the overall mortality associated with malnutrition (Food and Nutrition Bulletin, 1979).

Rao (1981) stated that available evidence indicated that both severe and mild forms of iron deficiency are associated with several deleterious effects in man. In children it may impair immune competence and reduce resistance to infection and hence increase morbidity. In pregnancy severe anemia is known to be associated with increased risk of premature delivery and increased maternal and fatal morbidity and mortality.

According to Lakhanpal (1976) iron deficiency is a nutritional disorder where the mean carpuscular haemoglobin concentration falls below the accepted normal level which is described as hypochromic anemia. The iron deficiency anemia is characterized by decreased size of red cells, reduced serum iron and decreased haemoglobin concentration.

4. Importance of iron supplementation

Hallberg *et al.* (1984) opined that there is a high prevalence of iron deficiency anemia in most developing countries. Anemia has a negative effects on health and well being. It is important to find effective and realistic methods to counteract the iron deficiency.

Bothwell *et al.* (1981) suggested that severe anemia during pregnancy could be prevented by either iron supplementation or by food fortification.

Costa *et al.* (1984) and Rao (1981) pointed out that habitual diets consumed in certain parts of America and India is quite low and at this low level of absorption, maintenance or iron balance is not possible in a large proportion of population respectively. This necessitates the supplementation of iron in their diets.

An open ended questionaire administered to the women showed that those receiving iron reported an improvement in appetite, a sense of well being and decrease in tiredness and palpitation. The supervisors also noted a marked behavioural alteration such as cheerfulness and lack of irritability in those receiving iron (Rahamathullah, 1983).

Rao (1981) pointed out that two main approaches for the control and prevention of iron deficiency anemia are (i) improvement of habitual diet to enhance iron availability - an approach which was not practicable in many population groups, (ii) direct intervention with additional iron supplementation of iron and folate in tablets or other suitable forms and fortification where a haematinic is added to one of the articles of diet.

5. Effect of iron supplementation on work output

Basta (1978) showed that supplementation with iron and a positive haemoglobin response reversed the earlier findings, and control groups maintained their lower productivity level.

Eswaran et al. (1981) carried out a study on 80 expectant mothers in the lower socio-economic status attending two Municipal Maternity Centres in Coimbatore where Modified Special Nutrition Programme (MSNP) and iron and folic acid supplementation were in operation. The results showed that the nutritional status of the expectant mothers improved with a combined supplementation of iron, folic acid, Bulgar wheat/Balahar and salad oil. By improving the mother's nutritional status, the condition of the new born also could be improved to some extent as indicated by the anthropometric measurements.

In a study conducted by Latham (1976) in Parnassus estate where supplementation was provided in the second half of the season there was a significant effect on weight for height on productivity both before and after supplementation. The cutters whose weight/height was below 85 per cent cut significantly less sugarcane than those whose weight/height was above 95 per cent. This significant relationship remained when factors such as age, weight, height and skinfold thickness were controlled.

According to the Annual Report of NIN (1978) a group of children receiving a daily supplementation of iron (20 mg) and folic acid (100 mcg) tablets showed significant increase in mean haemoglobin levels than that of the control group.

As per Year Book of India (1983) a prophylatic programme to prevent nutritional anemia among women and children, included the distribution of iron and folic acid tablets through health centres. This programme covered 2.4 crore mothers and children annually.

Rahamathullah (1983) pointed out that of the total 228 women (employed in Malabar-Wynaad) studied 53 had Hb level of 5 gms or less at the beginning of the study. The average Hb levels and mean body weight of the women were 6.1 gm and 48.1 kg respectively. The experiment consisted of feeding the anemic individuals with iron tablets accompanied by deworming treatment. At the end of the study a remarkable increase in Hb level and an improvement in their body weight was observed. They also showed a marked improvement in work performance as well as in the number of days worked.

The study on work efficiency conducted on 100 adolescent boys with an aid of ergometer revealed that boys who were heavier and without any excess fat with normal body weight for their age were able to do more work when compared to their counterparts who were lighter and less well nourished. Due to the difference in total weight, the work capacity of Americans and Indians at the same age was different. Our boys lagged behind American boys because of lower weight (Nutrition, 1982).

Mertz et al. (1984) stated that iron deficiency is a world wide problem affecting women of child bearing age and children. It affects the rich and the poor alike and in contrast to other trace elements, knows no geographic boundries.

Spurr et al. (1977) conducted a study on 46 sugarcane cutters of 18-34 years of age. The VO_2 max. and daily productivity had been measured in 46 sugarcane cutters. A multiple regression analysis demonstrated that productivity was simultaneously related to VO_2 max height and body fat (r = 0.685, P 0.001). The multiple regression equation was: productivity (tons/day) = 0.81 VO_2 max - 0.14 per cent fat + 0.03 height - 1.96. The data indicated that productivity was affected indirectly by nutritional status through the influence of the latter on height, fat content and VO_2 max.

Basta (1977) pointed out that iron deficiency anemia increases the mortality rate of women and decreases the learning ability of children. Basta's (1977) study on 571 road construction workers between 18 and 39 years of age showed that moderate to severe anemia (haemoglobin below 11.1 g/100 ml, haemotocrit of 33 per cent and below) was present in about 20 per cent of the anemic sample, was closely associated with poor performance in the Harvard step test. Their performance increased after iron supplementation.

Another study carried out by Basta (1977) on rubber plantation workers in Java showed that Tappers classified as anemic on the basis of WHO norms collected about 19 per cent less latex (corrected for age and type of tree) than non-anemic workers. An intervention programme was then carried out for six weeks. This consisted of supplying 300 rubber tappers, divided equally into two groups of anemics and non-anemics with one of two treatments; (a) 100 mg of elemental iron (in the form of ferrous sulphate) and (b) a saccharine placebo. After six weeks, work output measurements showed that the previously anemic tappers were collecting just as much latex as non-anemic ones. The haemoglobin levels of the anemic subjects were also improved.

The study carried out by Basta (1977) on 200 road construction workers in Northern Uttar Pradesh revealed that the work output of one of the two populations studied was also correlated with Hb levels. In both populations there were close relationship between work output and dietary iron and folate intake and height, weight and arm circumference.

Experimental Procedure

III. EXPERIMENTAL PROCEDURE

The experimental procedure pertaining to this study on 'Anemia and work output' is discussed under the following headings.

1. Selection of the area
2. Selection of the subjects
3. Assessing the nutritional status of the subjects
   a. Conducting food weighment survey
   b. Recording heights and weights
   c. Carrying out biochemical estimations
      i. Estimation of haemoglobin
      ii. Estimation of serum iron
      iii. Estimation of total iron binding capacity (TIBC)
      iv. Estimation of packed cell volume (PCV)
   d. Assessment of the clinical status
4. Recording pulse rate and blood pressure of the subjects
5. Determination of basal metabolic rate (BMR)
6. Determination of vital capacity
7. Recording the pulse rates while working on a static bicycle ergometer
8. Determination of work efficiency of the subjects for specific activities
9. Supplementation with iron tablets
10. Evaluating the work output after supplementation

1. Selection of the area

Tamil Nadu Agricultural University Farm was chosen as the place for conducting the research work. The place was chosen for its nearness and the co-operation extended by the autherities and farm workers.

2. Selection of the subjects

Thirty adult women who were anemic as judged by haemoglobin levels formed the experimental group and 30 adult women whose haemoglobin levels were satisfactory (above 10.5 g/100 ml of blood) formed the control group.

3. Assessing the nutritional status of the subjects

a. Conducting food weighment survey

On the basis of experience gained in nutrition surveys conducted in more than twenty countries by the Interdepartmental Committee on Nutrition for National Defense (ICNND) it is apparent that a combined approach including physical, biochemical and dietary assessments give more meaningful information than any one approach taken separately.

A diet survey (one day weighment survey) on a sub-sample of 10 subjects who were anemic and 10 subjects who were non-anemic was done.

The investigator visited the houses of the subjects and weighed all the raw food items before cooking. The weight of the cooked items were noted down after cooking. After this the subjects were asked to consume the weighed amount of food. After they had finished, the quantity of food left unconsumed was weighed and this was substrated from the cooked weight of the food given to her. From the above data, the quantity of cooked food consumed by the individual was obtained. From the cooked food consumed the raw ingredients used were calculated, and the nutrients available from the diet per day was calculated using the 'Nutritive Value of Indian Foods' (Gopalan et al., 1982).

b. Recording heights and weights

The pattern of growth and the physical state of the body, though genetically determined, are profoundly influenced by diet and nutrition. Hence anthropometric measurements are a useful criteria for assessing the nutritional status (Swaminathan, 1974). Therefore heights and weights were recorded for all the subjects.

The height was measured using a fibre glass tape fixed to the wall. The subjects were asked to stand erect and upright on a firm level floor barefooted against the tape with legs parallel and arms hanging freely at the sides. A wooden scale was placed gently on the head perpendicular to the wall and the height was measured from the tape nearest to 0.1 cm.

The weights were taken preferably in the morning after bowel movement and before breakfast. The subjects were wearing light clothing. The weights were measured on platform type beam balance capable of reading upto 0.1 kg.

c. Carrying out biochemical estimations

i. Estimation of haemoglobin

Schaefer (1966) opines that biochemical findings are extremely valuable in assessing sub-optimal nutrition where physical symptomatology cannot be recognized. Haemoglobin levels are perhaps the best single biochemical index of the general state of health of a population and the finding of a high incidence of anemia in a population is a cause to suspect iron deficiency whatever be its source.

A finger prick was made with a sterilised needle and 0.02 ml of blood was collected with the help of a micro pipette taking care not to allow any air bubble to enter into the pipette. The collected blood was blown out into a labelled filter paper. The concentration of haemoglobin was estimated after dilution of the blood sample in a solution that converts haemoglobin to cyanmethaemoglobin which was then quantified spectro-photometrically using the method of Crossby et al. (1954). The values arrived at were compared with those of Sauberlich (1976) and all those below the range of 10 g/100 ml were termed anemic in case of adult women. The procedure for the estimation of haemoglobin is given in Appendix I.

ii. Estimation of serum iron

Pearson (1966) points out that the earlier stages of iron depletion in the body might be detected by determination of serum iron levels and total iron binding capacity (TIBC).

Five ml of venous blood was collected and centrifuged for serum separation after the addition of potassium oxalates. The collected serum was used for estimating serum iron by the Dipridyl method of Varley (1969). The procedure for estimation of serum iron is given in Appendix II.

iii. Estimation of total iron binding capacity (TIBC)

Pearson (1966) warns that increased iron binding capacity is a characteristic of uncomplicated iron deficiency. Serum was obtained from the venous blood collected from the subjects. Total iron binding capacity of these serum samples were estimated by the Ramsay's Dipyridyl method (1969). The procedure for estimation of total iron binding capacity is given in Appendix III.

iv. Estimation of packed cell volume (PCV)

Packed cell volume was determined by means of a specially devised centrifuge tube known as hematocrit. Two ml of blood rendered non-coagulable, is drawn into a graduated capillary tube, placed in a centrifuge and revolved at a speed of 3000 rpm for 30 minutes. At the end of this time the original blood will be found to have separated into a clear colorless column of plasma and a red column of corpuscles. The lengths of the two columns are read off by means of the graduations on the tube. The length of the red column gives the packed cell volume (Best and Taylor, 1961).

d. Assessment of the clinical status

Pearson (1966) states that clinical examination is the most essential part of the nutritional surveys, since the ultimate objective is to assess levels of health of individuals and population groups as influenced by the diet they consume.

Numerous signs and symptoms of dietary deficiencies have been classified by several individual scientists or expert committees. Among those signs and symptoms of dietary deficiencies a few important ones have been used as the criteria for assessing the clinical status of the subjects.

4. <u>Recording pulse rate and blood pressure of the subjects</u>

Among the three principal attributes of the circulation, blood pressure, blood flow and blood volume, the blood pressure is the most easily determined and recorded (Best and Taylor, 1970).

The pulse rate and blood pressure of the subjects before and after different activities were also recorded.

Koretkoff (1905) introduced a convenient method by which the systolic and diastolic pressures could be ascertained only through listening to a sound. In this method commonly the pressure of the brachial artery is measured. The instrument used is known as sphygmomanometer.

<u>Auscultatory method</u>: The instrument is kept at the level of the heart and the cuff is tied round the upper arm. Pressure is raised to 200 mm of Hg and then gradually released. Variations of sounds are heard with a stethoscope placing its chest piece on the brachial artery, a little below the cuff. The sounds are heard due to occurrence of turbulence in the flow of blood through the narrowed blood vessels when the manometric pressure just coincides with the systolic blood pressure.

Due to giving air pressure in the cuff, the vessel is pressed and blood flow is obliterated. But while releasing the air pressure gradually, blood just begins to flow through the narrowed blood vessels and the pattern of flow is changed from streamline flow (silent) to turbulent flow (noisy) when the pressure is further released, normal streamline flow sets in and the sound is no longer heard. At this point manometric pressure coincides with the diastolic pressure. So, as the pressure is released the following variations of sounds are heard: First phase - sudden appearence of a clear tapping sound. This indicates systolic pressure. It persists while the pressure falls through 15 mm of Hg. ~~Second phase - the tap. It persists while the pressure falls through 15 mm of Hg.~~ Second phase - the tap sound is replaced by a murmur persisting for another 15 mm of Hg. Third phase - the murmur is replaced by a clear loud gong sound lasting for the next 20 mm of Hg. Fourth phase - the loud sound suddenly becomes muffled and rapidly begins to fade. This point indicates diastolic pressure. Fifth phase - absence of all sounds.

5. <u>Determination of basal metabolic rate of the subjects (BMR)</u>

<u>Indirect calorimetry</u>: Due to complications involved in direct calorimetry, heat output is calculated indirectly from O_2 consumption and CO_2 output.

The Benedict Roth apparatus is very useful, as the heat production can be calculated in this type of apparatus, by the oxygen consumption only, without determination of CO_2 elimination. The subject is allowed to breath from O_2 reservoir through a mouthpiece, the nose being clipped. The CO_2 eliminated in expiration is absorbed by soda lime to keep the O_2 reservoir pure.

The fall in the level of O_2 during the experiment is recorded which gives the value of O_2 consumption at the specified time. In this method, respiratory quotient of the subject is not determined.

After normal calories per hour and actual test calories per hour had been determined the smaller figure is substracted from the larger figure, then divided the difference always by the normal. Thus obtained decimal fraction when multiplied by 100 gives the Basal Metabolic Rate in per cent.

6. Determination of vital capacity of the subjects

Vital capacity is the maximal amount of gas that can be expelled from the lungs following a maximal inspiration (Best and Taylor, 1970). It can be measured by an instrument called Benedict's Roth Spirometer. The vital capacity of a subject indicates his respiratory efficiency. In anaemic individuals vital capacity will be generally affected therefore the vital capacity of the selected individuals was also carried out in our study. One end of the short rubber tubing which comes with the apparatus is connected to the open end of the two-way valve and the vital capacity mouth piece is inserted into the other end. The spirometer bell is down at the lowest point. The subject in the standing position, having taken a full breath, filling the lungs to the utmost, cleared off the nostrils with the thumb and fore finger and was requested to exhale into the apparatus. The pen made a straight line downward as the bell raised to the height of the exhalation. The difference between the initial and final points of the straight line gives the vital capacity.

7. <u>Recording the pulse rates while working on a static bicycle ergometer</u>

It is a modified bicycle specially constructed for carrying out standardised work whose wheel is rotated by pedalling without the actual progress of the bicycle in which the amounts of mechanical work per unit of time are registered. Pulse rates of the subjects were monitored while they were cycling at a speed of 55-60 revolutions per minute against the amounts of resistence in the sitting position on a static bicycle. The duration of the experiment was nine minutes. The pulse rates were monitered at third, sixth and ninth minute.

8. <u>Determination of work efficiency of the subjects for specific activities</u>

Both anemic and non-anemic groups of volunteers were requested to do the following activities, namely straw harvesting, cowpea haulms cutting, cowpea pod picking, sorghum harvesting and weeding, for 30 minutes and the area covered by them were measured using a measuring tape. The amount of cowpea pods picked by each individual was weighed and given in terms of grams.

9. <u>Supplementation with iron tablets</u>

All the 30 anemic women in the experimental group were supplemented with ferrous sulphate tablets of 120 mg per day for 90 days. The non-anemic volunteers were given a placebo tablet to avoid differenciation.

10. <u>Evaluating the work output after supplementation</u>

After supplementing the volunteers with iron tablets for 90 days the work output was again evaluated based on the area covered within 30 minutes while doing the following activities namely, straw harvesting, cowpea haulms cutting, cowpea pod picking, sorghum harvesting and weeding and compared with the earlier values.

The changes in blood pressure and pulse rates were also determined for the same activities after supplementation. The haemoglobin, serum iron, total iron binding capacity and packed cell volume were estimated after iron supplementation and was compared with the initial values. Similarly the basal metabolic rate and vital capacity were also compared.

Results and Discussion

IV. RESULTS AND DISCUSSION

The results and discussion pertaining to this study on 'Anemia and work output' are discussed under the following headings.

1. Nutritional status of the subjects at the start of the study
   - a. Mean food and nutrient intake
   - b. Mean heights and weights
   - c. Mean haemoglobin levels
   - d. Mean serum iron and TIBC levels
   - e. Mean packed cell volume
   - f. Clinical picture
2. Pulse rate and blood pressure of the subjects
3. Basal metabolic rate and vital capacity of the subjects
4. Work output during specific activities
5. Pulse rates of the subjects while working on a static bicycle ergometer
6. Impact of iron supplementation on the anemic subjects

1. Nutritional status of the subjects at the start of the study

a. Mean food and nutrient intake

Table I gives the mean food intake of the subjects participating in the study.

TABLE I

MEAN FOOD INTAKE OF THE SUBJECTS

Food stuffs (g)	ICMR recommended allowances(g)* (1984)	Food intake	
		Anemic group (g)	Non-anemic group (g)
Cereals	350	430	435
Pulses	55	20	26
Green leafy vegetables	125	18	53
Other vegetables	75	19	21
Roots and tubers	75	28	19
Fruits	30	0	9
Milk	100	10	19
Fats and oil	40	9	8
Sugar and jaggery	30	22	19
Non-vegetarian item	30	0	10
Eggs	30	0	0

* .. allowances are for moderate activity

The mean food intake of both the groups was inadequate with reference to all the foods with the only exception of cereals, where the intake was much higher than the recommended allowances. However, non-anemic women appeared to consume more of green leafy vegetables when compared to their counterparts in the anemic group which probably would have influenced a better haemoglobin level among these subjects.

Mean nutrient intake

Table II brings out the mean nutrient intake of the subjects.

TABLE II

MEAN NUTRIENT INTAKE OF THE SUBJECTS

Nutrients	ICMR recommended allowances* (1984)	Food intake	
		Anemic group	Non-anemic group
Proteins (g)	45	36	42
Energy (K cal)	2200	1600	1806
Calcium (mg)	400-500	358	453
Iron (mg)	30	23	25
Retinol (mcg)	750	156	434
Thiamine (mg)	1.1	1.3	1.4
Riboflavin (mg)	1.2	0.44	0.52
Ascorbic acid (mg)	50	21	95

* .. allowances are for moderate activity

The mean nutrient intake of the anemic women was inadequate with respect to all the nutrients except thiamine. The mean nutrient intake of the non-anemic women was inadequate with respect to proteins, energy, iron, retinol and riboflavin whereas it was adequate with respect to calcium, thiamine and ascorbic acid.

Though the mean intake of iron was low in both anemic and non-anemic women, the bio availability of iron among non-anemic women might have been better since their mean intake of ascorbic acid was high. Dietary ascorbic acid influences the absorption of iron according to Krause (1979).

Individual data of food and nutrient intakes are given in Appendix IV.

b. Mean heights and weights

In Table III we can see the anthropometric data of both the groups.

TABLE III

MEAN HEIGHTS AND WEIGHTS

Details	Anemic N-30		Non-anemic N-30
Mean height in cm	151.27 ± 5.071		151.03 ± 4.93
't' value		0.21*	
Mean weight in kg	41.6 ± 3.57		42.6 ± 3.18
't' value		1.11*	

* .. Not significant

All the subjects were selected in such a way that they were in the age group of 25-40 years. The mean height of the anemic women was 151.27 cm as against 151.03 cm recorded by the non-anemic women.

The mean weight of the anemic women was 41.6 kg against 42.6 kg of non-anemic women. The mean weights of both anemic and non-anemic women were less than 45 kg, the weight of an average Indian woman, suggested by ICMR (1984).

Statistical analysis of the heights and weights revealed that the differences in heights and weights between anemic and non-anemic women were not statistically significant. It is essential to keep the variations minimum in a study like this, since the differences in anthropometric measurements may influence the work output and energy expenditure. Therefore subjects for the study were chosen with differences in heights and weights being statistically insignificant.

Individual heights and weights are appended in Appendix V.

c. Mean haemoglobin levels

Table IV gives the mean haemoglobin levels of the subjects at the beginning of the investigation.

TABLE IV

MEAN HAEMOGLOBIN LEVELS OF THE SUBJECTS

Groups	N	Mean haemoglobin (g/100 ml)	't' value
Anemic	30	9.4 ± 0.392	
Non-anemic	30	13.0 ± 0.282	40.84**
Sauberlich (1976)		10.00	

* .. Significant at one per cent level

The anemic women had registered a mean value of 9.4 g/100 ml which was low when compared to 10 g/100 ml suggested by Sauberlich (1976). The mean haemoglobin values of the non-anemic women were above 10 g/100 ml confirming that they were non-anemic.

Statistical analysis between the values registered by the anemic and non-anemic women revealed that the values were significant statistically at one per cent level. It was important to choose such subjects with significantly different values so that it would be possible to attribute the differences in the activities, to the differences in the haemoglobin level.

Individual haemoglobin values are given in Appendix VI.

d. Mean serum iron and TIBC levels

The mean serum iron and TIBC levels of the subjects in the beginning of the study are given in Table V.

TABLE V

MEAN SERUM IRON AND TIBC OF THE SUBJECTS

Details	Mean serum iron (mcg/100 ml)	Mean TIBC
Anemic N-30	65.5 ± 4.23	425.6 ± 22.38
Non-anemic N-30	101.9 ± 2.31	313.6 ± 45.17
't' value	41.36**	11.95**
Cartwright and Wintrobe (1949)	..	482

** .. Significant at one per cent level

The anemic women registered a mean serum iron value of 65.5 mcg/100 ml against 101.9 mcg/100 ml recorded by the non-anemic.

Statistical analysis between the values registered by the anemic and non-anemic women, revealed that there was a significant difference at one per cent level, between both the groups. Individual serum iron values are given in the Appendix VII.

Davies et al. (1952) found a TIBC of 204-429 (mean 320) mcg/100 ml in females with a per cent saturation of 14-51 (average 33). Cartwright and Wintrobe (1949) pointed out that in case of iron deficiency anemia the range is 304-705 and average is 482 mcg/100 ml.

In the present study the anemic women registered a mean total iron binding capacity of 425.6 mcg/100 ml against 315.6 mcg/100 ml recorded by the non-anemic women.

Statistical analysis between the values registered by the anemic and non-anemic women, revealed that there was a significant difference at one per cent level, between both the groups. Individual total iron binding capacity values are given in the Appendix VIII.

e. Mean packed cell volume (PCV) of the subjects

Table VI highlights the mean packed cell volume of the subjects at the start of the study.

TABLE VI

MEAN PACKED CELL VOLUME OF THE SUBJECTS

Groups	N	PCV in per cent	't' value
Anemic	30	22.7 ± 4.19	
Non-anemic	30	38.8 ± 0.82	20.65**
Davidson et al. (1975)		45 - 48	

** .. Significant at one per cent level

Davidson et al. (1975) state that normal packed cell volume (PCV) is 45-48 per cent. Anemic women had registered a mean packed cell volume of 22.7 per cent against 38.8 per cent recorded by the non-anemic women.

Statistical analysis between the values registered by the anemic and non-anemic women showed that there was a significant difference at one per cent level between both the groups. Individual packed cell volume of the subjects are given in Appendix IX.

f. Clinical picture

In general the clinical picture of the non-anemic group appeared to be better than the anemic group. Out of the 30 anemic subjects 17 subjects had skin pallor and 12 subjects' hair was lacking lustre while out of 30 non-anemic subjects, only 6 subjects had skin pallor and 2 subjects' hair was lacking lustre. While doing work, 13 anemic subjects out of 30, became tired easily, 11 had poor breath-holding capacity and 6 subjects were exposed to the problem of giddyness whereas none of the non-anemic subjects were prone to these characteristic clinical symptoms of anemia. Other than these clinical symptoms, both the groups were free from other deficiency symptoms.

2. Pulse rate and blood pressure of the subjects

Table VII presents the mean pulse rate of the subjects recorded before and after the activity at the beginning of the study.

TABLE VII

MEAN PULSE RATE OF THE SUBJECTS BEFORE AND AFTER THE ACTIVITY

Group	N	Mean pulse rate before activity	't' value	Mean pulse rate after activity	't' value
Straw harvesting					
Anemic	30	82 ± 2.23	17.87**	105 ± 2.7	35.92**
Non-anemic	30	73 + 1.5		84 + 1.75	
Cowpea haulms cutting					
Anemic	30	82 ± 2.15	18.15**	103 ± 2.48	34.93**
Non-anemic	30	73 ± 1.67		84 ± 1.92	
Cowpea pod picking					
Anemic	30	82 ± 2.09	19.86**	93 ± 3.55	12.28**
Non-anemic	30	73 ± 1.34		83 ± 2.69	
Sorghum harvesting					
Anemic	30	83 ± 1.56	23.89**	103 ± 3.3	21.96**
Non-anemic	30	73 ± 1.68		84 ± 3.4	
Weeding					
Anemia	30	84 ± 1.31	27.09**	104 ± 3.01	27.32**
Non-anemia	30	73 ± 1.54		85 ± 2.66	

** .. Significant at one per cent level

It is obvious from Table VII that there was an increase in pulse rate after doing activities like straw harvesting, cowpea haulms cutting, cowpea pods packing, sorghum harvesting and weeding.

The difference was observed among all subjects irrespective of whether they were anemic or non-anemic. However it was noticed that the rate of increase in pulse rate was more for the anemic women than non-anemic women. This increased pulse rate among anemic women indicated that they had to exert more to do the same activity because they were anemic.

Statistical analysis also showed a significant difference in pulse rate at one per cent level for all the activities among anemic and non-anemic women.

Individual pulse rates taken before and after the activity are given in the Appendix X.

Table VIII depicts the mean blood pressure of the subjects before and after the activity for a specified period of time.

TABLE VIII

MEAN BLOOD PRESSURE OF THE SUBJECTS
BEFORE AND AFTER THE ACTIVITY

Group	N	Mean blood pressure	
		Before Activity	After Activity
<u>Straw harvesting</u>			
Anemic	30	116/79	122/82
Non-anemic	30	116/78	120/80
<u>Cowpea haulms cutting</u>			
Anemic	30	119/78	121/81
Non-anemic	30	118/78	118/79
<u>Cowpea pods picking</u>			
Anemic	30	118/78	120/81
Non-anemic	30	117/78	119/79
<u>Sorghum harvesting</u>			
Anemic	30	117/78	120/80
Non-anemic	30		
<u>Weeding</u>			
Anemic	30	119/79	123/82
Non-anemic	30	118/79	121/81

Both the systolic pressure and diastolic pressure appeared to increase on performing the activity irrespective of whether they were anemic or non-anemic but the increase was not significant. Individual blood pressure values of the subjects are given in the Appendix XI.

3. Basal metabolic rate and vital capacity of the subjects

Mean basal metabolic rate and vital capacity of the subjects are given in the Table IX.

TABLE IX

MEAN BASAL METABOLIC RATE AND VITAL CAPACITY OF THE SUBJECTS

Details	BMR in per cent	Vital capacity in ml
Anemic N30	46.9 ± 10.2	1998 ± 135.76
Non-anemic N-30	32.1 ± 3.6	2235 ± 127.76
't' value	7.49**	6.96**
Chatterjee (1980)	..	3100

** .. Significant at one per cent level

The mean basal metabolic rate of anemic women was 46.9 per cent against 32.1 per cent of non-anemic women, who participated in the present study.

Statistical analysis between the values registered by the anemic and non-anemic women revealed that there was a significant difference at one per cent level between both the groups. Individual basal metabolic rates are given in the Appendix XII.

The normal basal metabolic rate of age group 25-44 years is 35.7 per cent (the Mayo Foundation Normal Standards). The normal vital capacity of the women is 3,100 ml according to Chatterjee (1980). The anemic women registered a mean vital capacity of 1998 ml against 2235 ml recorded by non-anemic women.

The statistical analysis between the values registered by the anemic and non-anemic women revealed that there was a significant difference at one per cent level between both the groups. Individual vital capacity values are given in the Appendix XIII.

4. Work output during specific activities

Table X depicts the mean work out put of the subjects at the start of the study.

TABLE X

MEAN WORK OUTPUT OF THE SUBJECTS AT THE START OF THE STUDY

Group	N	Mean work output in terms of area covered in sq.m in 30 minutes	't' value
Straw harvesting			
Anemic	30	19 ± 1.03	27.34**
Non-anemic	30	28 ± 1.48	
Cowpea haulms cutting			
Anemic	30	19 ± 0.89	29.24**
Non-anemic	30	28 ± 1.6	
Cowpea pod picking			
Anemic	30	39 ± 0.91	25.8**
Non-anemic	30	48 ± 1.68	
Sorghum harvesting			
Anemic	30	28 ± 1.39	14.25**
Non-anemic	30	34 ± 1.84	
Weeding			
Anemic	30	28 ± 1.36	13.00**
Non-anemic	30	34 ± 2.13	
Quantity of pods picked in (g)			
Anemic	30	1342 ± 172.3	10.16**
Non-anemic	30	1705 ± 92.68	

** .. Significant at one per cent level

The mean area covered by anemic women during straw harvesting, cowpea haulms cutting, cowpea pod picking, sorghum harvesting and weeding within a specified period of 30 minutes, was 19 sq.m., 19 sq.m., 39 sq.m., 28 sq.m., and 28 sq.m., against 28 sq.m., 28 sq.m., 48 sq.m., 34 sq.m., and 34 sq.m., covered by non-anemic women respectively. The quantity of pods picked by anemic women was 1342 grams against 1705 grams picked by non-anemic women. These results indicate that non-anemic women performed better and their work output was higher when compared to the anemic women.

Statistical analysis also revealed that the differences in the area covered was significant at one per cent level for all the five activities.

Individual datas are given in the Appendix XIV.

5. <u>Pulse rates of the subjects while working on a static bicycle ergometer</u>

The mean pulse rates of the subjects taken by the ergometry technique at the start of the study are presented in Table XI.

TABLE XI

MEAN PULSE RATE OF THE SUBJECTS TAKEN WHILE WORKING ON AN STATIC BICYCLE ERGOMETER

Group	N	Mean pulse rate	't' value
<u>3rd minute</u>			
Anemic	30	99 ± 4.59	15.37**
Non-anemic	30	81 ± 4.47	
<u>6th minute</u>			
Anemic	30	110 ± 5.37	13.08**
Non-anemic	30	92 ± 5.29	
<u>9th minute</u>			
Anemic	30	119 ± 4.29	13.04**
Non-anemic	30	102 ± 5.97	

**.. Significant at one per cent level

The pulse rate had increased for all the groups after ergometry, irrespective of whether they were anemic or non-anemic but the rate of increase among anemic women was higher than that of non-anemic women which was statistically significant at one per cent level.

The individual pulse rates during ergometry are given in the Appendix XV.

6. <u>Impact of Iron Supplementation on the Subjects</u>

a. <u>Haemoglobin levels</u>

Table XII gives the mean haemoglobin levels before and after supplementation with iron tablets.

TABLE XII

MEAN HAEMOGLOBIN LEVELS OF THE SUBJECTS BEFORE AND AFTER SUPPLEMENTATION

Group	N	Mean haemoglobin (g/100ml)	't' value
Before supplementation	30	9.4 ± 0.392	39.44**
After supplementation	30	12.9 ± 0.289	
Sauberlich (1976)		10.0	

** .. Significant at one per cent level

The mean haemoglobin values of the anemic women increased from 9.4-12.9 g/100 ml after supplementation of their diets with iron tablets. The beneficial effects of iron supplementation was very evident from this study. The increase in haemoglobin was also statistically significant at one per cent level, revealing the greater scope of iron supplementation for improving anemic individuals. The same is seen evidently in figure. A

Vijayalakshmi *et al*. (1983) have reported similar significant increases in haemoglobin levels after 60 days of iron supplementation to anemic pregnant women.

The haemoglobin levels in the anemic subjects is given in the Appendix VI.

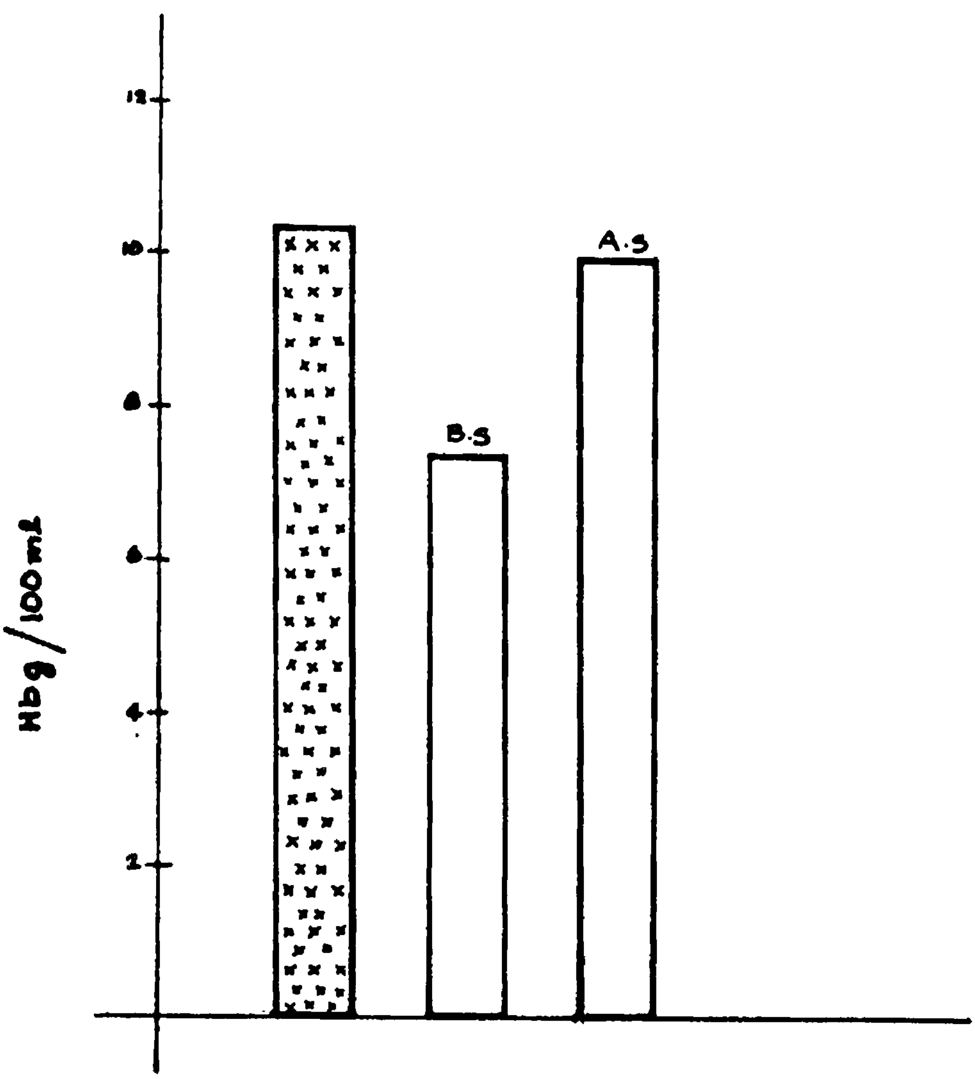
b. Serum Iron and TIBC levels

Table XIII depicts the mean serum iron and TIBC levels before and after supplementation with iron tablets.

Figure A MEAN HAEMOGLOBIN LEVELS OF THE SUBJECTS

SCALE

Y AXIS 1cm = 1.25g Hb



ANEMIC GROUP

NON-ANEMIC GROUP

B.S - BEFORE SUPPLEMENTATION

A.S - AFTER SUPPLEMENTATION

TABLE XIII

MEAN SERUM IRON AND TIBC OF THE SUBJECTS BEFORE AND AFTER SUPPLEMENTATION

Details	Mean serum iron (mcg/100 ml)	TIBC (mcg/100 ml)
Before supplementation N-30	65.5 ± 4.23	425.6 ± 22.38
After supplementation N-30	101.6 + 2.67	317.4 ± 44.35
't value	39.53**	11.93**
Cartwright and Wintrobe (1949)	--	482

** .. Significant at one per cent level

As is evident from Table XIII, the mean serum iron levels had increased among anemic women from 65.5 mcg/100 ml to 101.6 mcg/100 ml. Statistical analysis revealed that the increase was statistically significant at one per cent level. This also substantiates the beneficial effects of supplementation of iron to the anemic women.

The rise in serum iron levels in the anemic group is given in the Appendix VII.

From the Table XIII it is obvious that the mean total iron binding capacity had decreased from 425.6 to 317.4 mcg/100 ml as a result of iron supplementation. The present values are well within the normal values. Analysis also revealed that the decrease was statistically significant at one per cent level.

The decrease in total iron binding capacity of the anemic group is given in the Appendix VIII.

c. Packed Cell volume (PCV)

The mean packed cell volume (PCV) of the anemic group before and after supplementation with iron tablets are presented in Table XIV.

TABLE XIV

MEAN PACKED CELL VOLUME (PCV) OF THE SUBJECTS BEFORE AND AFTER SUPPLEMENTATION

Groups	N	Mean PCV in per cent	'T' value
Before	30	22.7 ± 4.19	19.73**
After	30	38.4 ± 1.2	

** .. Significant at one per cent level

The mean packed cell volume of the anemic group had increased from 22.7 per cent to 38.4 per cent after supplementation with iron tablets. The number of active cells capable of carrying oxygen in the blood increases due to the increased haemoglobin level which is a beneficial effect of iron supplementation. Statistical analysis also revealed that the increase was statistically significant at one per cent level.

The packed cell volume changes in the anemic subjects are given in the Appendix IX.

d. <u>Pulse Rate</u>

The mean difference in the pulse rate before and after activity and before and after supplementation are represented in Table XV.

TABLE XV.

MEAN PULSE RATE OF THE SUBJECTS BEFORE AND AFTER SUPPLEMENTATION

Group	N	Before activity	't' value	After activity	't' value
<u>Straw harvesting</u>					
Before	30	82 ± 2.23	21.14**	105 ± 2.70	39.62**
After	30	72 ± 1.32		83 ± 1.4	
<u>Cowpea haulms cutting</u>					
Before	30	82 ± 2.15	21.21**	103 ± 2.48	35.89**
After	30	72 ± 1.43		82 ± 2.03	
<u>Cowpea pod picking</u>					
Before	30	82 ± 2.69	20.66**	93 ± 3.55	15.37**
After	30	73 ± 1.15		82 ± 1.66	
<u>Sorghum harvesting</u>					
Before	30	83 ± 1.56	30.33**	103 ± 3.29	29.55**
After	30	72 ± 1.23		82 ± 2.08	
<u>Weeding</u>					
Before	30	83 ± 1.31	30.6**	94 ± 3.0	35.90**
After	30	72 ± 1.47		81 ± 1.82	

** .. Significant at one per cent level

This change or rather decrease in the rate of increase in pulse rate after activities indicates that there is less exertion after supplementation to do the same activity. Individual pulse rates after iron supplementation is given in the Appendix X.

e. Blood pressure

Table XVI gives the blood pressure levels before and after activity before and after supplementation.

TABLE XVI

MEAN BLOOD PRESSURE BEFORE AND AFTER SUPPLEMENTATION

Activities	N	Mean blood pressure	
		Before activity	After activity
Straw harvesting			
Before	30	116/78	122/82
After	30	115/77	121/80
Cowpea halums cutting			
Before	30	117/78	121/81
After	30	117/77	120/80
Cowpea pod picking			
Before	30	117/79	122/80
After	30	116/77	121/80
Sorghum harvesting			
Before	30	118/79	122/80
After	30	117/77	121/80
Weeding			
Before	30	118/80	124/82
After	30	117/77	122/80

Both the systolic and diastolic pressures increased after performing the activities but it was not statistically significant. Individual blood pressure values of the anemic group after supplementation with iron tablets are given in the Appendix XVI.

f. Basal Metabolic Rate (BMR) and vital Capacity

The mean basal metabolic rate (BMR) and mean vital capacity before and after supplementation are given in Table XVIA

TABLE XVII

MEAN BASAL METABOLIC RATE AND VITAL CAPACITY BEFORE AND AFTER SUPPLEMENTATION

Details	BMR in per cent	Vital capacity in ml
Before supplementation N-30	46.9 ± 10.2	1998 ± 135.76
After supplementation N-30	36.9 ± 1.72	2184 ± 77.87
't' value	5.30**	6.51**
Chatterjee (1974)		3100

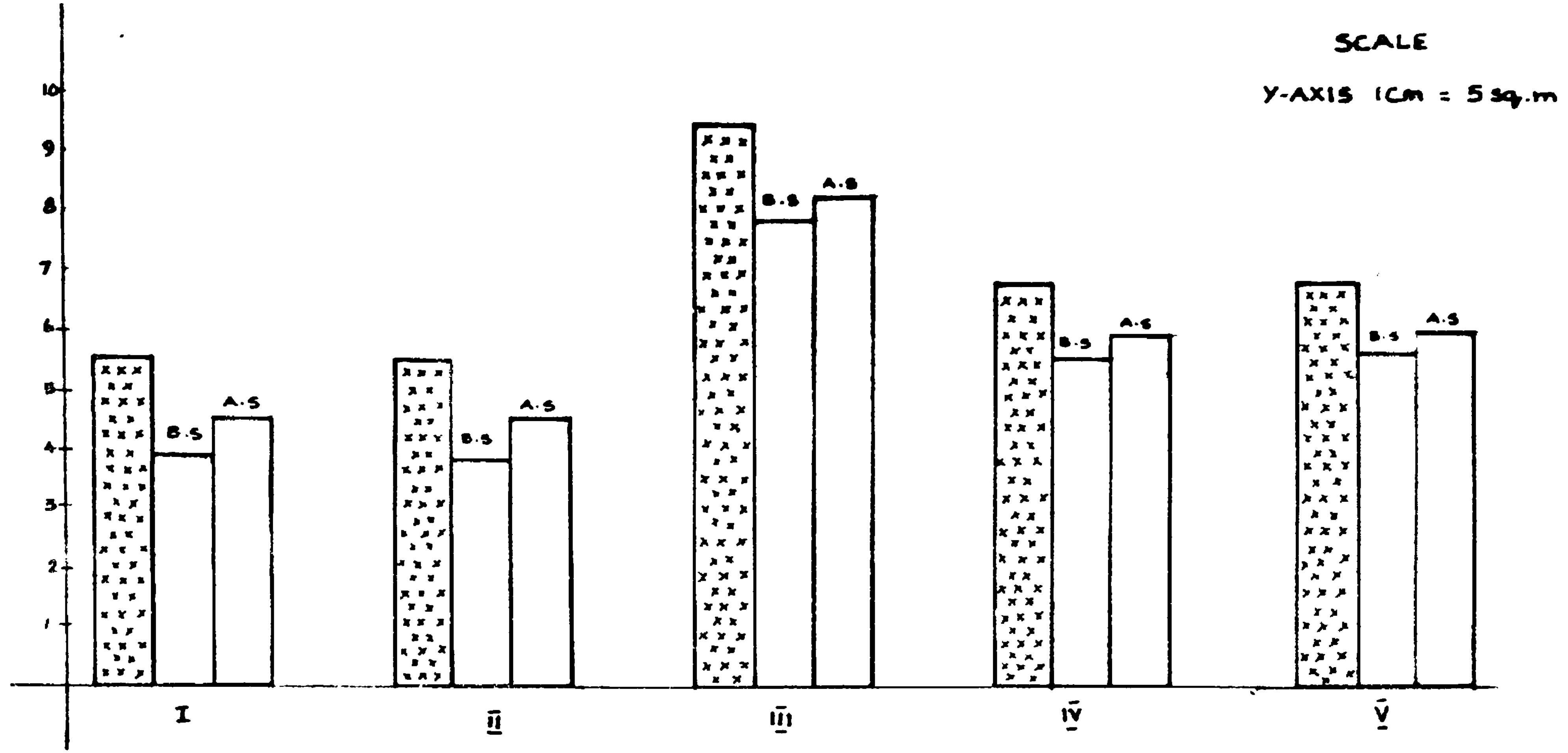
The mean basal metabolic rate of the anemic group had decreased from 46.9 per cent to 39.9 per cent. The difference in the BMR before and after supplementation indicated a Statistical significance at one per cent level. The individual values of BMR are given in Appendix XII.

The mean vital capacity of the anemic group had increased from 1998 ml to 2184 ml after supplementation with iron tablets. The maximal amount of gas expired from the lungs after a deep inspiration referred as vital capacity had increased from a low value to a somewhat satisfactory level which may be due to iron supplementation. However these values are still lower when compared to the values of Chatterjee (1974). Individual values are given in Appendix XIII.

g. Work output

Table XVIII gives the impact of iron supplementation on the work output.

Figure 8 **WORK TURNED OUT (Sq.m) IN 30 MINUTES**



☐ ANEMIC GROUP
⊠ NON-ANEMIC GROUP
B.S - BEFORE SUPPLEMENTATION
A.S. - AFTER SUPPLEMENTATION

I - STRAW HARVESTING
II - COWPEA HAULMS CUTTING
III - COWPEA PODS PICKING
IV - SORGHUM HARVESTING
V - WEEDING

Women who were anemic at the start of the study had subsequently become non-anemic because of iron supplementation. The mean area covered during straw harvesting, cowpea haulms cutting, cowpea pods picking, sorghum harvesting and weeding by them after supplementation had increased from 19 sq.m., 19 sq.m., 39 sq.m., 28 sq.m., 28 sq.m., to 22 sq.m., 22 sq.m., 42 sq.m., 30 sq.m., and 30 sq.m., respectively. The mean quantity of pods picked had also increased from 1342 to 1492 grams in 30 minutes. The increase in work output after supplementation was statistically significant at one per cent level. The same is seen evidently in figure B.

Individual area covered by the anemic group are given in the Appendix XIV.

h. <u>Pulse rate during ergometry</u>

The mean pulse rates taken while working on a static bicycle ergometer after supplementation are given in Table ~~XVIII~~. XIX

TABLE XIX

MEAN PULSE RATES OF THE SUBJECTS WHILE WORKING ON A STATIC BICYCLE ERGOMETER BEFORE AND AFTER SUPPLEMENTATION

Groups	N	Mean pulse rate	't' value
3rd minute			
Before	30	99 ± 4.59	19.97**
After	30	81 ± 1.82	
6th minute			
Before	30	110 ± 5.37	17.24**
After	30	91 ± 2.76	
9th minute			
Before	30	119 ± 4.29	18.88**
After	30	100 ± 3.46	

** .. Significant at one per cent level

The mean pulse rates of the anemic group had decreased from 99, 110, 119 to 81, 91, 100 respectively at 3rd, 6th and 9th minute of the exercise after the supplementation. Pulse rate (100) of the subjects after supplementation at 9th minute was almost same as that at 3rd minute (99) before supplementation. Statistical analysis revealed that the decrease in pulse rates are statistically significant at one per cent level.

Individual pulse rates are given in the Appendix XVII.

Summary and Conclusion

V. SUMMARY AND CONCLUSION

The study on 'Anemia and work output' was designed with the aim to find out the relationship between nutrition and work output with special reference to iron deficiency among farm women doing specific activities and to supplement the anemic subjects with 120 mg of ferrous sulphate for a period of 90 days and observe the impact of supplementation.

Subjects with similar anthropometric measurements and socio-economic background were selected for the experimental and control groups which included 30 subjects in each group.

Both anemic subjects and non-anemic subjects were studied with reference to their dietary intake, clinical status, biochemical examination, work output, pulse rate, blood pressure, basal metabolic rate, vital capacity and pulse rate and compared with each other. The agricultural activities for the study included straw harvesting, cowpea haulms cutting, cowpea pods picking, sorghum harvesting and weeding.

After supplementation its impact was studied by repeating all the parameters. Through this study the following facts were revealed.

1. The mean food and nutrient intake of the anemic subjects were less than that of the non-anemic subjects, specially with reference to green leafy vegetables.

2. The clinical assessment of anemic subjects showed that many of them exhibited easy fatiguability and pallor of the skin.

3. The mean haemoglobin levels, serum iron, packed cell volume of anemic subjects increased from 9.4 g/100 ml, 65.5 mcg/100 ml 22.7 per cent to 12.9 g/100 ml, 101.1 mcg/100 ml 38.4 per cent respectively. The mean total iron binding capacity of the anemic subjects decreased from 425.6 to mcg/100 ml to 317.4 mcg/100 ml after supplementation.

4. The rate of increase in pulse rate was decreased significantly while carrying out the same kind of activities after supplementation. Blood pressure values also showed some difference before and after supplementation but was not statistically significant. This indicates probably a better cardiac and pulmonary efficiency due to increased haemoglobin.

5. The basal metabolic rate of anemic subjects decreased markedly after supplementation indicating that the energy needed for their basal activities was minimised.

6. The vital capacity had increased after supplementation showing their improved breath holding capacities.

7. The mean pulse rates recorded by ergometry showed a decrease after iron supplementation.

The results of the study suggest a greater scope for programmes involving iron supplementation to working population to improve their work efficiency. A country like India is in dire need for efficient working population to improve its economic conditions and compete with other nations.

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Appendices

APPENDIX I

ESTIMATION OF HAEMOGLOBIN BY CYANMETHAEMOGLOBIN METHOD

The haemoglobin is treated with a reagent containing potassium ferric cyanide, potassium dihydrogen phosphate. The ferricyanide forms methaemoglobin which is converted to cyan methaemoglobin by the cyanide.

Reagents

Drapkin's diluent solution

Sodium bicarbonate	.. 1 g
Potassium cynanide	.. 0.05 g
Potassium ferric cyanide	.. 0.2 g
Distilled water	.. 1 litre

This solution is preserved in a dark bottle and preferably under cold storages. Its preparation and handling should be done with great care. This solution should not be used after it forms a precipitate at the bottom of the storage bottle.

Procedure:

1. Exactly 5 ml of the Drapkin's diluent solution is measured into a dry test tube from a burette (or) a pipette with suction bulb.

2. Exactly 0.02 ml of blood is transferred from a standard haemoglobin pipette into a diluent solution. Usual care in filling and cleaning of loaded haemoglobin pipette must be observed.

3. The pipette is rinsed three times with the diluent solution without allowing the formation of air bubbles in the solution.

4. The blood and the diluent are thoroughly mixed by rotating the tube.

5. Ten minutes time is allowed for the formation of cyamethaemoglobin.

6. Five ml of diluent solution is used as blank.

7. The readings are taken in photoelectric calorimeter at 540 m/u.

<u>Cliberation procedure</u>

1. Total blood iron is determined by Wong's method which would give absolute amount of haemoglobin.

2. Exactly 0.02 ml of this known blood sample is measured into 5.0, 7.5, 10.0, 12.5 and 15.0 ml of diluent solution. These are now equivalent to blood samples containing respectively 100, 67, 50, 40 and 30 per cent of the original haemoglobin concentration.

3. The intensity of the color is read using a green filter at 540 m/u against a bland set at zero optical density.

APPENDIX I

DETERMINATION OF IRON AND HAEMOGLOBIN BY WONG'S METHOD

Principle

The iron is detached from the haemoglobin molecules by treatment with concentrated sulphuric acid in the presence of potassium per-sulfate, without heating. After removal of the proteins by tungstic acid, the iron in the filtrate is determined colorimetrically. From the total iron content, the maemoglobin content is readily obtained, since the haemoglobin content is 0.34 per cent of iron and only 1 to 2 per cent or less of the total blood iron is non-haemoglobin iron.

Reagents

1. 10 per cent sodium tungstate
2. Saturated pottassium persulphate solution
3. Potassium cyanide
4. Standard iron solution
5. Working standard

Procedure

With an Ostwald (or) micropipette, accurately transfer 0.5 ml of well mixed oxalated whole blood into a 50 ml volumetric flask. Add 2 ml of saturated potassium persulphate solution. Mix and dilute to about 25 ml with water. Add 2 ml of 10 percent sodium tungstate solution. Mix and cool to room temperature under the tap and dilute to volume with water. Stopper and mix by inversion, filter through a dry, paper collecting the filterate in a dry flask. Prepare a standard in a second 50 ml volumetric flask by addition of 2 ml of concentrated suphuric acid. 2 ml of saturated potassium per sulphate and 2.5 ml of standard iron solution containing 0.1 mg of ferric iron per ml.

Cool to room temperature, dilute with water to the mark and mix. Prepare is a blank similar to the standard but omitting the standard iron solution.

Measure 20 ml of unknown filtrate, standard and blank if, necessary into separate test-tubes. To each add 0.5 ml of saturated persulphate solution followed by 2 ml of 3 N potassium thio cyanide solution. Mix by inversion and read within the next thirty minutes, setting the colorime ter to zero density with the blank at 480 m/u.

Calculation

$$\frac{\text{Density of unknown}}{\text{Density of standard}} \times 0.25 \times \frac{100}{0.5} \times \frac{1}{3.4} = \text{grams of haemoglobin per 100 ml of blood.}$$

APPENDIX II

ESTIMATION OF SERUM IRON DIPYRIDYL METHOD

Principle

Ferrous iron gives a pink colour with 2.2 dipridyl. A solution of dipyridyl in acetic is added to serum followed by a reducing agent. Proteins are removed by heating in boiling water and then centrifuging.

Reagents

1. 2.2 dipyridyl - 0.1, per cent acetic acid 3 per cent v/v
2. Sodium sulphate 0.1 m
3. Choloroform
4. Standard solution containing 200 micrograms of iron/ml
5. Working standard - dilute 3 ml of the stock solution to 100 ml with water to obtain a solution containing 3 mg/ml

Procedure

Mix equal volumes of serum, 0.1m sodium sulphate, and dipyridyl reagent in a glass stoppered tube which can be centrifuged. Heat in boiling water for five minutes. Cool and add 0.1 ml of chloroform, stopper and shake vigourously for five minutes at 300 rpm. If the supernatent is not completely clear, repeat the shaking and centrifuging. Read at 520 m/u standard in the same way.

Calculation

$$\text{Micrograms iron per 100 ml of the serum} = \frac{\text{Readings of unknown}}{\text{Readings of standard}} \times 300$$

This readings are linear with concentration to at least 500 per 100 ml. To obtain a caliberation curve, dilute 5 ml of the stock standard to 100ml with water and set up tubes containing 0.4, 0.8, 1.2, 1.6 and 2.0 ml this, make each to 2 ml with water and develop the color as described above and read against the blank. These correspond to 100, 200, 300, 400 and 500 /ug per 100 ml.

APPENDIX III

DETERMINATION OF TOTAL IRON BINDING CAPACITY & RAMSAY'S DIPYRIDYL METHOD

Reagents

1. Ferric chloride solution - 5 /ug iron/ml in 0.005 N Hcl. Prepare a stock solution containing 145 mg of $Fecl_2$/ 100 ml of 0.5 N acid dilute one to 100 ml with distilled water.
2. Magnesium carbonate- light for absorption
3. Sodium sulphite, 0.2 /u, 2.52 g of the anhydrous salt/ 100 ml.
4. 2.2 dipyridyl 0.2 per cent in acetic acid, 3 per cent chloroform and standard solutions as for the method.

Technique

Add 4 ml of the ferric chloride solution to 2 ml of serum. After allowing for 5 minutes add 400 g of Mg_2, CO_3 (100 mg for each ml of ferric chloride). Shake frequently and vigorously for 30-60 seconds. Centrifuge and pipette off 4 ml of the supernatent fluid for iron determination. If the dipydridyl methods is used add one ml each of the 0.2 /ug sulphite and 0.2 per cent dipyridyl and proceed as described previously for determining serum iron. The result gives the total iron binding capacity. If the serum iron is determined at the same time the per cent saturation is easily calculated.

Calculation

Total iron binding capacity in m/u 100 ml serum

$$= \frac{\text{Reading of unknown}}{\text{Reading of standard}} \times \frac{100}{1.33} \times f$$

$$= \frac{\text{Reading of unknown}}{\text{Reading of standard}} \times 450$$

APPENDIX IV

FOOD INTAKE IN ANEMIC SUBJECTS

FOOD STUFFS (g)	I	II	III	IV	V	VI	VII	VIII	IX	X
Cereals	400	25	375	390	440	420	480	460	450	455
Pulses	20	25	20	15	18	16	21	22	20	24
Green leafy Vegetables	-	-	-	50	-	30	60	40	-	-
Other Vegetables	25	30	20	-	20	20	10	-	25	35
Roots and Tubers	50	40	40	10	55	-	-	15	45	25
Fruits	-	-	-	-	-	-	-	-	-	-
Milk	10	20	-	-	-	20	15	-	-	15
Sugar and Jaggery	20	25	23	24	20	25	15	20	25	20
Fats and Oils	10									
Meat and fish	-	-	-	-	-	-	-	-	-	-
Eggs	-	-	-	-	-	-	-	-	-	-

APPENDIX-IV

FOOD INTAKE IN NON-ANEMIC SUBJECTS

FOOD STUFFS (g)	I	II	III	IV	V	VI	VII	VIII	IX	X
Cereals	425	450	400	420	430	425	440	445	480	430
Pulses	25	30	27	28	30	25	20	25	20	27
Green leafy Vegetables	75	80	60	80	85	70	-	-	80	-
Other Vegetables	10	15	20	-	20	10	50	60	10	10
Roots and Tubers	25	15	25	15	25	20	15	15	30	15
Fruits	-	15	-	30	-	10	-	15	20	-
Milk	20	15	15	20	20	15	15	20	20	25
Fats and Oil	10	5	7	8	10	10	12	8	5	8
Sugar and Jaggery	20	15	23	25	15	20	22	18	20	15
Pork	-	-	-	-	-	-	40	25	-	30
Eggs	-	-	-	-	-	-	-	-	-	-

APPENDIX-IV

NUTRIENT INTAKE IN ANEMIC SUBJECTS

NUTRIENTS	1	2	3	4	5	6	7	8	9	10
Protein (g)	37	38	31	33	34	36	38	39	36	37
Energy (K.cal)	1699	1760	1545	1619	1746	1751	1908	1903	1827	1843
Calcium (mg)	150	176	364	606	492	133	570	226	424	443
Iron (mg)	26	27	19	23	23	21	25	23	23	24
Carotene (mg)	88	140	77	3440	1136	122	240	168	98	748
Thiamine (mg)	1.278	1.213	1.098	1.136	1.315	1.1822	1.4017	1.2374	1.309	1.5924
Riboflavin (mg)	0.44	0.416	0.369	0.394	0.456	0.388	0.512	0.4275	0.454	0.455
Vitamin C (mg)	15	33.85	9.45	111	4.53	12.31	7.5	6.77	7.42	5.6

APPENDIX - IV

NUTRIENT INTAKE IN NON-ANEMIC SUBJECTS

Nutrients	1	2	3	4	5	6	7	8	9	10
Protein (g)	38	40	38	44	35	46	46	44	45	42
Energy (k.cal)	1759	1856	1686	1823	1752	1881	1868	1794	1889	1754
Calcium (mg)	368	678	707	461	740	560	157	179	366	375
Iron (mg)	19	25	25	27	24	30	23	23	34	22
Carotene (mg)	267	288	4153	5554	268	5960	138	142	307	284
Thiamine (mg)	1.217	1.28	1.2979	1.267	1.41	1.343	1.526	1.3795	1.505	1.3914
Riboflavin (mg)	0.532	0.598	0.4592	0.4402	0.620	0.4340	0.477	0.4695	0.659	0.462
Vitamin C (mg)	15.5	184.5	136.65	178.95	102.15	199.95	9.85	99.7	22.3	3.95

APPENDIX - V

INDIVIDUAL HEIGHTS AND WEIGHTS OF THE SUBJECTS

Number	Anemic group		Non-anemic group	
	Height in cms	Weight in kg	Height in cms	Weight in kg
1	148	49	152	41
2	158	42	148	41
3	156	40	150	40
4	145	41	150	39
5	156	38	145	44
6	145	41	155	40
7	155	43	150	55
8	153	40	158	42
9	157	41	135	42
10	158	43	156	43
11	150	44	145	40
12	140	39	156	42
13	155	47	145	42
14	155	41	153	41
15	150	40	148	41
16	151	45	150	42
17	155	35	154	42
18	160	46	158	47
19	156	40	150	40
20	145	41	149	41
21	156	42	155	43
22	149	40	160	42
23	147	40	154	41
24	148	43	154	47
25	145	40	149	41
26	143	35	155	47
27	154	37	153	47
28	150	52	148	41
29	150	42	154	40
30	148	41	145	43

APPENDIX - VI

INDIVIDUAL HAEMOGLOBIN LEVELS OF THE SUBJECTS

No.	Anaemic Haemoglobin g/100ml		No.	Non Anaemic Haemoglobin g/100 ml
	Before Supplementation	After Supplementation		
1	9.72	12.7	1	13.3
2	9.87	13.5	2	12.3
3	9.58	13.3	3	13.0
4	9.15	13.3	4	13.01
5	8.6	12.3	5	13.0
6	8.7	13.0	6	13.0
7	9.72	13.0	7	12.5
8	9.44	13.0	8	13.5
9	9.3	13.01	9	12.87
10	9.4	13.09	10	13.01
11	9.0	13.3	11	13.3
12	9.4	13.05	12	13.3
13	9.73	13.0	13	12.8
14	8.87	12.8	14	13.09
15	8.58	12.87	15	12.7
16	9.44	12.58	16	13.5
17	9.58	13.01	17	13.3
18	9.01	12.8	18	13.01
19	9.87	12.5	19	12.59
20	9.8	13.01	20	12.5
21	9.3	12.05	21	13.05
22	9.87	12.58	22	12.9
23	9.58	12.87	23	13.0
24	9.01	12.8	24	13.0
25	9.58	13.01	25	13.0
26	9.72	13.0	26	12.8
27	9.0	12.30	27	12.8
28	8.9	12.5	28	13.0
29	9.87	13.05	29	12.87
30	9.5	13.01	30	12.58

APPENDIX - VII

INDIVIDUAL SERUM IRON VALUES OF THE SUBJECTS

No.	Anaemic Serum Iron mcg/100ml		No.	Non Anaemic Serum Iron mcg/100 ml
	Before Supplementation	After Supplementation		
1	60.83	99.5	1	104.28
2	63.0	106.8	2	96.43
3	69.52	103.28	3	101.93
4	65.18	103.28	4	102.72
5	60.90	95.45	5	101.93
6	60.73	100.85	6	101.93
7	60.83	100.85	7	98.01
8	69.62	100.85	8	105.85
9	68.83	101.72	9	100.91
10	69.35	102.64	10	102.72
11	73.87	105.30	11	104.28
12	69.62	103.30	12	104.28
13	60.83	102.15	13	100.37
14	60.18	100.92	14	102.64
15	60.0	100.85	15	99.58
16	69.25	99.1	16	105.85
17	69.52	102.72	17	104.28
18	64.83	100.92	18	102.72
19	63.0	99 .0	19	98.72
20	63.66	101.72	20	98.01
21	67.35	106.0	21	101.15
22	63.0	98.72	22	101.93
23.	69.52	101.0	23	101.93
24.	67.85	99.0	24	101.93
25	69.52	104.0	25	100.91
26	60.83	95.0	26	100.91
27	93.69	92.4	27	101.93
28	60.66	99.2	28	100.91
29	63.05	102.5	29	98.01
30	69.52	102	30	101.85

APPENDIX - VIII

INDIVIDUAL TOTAL IRON BINDING CAPACITY OF THE SUBJECTS

No.	Anaemic Total Iron Binding capacity mcg/100ml		No.	Non Anaemic Total Iron Binding capacity mcg/100 ml
	Before Supplementation	After Supplementation		
1	393.75	270.0	1	253.13
2	399.36	265.0	2	393.75
3	421.86	270.0	3	382.50
4	405.00	255.0	4	360.00
5	450.36	394.0	5	281.25
6	461.25	379.0	6	292.50
7	444.38	279.0	7	298.13
8	427.13	292.0	8	360.00
9	427.56	297.13	9	253.13
10	421.86	305.15	10	298.13
11	410.63	355.0	11	281.25
12	399.36	374.85	12	360.00
13.	433.13	368.5	13	309.38
14	465.00	310.0	14	303.75
15	455.68	345.75	15	264.38
16	461.25	352.5	16	275.63
17	433.13	365.0	17	264.38
18	438.75	310.8	18	365.63
19	388.125	299.0	19	343.13
20	433.13	360.53	20	320.63
21	421.86	358.0	21	371.25
22	399.36	344.0	22	376.88
23	410.36	260.13	23	371.25
24	450.00	322.54	24	264.38
25	438.75	282.0	25	270.00
26	393.75	358.0	26	281.25
27	427.50	370.0	27	320.63
28	444.38	262.0	28	247.50
29	399.36	268.55	29	348.75
30	405.00	248.0	30	354.38

APPENDIX - IX

INDIVIDUAL PACKED CELL VOLUME OF THE SUBJECTS

No.	Anaemic Packed cell volume in %		No.	Non - Anaemic Packed cell volume in %
	Before Supplementation	After Supplementation		
1	24.3	38	1	39.9
2	24.68	41	2	36.9
3	23.95	39.9	3	39.0
4	22.68	39.9	4	39.03
5	21.5	38.0	5	39.0
6	21.75	39.0	6	39.0
7	24.3	38.5	7	37.5
8	23.6	38.75	8	40.0
9	23.25	38.5	9	38.61
10	23.5	39.3	10	39.0
11	22.5	39.5	11	39.9
12	23.6	38.5	12	39.9
13	24.33	38.5	13	38.4
14	21.18	37.0	14	39.27
15	21.45	39.0	15	38.1
16	23.60	36.5	16	40.5
17	23.95	38.0	17	39.9
18	25.53	37.5	18	39.03
19	24.68	36.85	19	37.77
20	24.5	38.5	20	39.5
21	23.25	37.5	21	39.15
22	24.68	36.5	22	38.7
23	23.95	38.61	23	39.0
24	22.53	36.5	24	39.0
25	23.95	39.5	25	39.0
26	24.3	39.5	26	38.4
27	22.5	35.75	27	38.4
28	22.25	38.5	28	39.01
29	24.68	39.0	29	38.61
30	23.75	39.0	30	37.74

APPENDIX - X

INDIVIDUAL PULSE RATE IN SUBJECTS IN PERFORMING STRAW HARVESTING

No.	Anaemic				No.	Non - Anemic	
	Before Supplementation		After Supplementation				
	Before Activity	After Activity	Before Activity	After Activity		Before Activity	After Activity
1	79	103	72		1	74	80
2	81	102	71		2	72	80
3	80	100	75		3	71	82
4	79	101	75		4	73	83
5	79	104	75		5	75	84
6	82	105	72		6	72	84
7	84	103	72		7	73	82
8	80	105	72		8	71	82
9	76	107	72		9	74	83
10	81	108	74		10	73	83
11	84	109	72		11	75	80
12	84	110	72		12	71	83
13	87	105	72		13	73	82
14	84	103	72		14	73	82
15	79	104	72		15	74	84
16	81	105	72		16	74	86
17	82	106	72		17	75	85
18	81	107	72		18	75	82
19	82	103	72		19	75	85
20	83	104	72		20	73	85
21	82	108	72		21	71	84
22	82	109	70		22	71	86
23	83	108	72		23	73	87
24	86	103	70		24	72	86
25	82	105	72		25	74	84
26	83	104	72		26	76	85
27	84	103	72		27	74	83
28	83	102	70		28	73	85
29	81	100	70		29	70	84
30	82	101	70		30	72	86

APPENDIX - X

INDIVIDUAL PULSE RATE OF THE SUBJECTS WHILE COWPER HAULMS CUTTING

No.	Anaemic: Before Supplementation: Before Activity	Anaemic: Before Supplementation: After Activity	Anaemic: After Supplementation: Before Activity	Anaemic: After Supplementation: After Activity	No.	Non - Anaemic: Before Supplementation: Before Activity	Non - Anaemic: After Supplementation: After Activity
1	80	100	76	86	1	72	81
2	81	103	74	82	2	73	82
3	80	102	73	87	3	70	80
4	79	100	72	80	4	72	81
5	80	101	72	82	5	74	83
6	81	99	74	81	6	73	82
7	83	101	74	85	7	72	81
8	79	105	73	85	8	70	80
9	77	106	72	80	9	73	82
10	82	107	73	81	10	74	83
11	83	109	72	81	11	76	85
12	86	103	73	89	12	70	81
13	84	100	70	84	13	72	81
14	85	105	70	80	14	73	84
15	83	104	70	80	15	73	84
16	80	103	73	81	16	74	85
17	82	102	71	80	17	76	87
18	83	105	71	80	18	73	82
19	80	99	71	82	19	76	85
20	81	100	71	82	20	72	84
21	85	103	71	80	21	71	83
22	84	104	72	78	22	70	85
23	80	100	73	81	23	74	86
24	84	105	73	82	24	74	86
25	85	104	71	81	25	73	83
26	83	105	71	81	26	75	84
27	83	104	70	81	27	73	85
28	82	101	71	80	28	72	86
29	82	102	72	80	29	73	83
30	80	100	72	82	30	74	85

APPENDIX - X

INDIVIDUAL PULSE RATE OF THE SUBJECTS WHILE COW PEAPOD PICKING

No.	Anemic				No.	Non - Anemic	
	Before Supplementation		After Supplementation.			Before Supplementation	After Supplementation.
	Before Activity	After Activity	Before Activity	After Activity		Before Activity	After Activity
1	80	88	74	85	1	73	82
2	82	89	73	84	2	75	86
3	81	90	72	80	3	72	81
4	78	87	74	81	4	71	80
5	80	90	74	83	5	74	83
6	80	91	73	83	6	75	86
7	82	92	73	84	7	74	87
8	78	85	73	81	8	72	80
9	78	86	72	82	9	71	81
10	83	89	73	82	10	74	83
11	84	92	74	84	11	75	88
12	85	93	73	85	12	72	82
13	85	94	70	82	13	71	80
14	84	95	74	81	14	73	84
15	84	95	73	83	15	74	86
16	80	91	72	80	16	72	81
17	81	90	73	82	17	74	82
18	84	93	73	81	18	75	81
19	80	94	73	80	19	74	80
20	82	95	70	80	20	75	86
21	84	96	71	80	21	74	87
22	85	97	71	79	22	73	83
23	81	98	73	81	23	72	81
24	83	98	74	83	24	73	80
25	84	98	75	80	25	71	80
26	82	97	73	80	26	73	81
27	84	95	71	83	27	74	80
28	83	94	73	80	28	75	86
29	81	93	71	80	29	73	86
30	81	92	71	82	30	72	87

APPENDIX - X

INDIVIDUAL PULSE RATE OF THE SUBJECTS WHILE SORGHUM HARVESTING

No.	Anemic				No.	Non - Anemic	
	Before Supplementation		After Supplementation				
	Before Activity	After Activity	Before Activity	After Activity		Before Activity	After Activity
1	82	94	73	86	1	73	82
2	83	98	76	87	2	72	80
3	84	102	74	83	3	70	78
4	84	100	74	80	4	72	80
5	82	101	74	83	5	74	84
6	82	103	74	85	6	71	81
7	80	104	74	85	7	72	82
8	80	108	74	80	8	70	80
9	80	105	74	83	9	75	83
10	82	103	72	82	10	72	81
11	85	102	73	80	11	74	82
12	84	160	72	82	12	72	80
13	85	100	74	84	13	74	83
14	84	101	75	84	14	74	84
15	83	98	74	84	15	73	82
16	82	99	72	82	16	72	83
17	81	99	74	80	17	74	85
18	83	102	72	81	18	76	84
19	82	105	74	81	19	73	85
20	81	103	74	80	20	76	85
21	83	104	73	80	21	70	82
22	86	104	72	80	22	74	89
23	83	105	73	80	23	73	90
24	84	108	75	82	24	74	85
25	83	109	72	80	25	72	92
26	81	102	72	82	26	75	89
27	85	106	72	80	27	73	86
28	82	107	70	79	28	75	87
29	82	103	72	81	29	72	89
30	81	104	73	80	30	70	88

APPENDIX - X

INDIVIDUAL PULSE RATE OF THE SUBJECTS WHILE WEEDING

No.	Anemic				No.	Non- Anemic	
	Before Supplementation.		After Supplementation			Before Activity	After Activity
	Before Activity	After Activity	Before Activity	After Activity			
1	83	97	72	88	1	74	84
2	84	99	72	82	2	73	82
3	83	103	72	80	3	72	80
4	84	104	72	82	4	74	82
5	83	105	70	80	5	75	80
6	83	103	72	81	6	73	84
7	82	107	76	83	7	70	80
8	82	104	72	80	8	72	83
9	81	103	75	86	9	76	84
10	83	104	70	86	10	73	81
11	86	102	70	86	11	75	82
12	85	100	73	80	12	73	84
13	84	104	73	82	13	74	86
14	83	103	72	80	14	73	83
15	83	104	72	80	15	74	80
16	82	100	70	80	16	73	82
17	84	99	73	81	17	74	85
18	85	106	73	80	18	75	84
19	86	107	72	80	19	76	86
20	87	108	72	81	20	74	87
21	83	107	74	81	21	72	88
22	84	108	70	81	22	70	89
23	82	109	74	83	23	74	84
24	83	107	71	80	24	71	89
25	83	103	71	82	25	73	86
26	83	104	71	81	26	74	89
27	88	108	71	81	27	75	87
28	84	105	72	81	28	76	85
29	83	100	72	80	29	72	84
30	82	103	74	80	30	73	86

APPENDIX - XI

INDIVIDUAL BLOOD PRESSURE OF THE SUBJECTS IN STRAW HARVESTING AT THE START OF THE STUDY

No.	Anaemic Blood Pressure Before Activity	Anaemic Blood Pressure After Activity	No.	Non - Anaemic Blood Pressure Before Activity	Non - Anaemic Blood Pressure After Activity
1	118/80	124/81	1	120/80	122/81
2	120/80	124/82	2	120/80	123/82
3	118/80	123/82	3	120/80	124/81
4	110/80	120/82	4	120/80	123/81
5	113/80	120/83	5	120/80	121/81
6	117/80	120/81	6	110/80	120/80
7	120/80	124/81	7	115/80	117/80
8	120/80	124/82	8	120/80	120/80
9	110/70	120/83	9	115/75	117/79
10	110/75	120/80	10	110/70	110/70
11	110/80	120/82	11	110/80	120/80
12	115/80	120/81	12	110/80	120/81
13	120/80	123/81	13	115/80	120/81
14	120/80	124/82	14	120/80	121/82
15	118/78	122/81	15	120/80	123/82
16	120/80	122/82	16	120/78	122/80
17	118/80	125/82	17	120/79	122/80
18	120/80	124/83	18	11[illegible]/75	118/78
19	120/80	120/82	19	115/80	119/80
20	118/80	121/82	20	110/79	120/81
21	110/80	123/81	21	110/78	120/80
22	115/75	120/82	22	115/80	120/80
23	110/80	123/80	23	115/75	120/80
24	115/80	124/82	24	120/80	122/81
25	115/75	124/81	25	110/80	110/82
26	120/80	120/80	26	120/80	122/80
27	118/80	120/81	27	115/80	120/81
28	115/75	122/81	28	117/80	120/80
29	118/78	123/81	29	118/79	120/80
30	115/78	120/80	30	120/80	122/80

APPENDIX - XI

INDIVIDUAL BLOOD PRESSURE OF THE SUBJECTS WHILE COWPER HAUMLS CUTTING AT THE START OF THE STUDY

No.	Anaemic Blood Pressure		No.	Non - Anaemic Blood Pressure	
	Before Activity	After Activity		Before Activity	After Activity
1	120/80	122/80	1	120/80	122/80
2	121/80	125/80	2	120/80	121/80
3	115/80	120/80	3	110/80	115/80
4	115/80	118/80	4	110/80	117/80
5	110/75	115/80	5	115/80	117/80
6	110/75	118/78	6	115/80	115/80
7	120/80	122/80	7	110/70	110/70
8	122/80	124/80	8	110/75	110/75
9	120/80	122/80	9	115/70	117/72
10	120/80	122/80	10	115/75	117/77
11	110/75	115/80	11	115/80	118/80
12	115/70	120/75	12	115/80	118/80
13	120/78	120/80	13	110/80	115/80
14	118/80	120/80	14	120/80	122/80
15	118/78	120/80	15	120/80	122/80
16	115/80	117/80	16	120/80	120/80
17	120/80	122/82	17	118/78	120/80
18	110/75	115/75	18	110/75	120/80
19	110/80	112/80	19	112/75	120/78
20	120/80	121/81	20	120/80	121/80
21	120/80	220/80	21	121/80	122/80
22	110/80	119/80	22	118/80	120/80
23	115/80	118/80	23	120/80	122/80
24	120/82	122/83	24	180/80	122/80
25	120/81	121/83	25	121/80	122/80
26	120/80	124/82	26	118/80	120/80
27	120/78	123/79	27	120/80	121/80
28	121/81	124/82	28	115/75	117/78
29	120/79	122/81	29	120/80	120/80
30	120/80	124/80	30	118/80	120/80

APPENDIX - XI

INDIVIDUAL BLOOD PRESSURE WHILE COWPER POD PICKING AT THE START OF THE STUDY

No.	Anaemic Blood Pressure		No.	Non - Anaemic Blood Pressure	
	Before Activity	After Activity		Before Activity	After Activity
1	120/80	121/82	1	120/78	120/80
2	120/81	122/82	2	110/75	115/80
3	120/80	122/80	3	110/70	110/70
4	110/75	115/76	4	110/80	115/80
5	110/70	115/70	5	120/80	122/80
6	118/80	120/80	6	118/78	120/78
7	118/75	120/75	7	120/78	121/78
8	115/80	120/80	8	6122/80	122/80
9	120/80	121/81	9	120/81	120/80
10	115/80	120/80	10	120/80	121/80
11	120/81	121/81	11/	118/75	120/75
12	125/80	126/82	12	120/80	121/80
13	110/70	115/70	13	115/80	120/80
14	115/70	120/70	14	118/80	120/80
15	115/75	120/75	15	120/80	121/80
16	120/75	120/75	16	120/80	121/80
17	120/70	124/70	17	120/80	120/80
18	110/70	115/70	18	110/80	115/80
19	120/71	120/73	19	115/80	115/80
20	118/78	122/80	20	115/80	118/80
21	120/82	122/82	21	120/75	121/75
22	115/75	120/75	22	110/75	115/75
23	110/75	115/75	23	115/80	117/80
24	110/70	115/75	24	120/80	120/80
25	115/75	120/75	25	125/80	127/80
26	115/80	115/80	26	120/80	122/80
27	110/80	115/80	27	115/78	117/78
28	120/80	122/80	28	120/78	120/78
29	122/80	125/80	29	110/70	115/70
30	125/80	130/80	30	120/80	120/80

APPENDIX - XI

INDIVIDUAL BLOOD PRESSURE WHILE SORGHUM HARVESTING AT THE START OF THE STUDY

No.	Anamic Blood Pressure		No.	Non - Anaemic Blood Pressure	
	Before Activity	After Activity		Before Activity	After Activity
1	118/80	122/80	1	117/80	120/80
2	118/80	124/80	2	115/80	120/80
3	120/80	123/80	3	120/80	121/80
4	118/80	124/81	4	121/80	122/80
5	115/80	120/82	5	120/80	122/80
6	115/75	12 0/80	6	120/80	121/80
7	1110/70	115/75	7	115/70	120/75
8	110/80	118/81	8	110/70	115/75
9	115/80	118/82	9	115/80	120/80
10	118/80	120/81	10	118/78	120/80
11	120/80	120/80	11	120/80	122/81
12	118/78	120/80	12	120/80	121/82
13	118/75	122/79	13	118/80	120/81
14	110/70	123/80	14/	115/80	120/81
15	110/80	120/85	15	118/80	120/80
16	115/80	120/82	16	119/79	122/81
17	120/80	122/82	17	119/80	122/80
18	120/78	124/81	18	120/80	125/80
19	120/75	125/80	19	118/78	120/80
20	120/80	125/80	20	115/75	124/78
21	120/80	125/80	21	120/80	123/80
22	117/80	124/81	22	120/80	124/80
23	118/80	123/81	23	120/80	125/80
24	120/80	124/82	24	120/80	123/82
25	120/78	123/81	25	120/80	122/81
26	118/70	122/79	26	121/80	122/81
27	120/80	122/80	27	118/78	120/80
28	120/80	121/81	28	119/79	120/80
29	118/80	122/82	29	115/70	117/75
30	120/80	123/81	30	110/80	115/81

APPENDIX - XI

INDIVIDUAL BLOOD PRESSURE OF THE SUBJECTS WHILE WEEDING AT THE START OF THE STUDY

No.	Anaemic Blood Pressure		No.	Non Anaemic Blood Pressure	
	Before Activity	After Activity		Before Activity	After Activity
1	118/80	185/82	1	180/80	122/81
2	119/80	124/82	2	118/80	123/81
3	118/80	123/81	3	120/80	123/81
4	115/75	125/82	4	115/80	120/81
5	110/80	120/82	5	110/80	120/80
6	120/80	125/82	6	120/80	122/80
7	121/80	126/82	7	120/80	122/80
8	120/80	127/83	8	110/80	120/80
9	110/80	120/82	9	115/80	118/80
10	115/80	122/81	10	115/80	119/80
11	120/80	122/82	11	117/80	120/81
12	115/80	120/81	12	118/78	120/80
13	120/80	125/82	13	118/78	121/80
14	118/80	124/83	14	120/80	121/80
15	118/80	125/82	15	121/80	122/80
16	120/80	124/82	16	120/80	123/80
17	115/80	126/81	17	121/80	124/80
18	118/80	124/82	18	120/80	125/80
19	118/80	123/81	19	120/80	129/82
20	120/80	124/82	20	120/80	120/81
21	118/80	122/81	21	120/80	121/80
22	120/80	125/83	22	120/81	122/81
23	120/80	124/83	23	120/80	121/80
24	120/80	127/83	24	120/81	124/81
25	115/80	120/81	25	120/80	122/80
26	121/80	126/82	26	120/80	121/81
27	120/80	125/81	27	115/80	118/82
28	118/80	124/81	28	117/81	120/82
29	115/70	120/78	29	118/80	121/81
30	110/75	122/80	30	117/75	121/81

APPENDIX - XII

INDIVIDUAL BASAL METABOLIC RATE OF THE SUBJECTS

No.	Anemic Basal Metabolic Rate 10%		No.	Non - Anemic Basal Metabolic Rate 10%
	Before Supplementation	After Supplementation		
1	38.22	35.0	1	34.5
2	45.41	36.0	2	33.1
3	55.82	34.5	3	31.6
4	62.30	38.0	4	39.6
5	54.60	33.75	5	27.8
6	64.00	37.0	6	28.7
7	46.50	36.0	7	28.5
8	46.60	33.0	8	31.5
9	39.70	35.0	9	40.[illegible]
10	38.70	35.0	10	32.7
11	53.90	38.0	11	34.3
12	41.20	35.0	12	35.9
13	38.80	35.25	13	34.6
14	46.00	39.00	14	27.3
15	47.00	39.00	15	32.2
16	45.20	33.00	16	31.2
17	56.80	36.00	17	36.2
18	42.80	37.00	18	27.0
19	49.20	34.00	19	33.1
20	58.7	37.5	20	33.5
21	48.00	36.5	21	31.0
22	42.80	33.5	22	26.0
23	52.20	38.5	23	34.0
24	48.00	36.5	24	29.0
25	55.00	37.5	25	32.0
26	54.00	38.5	26	28.0
27	40.8	34.5	27	27.0
28.	49.6	37.0	28	36.1
29	44.7	35.5	29	31.0
30	47.8	34.5	30	34.6

APPENDIX - XIII

INDIVIDUAL VITAL CAPACITY OF THE SUBJECTS

No.	Anaemic Vital capacity in ml. Before Supplementation	Anaemic Vital capacity in ml. After Supplementation	No.	Non - Anaemic Vital capacity in ml.
1	2000	2250		2300
2	2200	2250		2250
3	2100	2200		2350
4	2150	2200		2200
5	2000	2100		2150
6	2050	2150		2000
7	2075	2275		2250
8	2100	2250		2150
9	2000	2100		2175
10	2000	2150		2100
11	2100	2250		2300
12	1900	2210		2250
13	1800	2110		2300
14	1950	2225		2250
15	2100	2325		2750
16	1500	1950		2100
17	1800	2110		2150
18	2000	2200		2175
19	1900	2100		2200
20	2000	2220		2100
21	2100	2250		2350
22	2050	2150		2300
23	2000	2100		2200
24	2100	2225		2210
25	2150	2250		2220
26	1950	2100		2240
27	1850	2150		2270
28	1900	2150		2300
29	2000	2220		2350
30	2100	2300		2100

APPENDIX - XIV

INDIVIDUAL WORK OUT PUT IN TERMS OF AREA COVERED (STRAW HARVESTING)

No.	Anemic: Area covered in sq.m. Before Supplementation	Anemic: Area covered in sq.m. After supplementation	No.	Non - Anemic: Area covered in sq.m
1	21.0	23.0	1	26.0
2	22.0	25.0	2	26.0
3	20.5	22.5	3	25.0
4	18.0	23.0	4	27.0
5	18.0	20.0	5	28.0
6	19.0	22.0	6	29.0
7	20.5	22.5	7	30.0
8	18.5	20.5	8	30.0
9	18.0	20.0	9	28.5
10	18.0	20.0	10	27.0
11	20.0	25.0	11	27.5
12	18.5	20.5	12	28.5
13	18.5	22.5	13	27.5
14	19.0	22.0	14	28.0
15	18.5	20.0	15	29.0
16	18.0	20.0	16	28.0
17	20.0	22.0	17	29.5
18	19.5	21.0	18	26.0
19	19.0	22.0	19	24.0
20	19.0	22.0	20	26.5
21.	20.5	22.0	21	28.0
22	18.5	20.0	22	29.0
23	19.0	20.0	23	30.0
24	19.5	20.0	24	28.5
25	18.0	22.5	25	25.5
26	18.5	20.0	26	27.5
27	18.5	20.0	27	29.0
28	18.0	20.5	28	27.0
29	18.5	20.0	29	28.0
30	20.0	20.5	30	27.5

APPENDIX - XIV

INDIVIDUAL WORK OUTPUT IN TERMS OF AREA COVERED COWPEA HAULMS CUTTING

No.	Anaemic Area covered in sq.m Before Supplementation	Anaemic Area covered in sq.m After supplementation	No.	Non- Anaemic Area covered in sq.m
1	20.0	25.0	1	25.0
2	21.0	24.0	2	24.0
3	19.5	26.0	3	26.0
4	19.0	24.5	4	27.5
5	18.5	30.0	5	30.0
6	18.0	28.0	6	28.0
7	21.5	28.5	7	28.5
8	18.5	29.0	8	29.0
9	18.0	27.5	9	27.5
10	19.0	28.0	10	28.0
11	19.5	27.5	11	27.5
12	19.5	28.0	12	28.0
13	19.5	27.5	13	27.5
14	18.5	28.0	14	28.0
15	18.0	29.0	15	29.0
16	20.0	29.5	16	29.5
17	20.0	30.0	17	30.0
18	19.5	25.0	18	25.0
19	20.0	25.0	19	25.0
20	20.0	27.5	20	27.5
21	20.0	28.0	21	28.0
22	18.0	30.0	22	30.0
23	18.5	29.0	23	29.0
24	19.0	29.5	24	29.5
25	19.5	26.5	25	26.5
26	18.0	27.0	26	27.0
27	19.5	28.0	27	28.0
28	19.0	26.5	28	26.5
29	20.0	26.0	29	26.0
30	20.5	25.5	30	25.5

APPENDIX XIV

INDIVIDUAL WORK OUTPUT INTERMS OF AREA COVERED
(COWPEA POD PICKING)

Anaemic			Non Anaemic		
No.	Area covered in sq.m.	Quantity of pods picked in g.	No.	Area covered in sq.m.	Quantity of Pods picked in g
1	40.0	1500	1	45.0	1600
2	41.0	1200	2	48.0	1800
3	39.0	1500	3	46.0	1750
4	40.0	1200	4	4[illegible].0	1700
5	38.0	1300	5	50.0	1600
6	39.0	1300	6	51.0	1700
7	40.0	1400	7	47.5	1600
8	40.0	1500	8	46.0	1750
9	40.0	1000	9	45.0	1850
10	38.0	1000	10	45.0	1650
11	38.0	1500	11	45.3	1670
12	39.0	1500	12	47.4	1750
13	39.0	1000	13	48.5	1760
14	38.5	1500	14	48.0	1700
15	38.0	1500	15	47.5	1800
16	39.0	1400	16	50.0	1800
17	39.0	1500	17	50.0	1850
18	40.0	1500	18	49.5	1750
19	40.0	1000	19	49.4	1800
20	40.0	1500	20	49.0	1775
21	39.5	1200	21	48.0	1750
22	38.5	1200	22	45.0	1500
23	38.0	1250	23	46.7	1600
24	39.5	1350	24	49.3	1800
25	39.0	1450	25	46.0	1550
26	40.0	1400	26	47.0	1580
27	40.5	1500	27	47.5	1650
28	38.0	1350	28	46.5	1575
29	37.5	1250	29	48.0	1725
30	38.0	1300	30	47.5	1750

APPENDIX - XIV

INDIVIDUAL WORK OUTPUT IN TERMS OF AREA COVERED (SORGHUM HARVESTING)

No.	Anaemic Area covered in sq.m. (Before Supplementation	After Supplementation	No.	Non Anaemic Area covered in sq.m.
1	26.0	30.0	1	32.0
2	27.5	30.5	2	35.0
3	28.0	32.0	3	33.5
4	29.0	32.0	4	34.5
5	30.0	35.0	5	32.5
6	28.0	34.0	6	31.0
7	28.5	30.5	7	30.0
8	28.5	28.5	8	32.5
9	27.0	30.5	9	33.5
10	26.0	29.0	10	36.0
11	25.5	27.5	11	37.5
12	30.0	32.5	12	36.5
13	30.0	35.0	13	33.5
14	27.5	29.0	14	33.0
15	26.0	28.0	15	34.0
16	28.0	29.0	16	32.5
17	27.5	28.0	17	32.5
18	28.5	30.5	18	32.0
19	29.0	30.5	19	31.5
20	29.5	31.0	20	34.5
21	26.0	28.0	21	35.0
22	25.5	28.5	22	35.0
23	27.0	27.5	23	36.0
24	28.5	30.5	24	36.5
25	29.0	32.5	25	37.0
26	30.0	32.0	26	34.0
27	28.0	30.0	27	34.5
28	26.0	27.5	28	32.5
29	27.0	29.0	29	32.0
30	28.0	31.5	30	34.5

APPENDIX xiv

INDIVIDUAL WORK OUTPUT INTERMS OF AREA COVERED WEEDING

No.	Aneamic: Area covered in sq.m. Before Supplementation	Aneamic: Area covered in sq.m. After Supplementation	Non Aneamic: No.	Non Aneamic: Area covered in sq.m.
1	27.0	28.0	1	33.0
2	27.5	30.0	2	32.5
3	28.0	33.0	3	33.5
4	30.0	34.0	4	30.5
5	25.5	29.0	5	35.0
6	26.5	30.0	6	36.5
7	27.5	30.0	7	37.0
8	27.5	30.0	8	37.0
9	30.0	32.0	9	32.5
10	30.0	33.0	10	37.5
11	28.5	30.0	11	38.0
12	29.0	33.0	12	33.0
13	29.5	32.5	13	34.0
14	26.5	28.0	14	35.0
15	26.5	29.0	15	35.0
16	26.0	28.0	16	35.0
17	28.5	29.0	17	32.5
18	27.5	29.5	18	31.0
19	28.5	30.5	19	30.5
20	27.5	30.5	20	33.0
21	28.0	30.0	21	32.5
22	25.0	28.0	22	33.0
23	26.0	28.0	23	32.5
24	25.0	27.5	24	33.5
25	27.5	30.5	25	32.5
26	28.0	29.5	26	32.5
27	29.0	32.5	27	31.0
28	27.5	30.5	28	30.5
29	28.5	30.5	29	34.5
30	28.0	32.0	30	36.0

APPENDIX - XV

INDIVIDUAL PULSE RATES DURING ERGOMETRY AT THE START OF THE STUDY

No.	3rd Minute		6th Minute		9th Minute	
	Anaemic	Non Anaemic	Anaemic	Non Anaemic	Anaemic	Non Anaemic
1	95	83	105	94	115	104
2	100	88	111	99	120	109
3	108	76	117	99	124	109
4	105	75	115	88	124	93
5	102	88	118	102	124	111
6	100	85	113	94	120	104
7	88	88	99	101	111	109
8	88	76	102	90	111	100
9	102	80	113	90	124	102
10	99	85	112	96	120	106
11	92	85	102	96	115	106
12	95	74	105	85	120	95
13	98	75	108	84	120	93
14	100	77	109	88	117	93
15	101	78	109	85	117	95
16	100	89	113	96	123	106
17	105	80	115	94	120	104
18	98	86	109	96	118	109
19	98	83	108	94	120	108
20	102	86	116	94	122	109
21	100	83	108	90	116	104
22	97	82	109	92	116	102
23	90	84	101	94	113	106
24	95	75	105	90	114	100
25	95	77	108	85	120	95
26	102	78	118	84	122	95
27	98	80	109	90	118	102
28	100	77	107	88	116	95
29	98	74	110	85	120	95
30	100	76	112	85	120	95

APPENDIX XVI

INDIVIDUAL WORK OUTPUT INTERMS OF AREA COVERED (COWPEA POD PICKING) AFTER SUPPLEMENTATION

Number	Area covered in sq.m.	Quantity of Pods picked
1	45.0	1600
2	47.0	1500
3	45.0	1300
4	43.0	1500
5	40.0	1400
6	43.0	1400
7	41.0	1400
8	43.0	1600
9	43.0	1450
10	4.0	1200
11	40.0	1600
12	42.5	1600
13	39.5	1400
14	40.0	1550
15	40.5	1700
16	42.0	1500
17	40.0	1600
18	42.0	1550
19	42.0	1300
20	42.5	1500
21.	42.0	1400
22	39.5	1300
23	40.5	1300
24	40.5	1400
25	43.0	1650
26	48.5	1700
27	42.5	1650
28	40.5	1500
29	39.5	1400
30	40.5	1550

APPENDIX -XVI

INDIVIDUAL BLOOD PRESSURE OF THE WHILE STRAW HARVESTING AFTER SUPPLEMENTATION

No.	Before Activity	After Activity
1	120/80	122/81
2	110/80	120/80
3	115/80	120/80
4	115/80	120/81
5	120/80	122/81
6	118/80	120/80
7	118/80	122/80
8	115/75	120/80
9	120/80	123/80
10	110/80	120/80
11	115/80	115/75
12	120/80	122/80
13	110/80	123/80
14	110/75	115/80
15	110/80	120/81
16	115/80	120/80
17	120/80	122/81
18	115/75	120/80
19	115/80	120/81
20	115/80	120/80
21	115/80	120/80
22	115/80	120/80
23	115/80	122/80
24	118/80	120/80
25	118/80	120/80
26	115/80	120/80
27	120/80	122/80
28	115/80	120/80
29	120/80	121/80
30	120/80	122/80

APPENDIX – XVI

INDIVIDUAL BLOOD PRESSURE OF THE WHILE COCAPEA HAULMS CUTTING AFTER SUPPLEMENTATION

No.	Before Activity	After Activity
1	110/80	120/30
2	120/80	125/80
3	110/70	121/81
4	115/80	120/82
5	120/80	122/80
6	110/70	120/80
7	120/80	122/82
8	118/80	122/81
9	118/80	120/80
10	120/80	122/81
11	115/75	123/81
12	120/80	122/81
13	120/80	124/80
14	120/80	124/82
15	120/75	124/80
16	118/70	120/80
17	117/80	123/80
18	115/80	120/80
19	120/80	120/80
20	110/70	120/80
21	110/75	120/80
22	120/80	122/80
23	120/80	121/80
24	120/80	121/80
25	120/80	123/80
26	115/75	122/80
27	115/80	121/80
28	120/80	122/80
29	120/80	122/80
30	115/75	122/80

APPENDIX - XVI

INDIVIDUAL BLOOD PRESSURE OF THE COWPEA POD PICKING AFTER SUPPLEMENTATION

No.	Before Activity	After Activity
1	120/80	121/80
2	118/80	125/80
3	115/80	120/80
4	110/70	120/80
5	115/81	120/83
6	120/75	123/80
7	110/75	120/80
8	117/80	120/80
9	120/75	124/81
10	110/75	120/80
11	110/70	120/80
12	115/80	120/81
13	110/75	123/80
14	115/80	123/81
15	120/80	122/81
16	120/82	120/90
17	118/80	122/80
18	120/80	121/80
19	120/80	122/80
20	115/75	121/80
21	118/80	122/80
22	117/80	123/80
23	120/80	120/80
24	110/75	120/80
25	120/80	122/80
26	110/75	120/80
27	120/50	120/80
28	118/80	121/80
29	120/80	121/80
30	118/80	122/80

APPENDIX - XVI

INDIVIDUAL BLOOD PRESSURE OF THE SORGHUM HARVESTING AFTER SUPPLEMENTATION

No.	Before Activity	After Activity
1	115/80	122/80
2	115/82	124/81
3	115/75	120/80
4	120/80	121/81
5	110/70	120/80
6	119/78	124/81
7	120/80	124/82
8	120/80	122/82
9	120/80	120/80
10	120/80	123/80
11	117/80	124/80
12	115/75	124/80
13	115/75	123/80
14	115/75	125/80
15	120/80	121/80
16	120/75	120/80
17	115/75	124/80
18	120/75	122/80
19	117/80	120/80
20	115/80	120/80
21	115/70	120/80
22	118/80	121/80
23	110/70	120/80
24	119/80	124/80
25	115/80	122/80
26	120/80	120/80
27	110/75	115/80
28	120/80	120/80
29	120/80	123/80
30	120/80	122/80

APPENDIX XVI

INDIVIDUAL BLOOD PRESSURE OF THE WEEDING (HOEING) AFTER SUPPLEMENTATION

Number	Before Activity	After Activity
1	120/80	123/80
2	115/81	121/80
3	120/75	123/80
4	120/80	122/82
5	110/80	120/82
6	115/80	120/80
7	115/75	120/80
8	120/80	124/81
9	110/70	122/81
10	110/70	122/80
11	120/80	122/81
12	115/80	120/80
13	120/80	124/80
14	120/75	122/80
15	115/75	120/80
16	117/75	122/80
17	121/80	123/80
18	110/70	120/80
19	115/75	123/80
20	117/80	122/80
21	117/80	121/80
22	120/80	122/80
23	120/80	123/80
24	115/70	121/80
25	115/70	122/80
26	120/80	122/80
27	121/80	122/80
28	120/80	122/80
29	115/75	120/80
30	120/80	121/80

APPENDIX - XVII

INDIVIDUAL PULSE RATES WHILE WORKING ON AN STATIC BICYCLE ERGOMETER AFTER SUPPLEMENTATION

No.	3rd Minute	6th Minute	9th Minute
1	85	97	105
2	80	91	105
3	84	95	107
4	80	90	102
5	80	92	100
6	80	95	107
7	80	90	100
8	79	87	96
9	82	93	103
10	80	92	102
11	83	94	102
12	85	90	97
13	80	90	97
14	80	90	103
15	78	89	99
16	83	90	101
17	83	90	95
18	82	89	94
19	82	97	104
20	83	90	97
21	81	90	101
22	82	88	95
23	80	92	100
24	80	88	98
25	80	87	99
26	84	96	103
27	80	88	96
28	82	93	100
29	84	93	102
30	81	90	99