METHODOLOGY

CHAPTER III

METHODOLOGY

Methodology refers to the theoretical analysis of the methods appropriate to a field of study or to the body of methods and principles particular to a branch of knowledge. Research methodology is a way to systematically solve the research problem. The present chapter unfolds various methods and techniques that were used to conduct this study and arrive at conclusions. The chapter has been discussed under the following sub-heads:

3.1 Research design
3.2 Conceptual framework
3.3 Variables
3.4 Operational definitions
3.5 Description of the study area
3.6 Sampling design
3.7 Data collection
3.8 Analysis of data

3.1 Research design

Research design is a basic plan for a piece of research. It provides the glue that holds the research study together. A design is used to structure the research, to show how all the major parts of the research study- the samples of groups, measures, treatments or programs, and methods of assignment – work together to try to address the central research questions. In conformity with the objectives of the study, descriptive survey and experimental design were formulated to proceed with the study.

Descriptive survey was planned and systematically carried out to gather data on background characteristics, anthropometric variables, and weeding operation. Split plot experimental design was set up for carrying out the

experimental trials. Four improved weeders were ergonomically assessed along with traditionally used *khutti.* Physiological cost of weeding, muscular stress, postural stress, and bodily discomfort experienced while working with different weeders were examined. In addition to these parameters, weeding efficiency and output (area weeded) achieved with different weeders were also measured.

3.2 Conceptual framework

A conceptual framework provides a "cognitive map", or set of interrelated concepts for understanding a process (Boone, 2002).

3.2.1 Conceptual framework for descriptive study: To get clearer and deeper understanding of the way in which weeding operation causes discomfort to the women farmers, an attempt was made to identify various possible variables which have their contribution in rendering this operation arduous and drudgery prone. Guided by the available literature and related researches, the variables were organized to develop a conceptual framework. The schematic representation of the various factors which were thought to be contributive in making weeding operation uncomfortable is depicted in fig-1.

The study conceptualized that the discomfort experienced by women farmers while performing weeding with traditional tools depends upon three groups of variables viz., personal, family and situational variables. Personal variables include age, height, and health status of the women. Family variables include landholding size, and the number of family members who help in weeding. Situational variables include the number of hours per day spent in weeding, posture adopted while weeding, and the number of days spent in performing weeding.

Conceptual Framework for descriptive please study

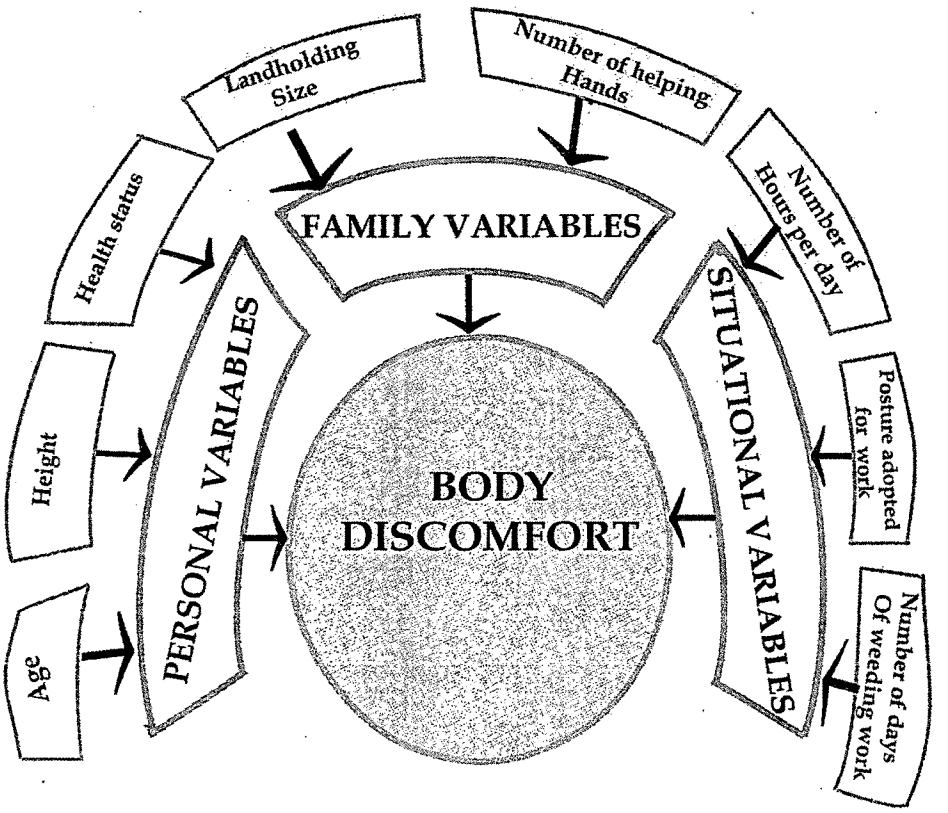
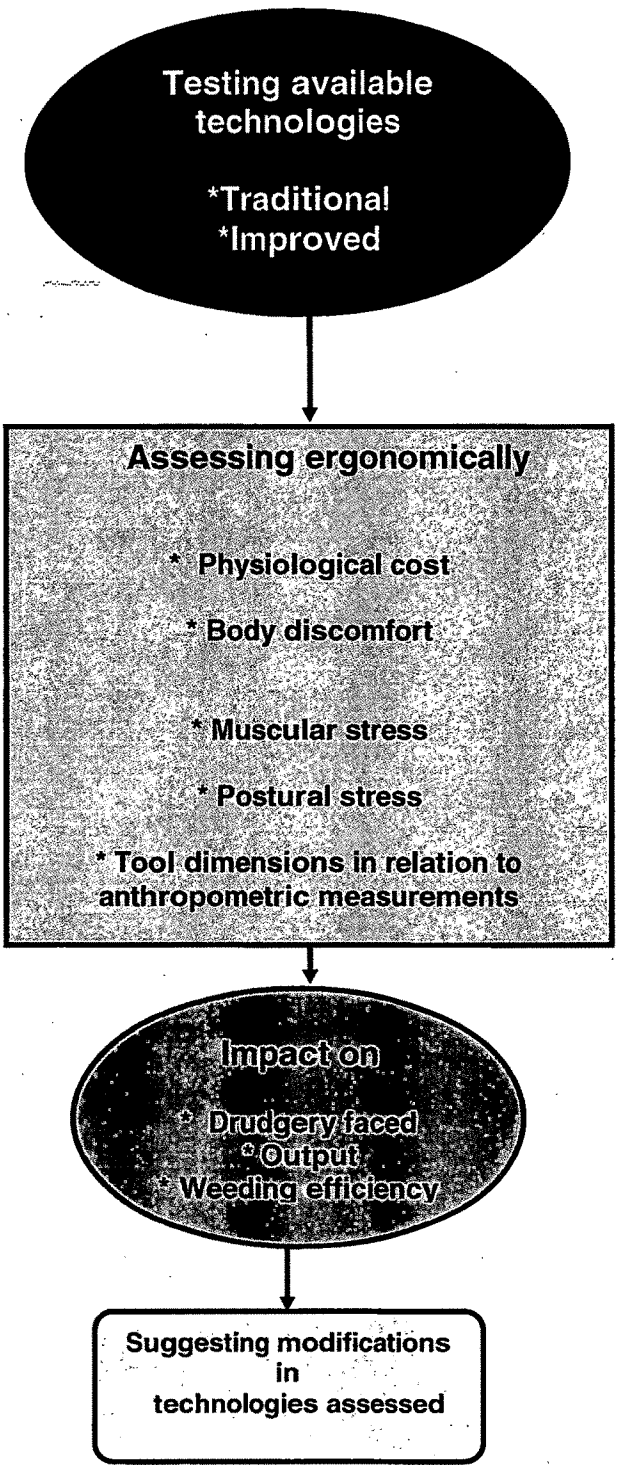


Fig.1 Conceptual framework for descriptive study

3.2.2 Conceptual framework for experimental study: The study conceptualized that impact on the drudgery faced by women workers plus output of the worker would differ with the use of traditional and improved technology. It was further conceptualized that the drudgery faced by women depends upon the kind of weeding technologies used by the women workers. The physiological cost of weeding and output of the worker would also vary with the use of different weeding technologies. Tools were assessed both ergonomically as well as efficiency-wise. The ergonomic assessment was done in terms of physiological cost, body discomfort experienced, postural stress, muscular stress and tool dimensions in relation to the anthropometric characteristics of the women workers. Area covered (output) and weeding efficiency were determined to describe the efficiency of the weeders.

Fig. Conceptual framework for experimental study



3.3 Variables

3.3.1 Hypothetical relationship between variables of Descriptive Study

Independent variables

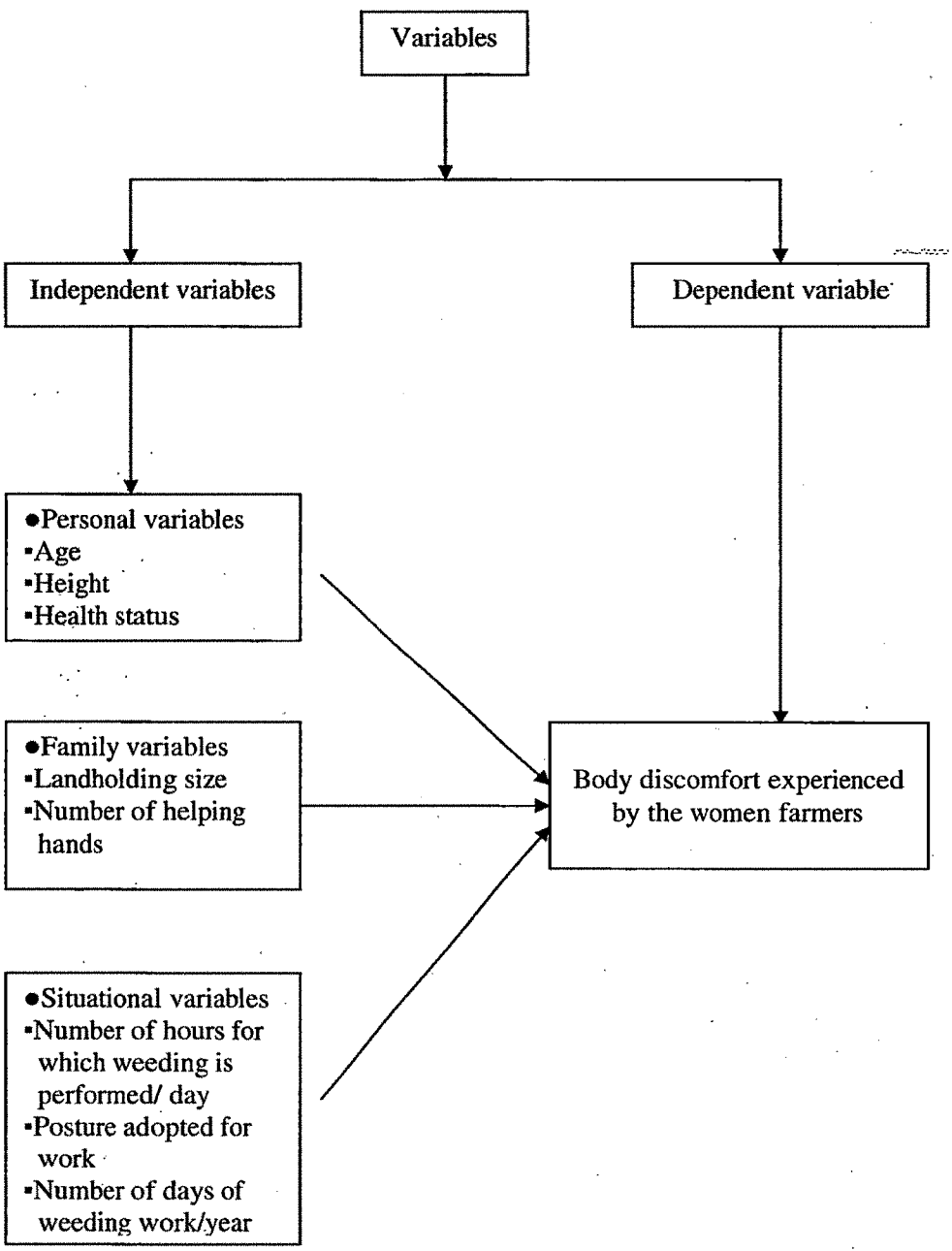
A. Personal variables: These include age and health status of the women farmers.

Age: For the present study age refers to the number of completed years since the birth of the respondent. A number of studies have highlighted the effect of age on the health and discomfort felt by women workers in different occupations. For instance, Shallini,2000; Singh 2000; Agarwal 2002; found that older women involved in construction work, food processing industries and agricultural labour complained more regarding discomfort/health problems compared to younger ones. The influence of age on body discomfort experienced on operation with the different weeding technologies was considered worthwhile to study.

Health status of the women: This refers to the physical well-being of the women. It was assessed in terms of the frequency of falling ill, existence of chronic diseases, ponderal index. Physical performance may indeed be affected by the individual's state of health. Chronic diseases such as cardiovascular disease, pulmonary disorders, gastrointestinal ailments or skeletal-muscular complaints may prevent the individual from doing certain jobs or from working under certain environmental conditions, such as excessive heat or abnormal atmospheric pressures.

Standing height: Standing height of an individual is an important anthropometric variable. It was assumed that height of the women farmers would affect the discomfort experienced by the women farmers. Irrespective of the height differences of women farmers they were using a traditional tool of a standardized height thus causing inconvenience during work. Therefore investigator was interested in examining the relationship between the two.

Fig.3. Hypothetical relationship of variables for descriptive study



B. Family variables: These include landholding size and number of helping hands.

Landholding size: For the present study, this implies total area under cultivation in Kanals (1kanal = 384m^2). Studies have shown that work participation of women vary with the size of the landholding. Women as compared to men, in small and marginal farm families in the villages carry a very heavy load of work both on the farm and in the home, with very limited access to, and control over, the resources necessary for farming or homemaking. Women belonging to small farm holdings, lower caste, with low socio-economic status with less education, with less material possession and having less urban contact were participating more in agricultural activities. Dayal and Pandey (1996) observed that with the increase in land holding, participation of rural women in sowing activities decreases. As regards harvesting operation they found that rural women belonging to families having marginal and small land holdings perform more work in farm related activities in comparison to landless women. Keeping in view the importance of this variable its relationship with the discomfort experienced by the women performing weeding operation was determined.

Number of helping hands: Help received in terms of number of family members was considered an important variable determining the discomfort experienced by women. It perhaps would affect the amount of work performed by the woman both at home and field front and, if not at both, at least at one of the two.

C. Situational variables

Number of hours spent in weeding in a day: It refers to the number of hours for which a woman performs weeding operation in a day. It definitely would influence the body discomfort experienced by women workers.

Number of days of weeding work: This refers to the total number of days in a year for which a woman performs weeding operation.

Dependent variable

Body discomfort experienced by women workers: It is defined as the pain arising as a result of the working posture and/or the excessive stress on muscles due to the effort involved in performing weeding with different weeding technologies.

Hypothetical relationship between variables for the experimental Study

Independent variable

Weeding technology: It was assumed that the type of technology used for weeding operation would influence the drudgery faced by the women farmers. Type of technology used would also determine the weeding efficiency and output (area weeded). Four improved weeders and one traditional weeder (*Khutti*) were evaluated.

Intervening variables

Physiological cost of weeding: Physiological cost is an important parameter for the ergonomic assessment. It was measured in terms of heart rate and energy expenditure.

Heart rate (HR, beats/min): It is the number of ventricular beats per minute. A number of researchers have used heart rate as a parameter of ergonomical evaluation. Brouha(1960), Jones et al. (1968), Sarkey et al(1966), Le blanc(1953), Tomilson(1970) reported that heart rate rises sharply during the very first 15 seconds of exercise and then gradually it becomes constant. But they also indicated that in case of severe exercise the secondary increase may also occur. Nag et al. (1988) used heart rate responses as one of the measures for ergonomical evaluation of nine different types of sickles. Tewari et al. (1991) used heart rate as a measure of physiological assessment while evaluating three manually operated weeders.

A relationship among variables for the experimental study has been shown in the figure ( )

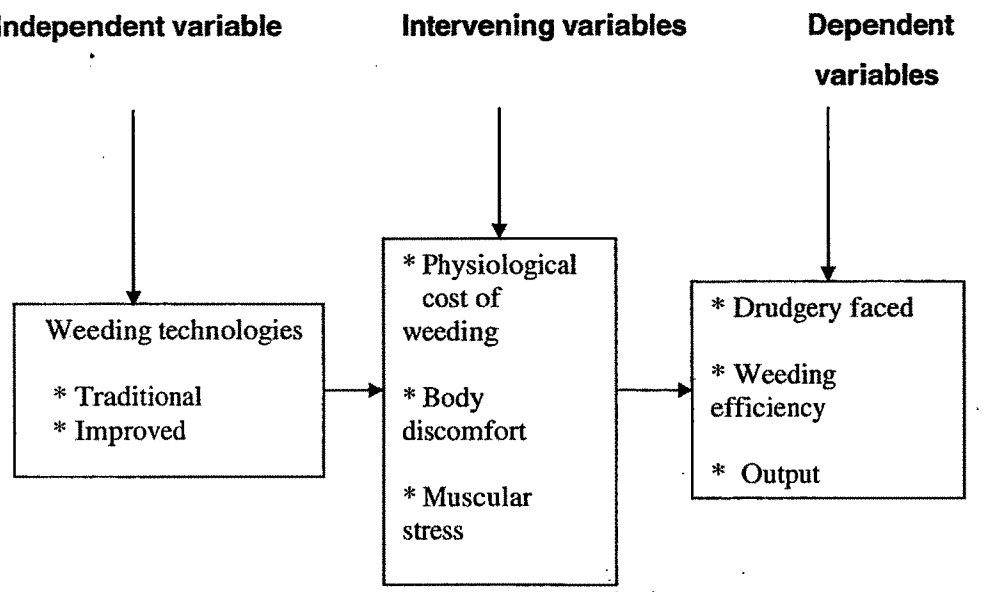


Figure: Hypothetical relationship among variables for experimental study

Energy expenditure (kJ/min): This parameter has been used by several researchers to assess the physiological cost of work. For instance, Yadav(1988), Kathirvel et al.(1991), Gite(1996), Kumar and Parvathi(1998) carried out ergonomical evaluation of different agricultural equipments using energy expenditure as one of the parameters. In the context of present study, it refers to the amount of energy expended in carrying out weeding activity with different weeding technologies.

Muscular stress: This is another parameter for ergonomical evaluation of activities and tools. Grandjean stated muscular effort produces a troublesome fatigue in the muscles concerned. According to him, when the muscular effort is less than 15-20 per cent of the maximum, blood flow is normal but gets contracted in proportion to the force exerted, thereby causing muscular discomfort. It was assessed in terms of reduction in hand grip strength. Oberoi et al. (2006) assessed the muscular stress of rural women while performing

different activities with traditional and improved tools. In the present study also this parameter has been used for ergonomic evaluation of weeder.

Postural stress: If the work is not carried in correct posture discomfort is felt after short duration. Postural stress is an important parameter for ergonomical evaluation of the activities, tools, equipments. Even small changes in the working posture prove to be beneficial to the worker. It is very important to test the technologies in terms of the working posture as poor posture affects the musculoskeletal system, sometimes severely. Various researchers have used this variable as one of the parameters for assessing the technologies. The postural stress was determined in terms of angle of deviation.

Body discomfort: Body discomfort may be due to two factors viz., awkward posture and excessive stress on muscles (Gite, 1996). He opined that subjective rating appeared to be a valid method for its assessment. Further, in many of the situations, though the work may be well within the physiological cost criteria, the body discomfort may restrict the duration of work depending upon the static loading component involved in it. It was determined in terms of score on a visual analogue discomfort scale ranging from 0-10. Many scientists have used this parameter for determining the ergonomical soundness of the agricultural equipments. For instance, Karthirvel et al. (2003) assessed the operator's body discomfort for direct paddy seeder. Balaskari et al. (2003) conducted a study to assess overall discomfort rating and body part discomfort of the tractor operators.

Dependent variables

Drudgery faced: This refers to the amount of hard work put in and difficulties faced by the women farmers while performing weeding operation with different weeding technologies.

Weeding efficiency: This implies the number of weeds weeded out in one metre square area while performing weeding operation.

Output: This refers to the area weeded in thirty minutes of operation with different weeding technologies.

3.4 Operational definitions

Ergonomics: For the present study ergonomics has been defined as the study of worker and his/her relationship with the work and tools used for work. The study deals with the weeding operation in relation to the use of different technologies by the women workers in order to see their suitability to the women farmers, to suggest modifications if needed, so that the weeding technologies can be made more comfortable and efficient according to the capacities of the worker.

Ergonomic assessment: In the context of the present study ergonomic assessment means evaluating traditional and improved technology on the basis of ergonomic parameters.

Anthropometric measurements: These include body measurements which were considered important for weeding tool. They are as under:

Weight: It was measured on calibrated weighing scale in kilograms.

Stature: The vertical distance from the standing surface to the top of the head. The subject stands erect and looks straight forward.

Elbow height: The vertical distance from the standing surface to the top of the radiale. The subject stands erect and looks straight forward.

Knee height: The vertical distance from the standing surface to the mid-point of knee cap. The subject stands erect and looks straight forward.

Waist back length: The vertical distance along the spine from the waist level to the cervical (the tip of the seventh cervical vertebra). The subject stands erect and looks straight forward.

Forearm hand length: The distance from the base of the hand to the top of the middle finger measured along the long axis of the hand.

Hand length: The distance from the base of the hand to the top of the middle finger measured along the long axis of the hand.

Hand breadth at metacarpal III: The breadth of the hand as measured across the distal ends of the metacarpal bones.

Hand breadth across thumb: The breadth of the hand measured across the level of the distal end of the metacarpal of the thumb.

Palm length: The distance from the base of hand to the furrow where the finger folds upon the palm.

3.5 Description of study area

The study was conducted in Kangra district of Himachal Pradesh. It is situated on the southern escarpment of the Himalayan land and is throughout broken in a massive confusion of hills and valleys. Dhauladhar on the north rises upto 5,000 metres above mean sea level. It is bounded in the north by the districts of Chamba and Lahaul-Spiti, in the south by Hamirpur and Una districts, in the east by Mandi district and in the West by Gurdaspur district of Punjab. Kangra district came into existence on 1st September 1972.

3.5.1 Location: The district of Kangra lies between 31°21′ to 32°59′ N latitude and 75°to 77°45′ E longitude. The elevation varies from 730-750 metres above mean sea level.

3.5.2 Physiography: The district has mountainous terrain and rugged topography. It has maximum length of 150 km in east–west direction and 100 km in the north–south direction. Topographically, the district can be divided into the following three zones.

1. **Lower hills and valleys:** Elevations upto 925 m above mean sea level.
2. **Mid- hills:** elevations ranging between 925m and 1,500 above mean sea level.
3. **High- hills:** elevations ranging from 1,500 m to 5000 m above mean sea level.

The beas river passes through this district. The main perennial rivulets of the district are Binwa, Awa, Neugal, Baner, Manjhi and Gaj, some of which have scope for minor hydro-electric potential in addition to irrigation facilities.

3.5.3 Area, population and literacy rate: Area covered by the Kangra district is 5,739 square kilometers. According to 2001 census the total population of the district was 13, 39,030 consisting of 6, 61,254 males and 6, 77,776 females. Out of the total population, 12, 66,745 people were residing in rural areas while 72,285 people were living in the urban area. The sex-ratio in the district was 1025 females per 1000 males. The population density was 233 persons per square kilometre.

3.5.4 Climate: The climate of Kangra district is characterized by a hot summer and well distributed rainfall during south-west monsoon, which lasts from June to September and coincides with *kharif* harvest. From October to the end of May, generally, dry conditions prevail except for few light showers received from the westerly depressions. These winter showers are beneficial for *rabi* crops. The cold season from December to February is followed by the hot season from March to May. October and November make up post-monsoon period.

3.5.5 Agriculture: In this land-locked hilly district, agriculture is not merely an occupation but an established tradition and an accepted way of life. The principal crops of Kangra district are wheat, maize, paddy and barley. Their respective production in the agricultural year 1995-96 was 115.7, 97.6, 46.9, 3.8 thousand metric tones. The Kangra district topped in potato production in the agriculture year 1996-97 with the total produce of 28,600 metric tones. Being a hilly area, step farming is practiced.

3.6 Sampling design

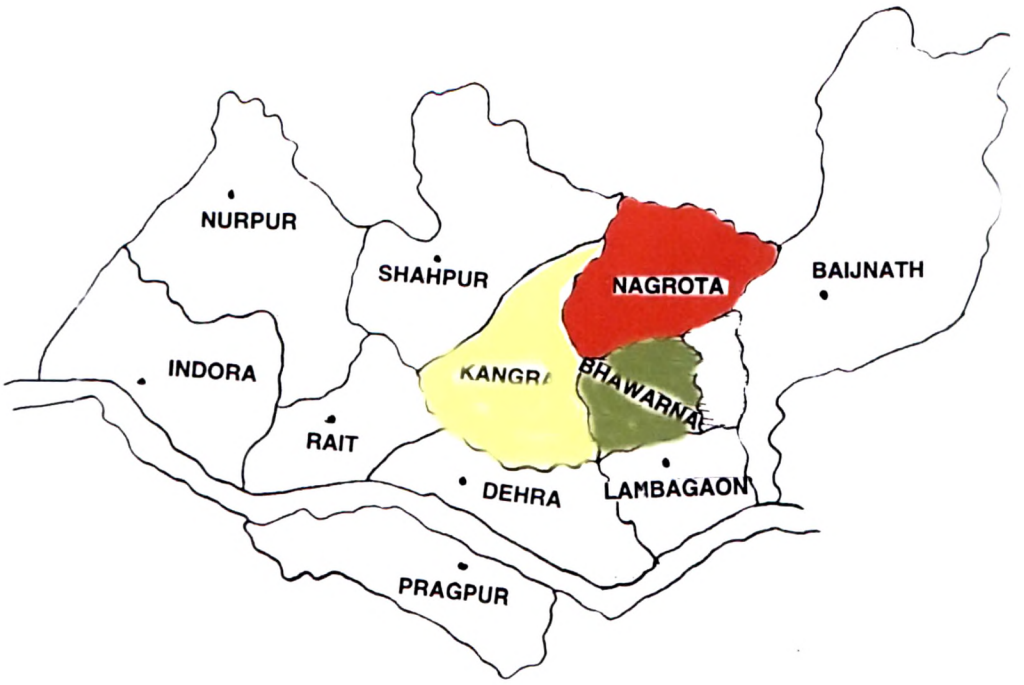
A multistage purposive cum random sampling was done to select sample of the study.

Population: The population of the present study included women farmers involved in weeding operation in Kangra district, Himachal Pradesh.

3.6.1 Sample selection for descriptive study: The sample selection was carried out in three stages:

Stage I- Selection of the blocks: The Kangra district comprises 14 blocks. Out of these, three blocks viz; Kangra, Nagrota and Bhawarna were selected purposively. These three blocks were selected on the basis of information obtained from the officials at Krishi Vigyan Kendra, Kangra (KVK). In these three blocks, women farmers were reported to perform weeding operation for the most time of the year.

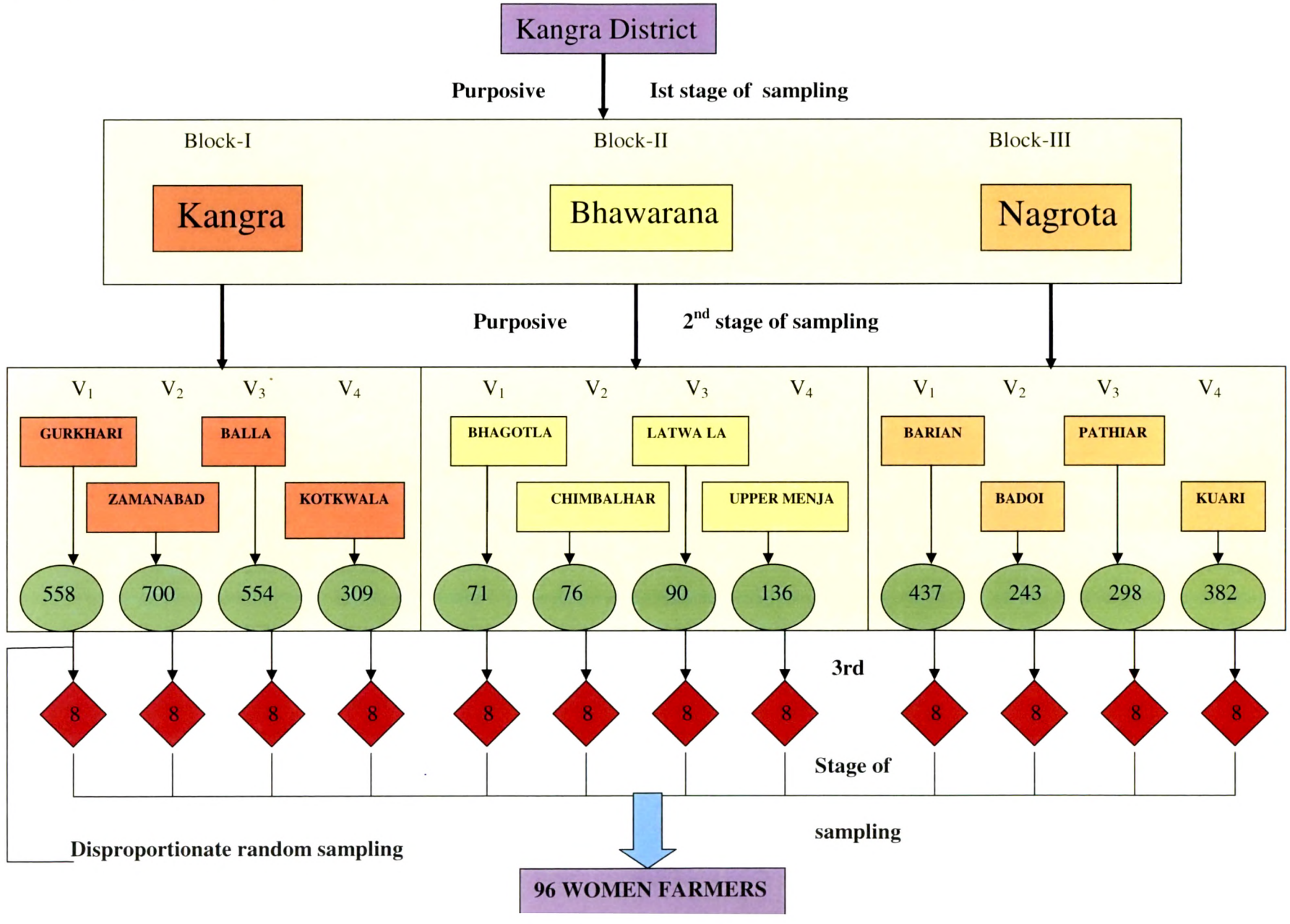
Stage II- Selection of the villages: In the second stage of sampling, 4 villages from each block were drawn purposively. While drawing villages two things were kept in mind: (a) geographical location of the villages (b) the



SELECTED BLOCKS

: Blocks of Kangra district

Sampling Design For Descriptive Study



information provided by the block officials related to women involved in weeding operation. Thus the villages lying close to each other and where women were actively involved in weeding operation were selected. The reason was to economize on traveling expenses. Also as per the information provided by the block officials at Krishi Vigyan Kendra, Kangra, farmers in the selected villages were doing vegetable cultivation for commercial purposes requiring weeding operation for larger part of the year. Furthermore, women especially were reported to be actively involved in weeding operation.

Stage III- Selection of the households: For the purpose of choosing households from the selected villages complete list of households in each selected village was procured from the block officials. Comparison of number of households in the selected villages showed lesser number of households in the villages of Bhawarna block than those in the villages of Kangra and Nagrota blocks. Moreover, farmers in the villages of Bhawarna block were predominantely cultivating potato while in the selected villages of Kangra block farmers were primarily cultivating vegetables such as cabbage, cauliflower, ladyfinger, brinjal etc. In the selected villages of Nagrota block farmers were cultivating potato as well as other vegetables. To ensure adequate representation equal number of households were selected from each of the selected villages. Thus the households were disproportionately selected at random from the selected villages. In each household, the woman who was largely responsible for farming activities acted as the respondent for the study.

Sample size: The sample comprised 96 women farmers for descriptive study.

3.6.2 Sample selection for experimental study: Two villages namely Balla and Kotkwala were purposively selected from Kangra block for carrying out experimental study. These two are adjoining villages with little climatic differences. From these two villages eight women farmers participated in the experimental study. Initially the aim and the procedure of the study were addressed to the village ladies via meeting organized in association with the mahila pradhans. Ladies who were willing to participate were examined for

their good health. This was ascertained by studying their resting heart rate. At the time of data collection cabbage and cauliflower cultivation was going on and therefore women were extensively involved in weeding operation.

3.7 Data collection

Methods and procedures of data collection adopted for collected data have been described separately for survey and experimental study.

3.7.1 Method of data collection for descriptive study:

The data were collected through personal interviews visiting each household separately. Interviews were conducted in both Hindi and local dialect to provide more comfort to the respondents during interviews. Before beginning the interview, the investigator introduced herself to the respondent and explained the purpose of the interview.

Tool used: For meeting descriptive data needs a structured interview schedule was constructed. It consisted of various sections which sought responses to various desired questions.

Section I: This section consisted of questions to seek information related to the background characteristics. The section dealt with the personal characteristics of respondents such as age, education, and family characteristics such as socio-economic, agricultural and livestock details.

Section II: This section had questions framed to gather information on weeding operation. The questions elicited responses on such information as the crops for which weeding operation is carried; number of times for which weeding operation is carried out in different crops; tools used for carrying out weeding operation; postures used for carrying out weeding operation; time for which weeding operation is carried continuously; frequency of rest periods; duration of rest periods etc.

Section III: This section dealt with measurement of anthropometric dimensions, and subjective assessment of the body discomfort felt by women workers while working with traditional weeding tools. Both overall body discomfort and body part discomfort were assessed.

3.7.2 Procedure for collecting experimental data

Split plot design: Split plot experimental design was used for the ergonomic assessment of the weeders. When some factors are to be studied more critically or with greater precision than the others the split plot design is used. In a split plot design, one of the factors is assigned to the main plot. The assigned factor is called the main-plot factor. The main plot is divided into subplots to which the second factor, called the subplot factor, is assigned.

With a split-plot design, the precision for the measurement of the effects of the main-plot factor is sacrificed to improve that of the subplot factor. Measurement of the main effect of the subplot factor and its interaction with the main-plot factor is more precise than that obtainable with a randomized complete block design. For the present study, eight women subjects were main plot treatments and the five weeders were subplot treatments. Three replications were carried.

Figure 3.6 A layout of a split-plot design involving five weeders (W_1,W_2,W_3,W_4,W_5) as subplot treatments and eight subjects (S_1,S_2,S_3,S_4,S_5,S_6,S_7,S_8) as main plot treatments, in three replications.

S_1	S_3	S_4	S_6	S_5	S_7	S_8	S_2
W_1	W_2	W_3	W_4	W_4	W_1	W_5	W_1
W_2	W_3	W_5	W_3	W_5	W_3	W_4	W_2
W_4	W_5	W_4	W_2	W_3	W_4	W_2	W_4
W_5	W_4	W_1	W_5	W_1	W_2	W_3	W_3
W_3	W_1	W_2	W_1	W_2	W_5	W_1	W_5

Replication I

S_2	S_3	S_5	S_6	S_7	S_8	S_1	S_4
W_2	W_1	W_1	W_5	W_3	W_4	W_3	W_1
W_3	W_2	W_2	W_4	W_5	W_3	W_5	W_2
W_5	W_3	W_4	W_2	W_4	W_2	W_2	W_5
W_4	W_4	W_5	W_3	W_1	W_5	W_1	W_3
W_1	W_5	W_3	W_1	W_2	W_1	W_4	W_4

Replication II

S_8	S_1	S_3	S_2	S_4	S_5	S_6	S_7
W_1	W_2	W_4	W_5	W_3	W_2	W_4	W_1
W_3	W_5	W_5	W_1	W_5	W_3	W_1	W_5
W_5	W_4	W_3	W_4	W_4	W_1	W_5	W_3
W_4	W_3	W_1	W_2	W_1	W_5	W_2	W_4
W_2	W_1	W_2	W_3	W_2	W_4	W_3	W_2

Replication III

Test code and procedure for ergonomic evaluation of manually operated weeders developed by CIAE, Bhopal was used for the present study. Five manually operated weeders, four improved namely CIAE wheel hoe, draw weeder, V-Blade hoe, and Falcon hoe, and traditional weeder, khutti were evaluated. These tools were used because they were long handled and the investigator wanted to introduce weeding tools with the long handle. The wheel hoe used for the present study was light in weight compared to other available wheel hoes.

Procedure for recording heart rate

1. First of all, subject was given rest for a period of 30 minutes as she came walking from her home to the fields. During rest period, heart rate monitor was fixed to the subject. The rest was given in the sitting posture

and under shade. During rest period subject was not allowed to talk and take eatables. Heart rate for the rest condition was recorded.

2. After that subject was asked to operate the weeder in the field at appropriate speed. She was allowed to maintain proper depth and handle height. She was allowed to scrap the soil/weeds from the blade, when required.
3. Data for heart rate of 6^{th} to 30^{th} minute of weeding operation was recorded and average heart rate was computed.
4. After operation of 30 minutes with the weeder the subject was given a rest of 15 minutes and the recovery heart rate was measured.
5. The procedure was repeated for recording heart rate of operation with the remaining weeders.
6. In this way, heart rate was recorded for all the subjects to complete first replication.
7. The above mentioned procedure was repeated for other replications.

Calculation of energy expenditure: Energy expenditure was estimated from the heart rate values using the following formula (Verghese, 1994)

Energy expenditure (kJ/min) = 0.159 × Average heart rate (beats/min) - 8.72

Measurement of muscular stress: Grip dynamometer was used to assess the reduction in the strength of the muscles of the hand involved in gripping weeders. It consists of a handle for hand grip connected with a spring to pointer on the marked dial. The subject was asked to pull the grip handle before the start of the activity separately with the right and left hand and reading on the dial was noted down in kilograms. Then subject worked with the weeder for 30 minutes and then again the subject was asked to pull the handle and the reading on the dial of grip dynamometer was recorded. The reduction in the grip strength was calculated using the following formula:-

$$\% \text{ reduction in grip strength} = {}^{Sr-Sw}\!/_{Sr} X100$$

where Sr =strength of hand muscles at rest

Sw = strength of hand muscles after weeding operation

Measurement of postural stress: Postural stress was measured using flexi curve. Flexi curve is a light plastic wire which can be moulded in any direction. Before performing weeding angle of bend was recorded for both upper back and lower back. The subject was then asked to perform weeding. The angle of bend was again measured for upper back and lower back during weeding operation. The angle of bend before activity was subtracted from the angle of bend during activity to find out the extent of change in the angle of bend.

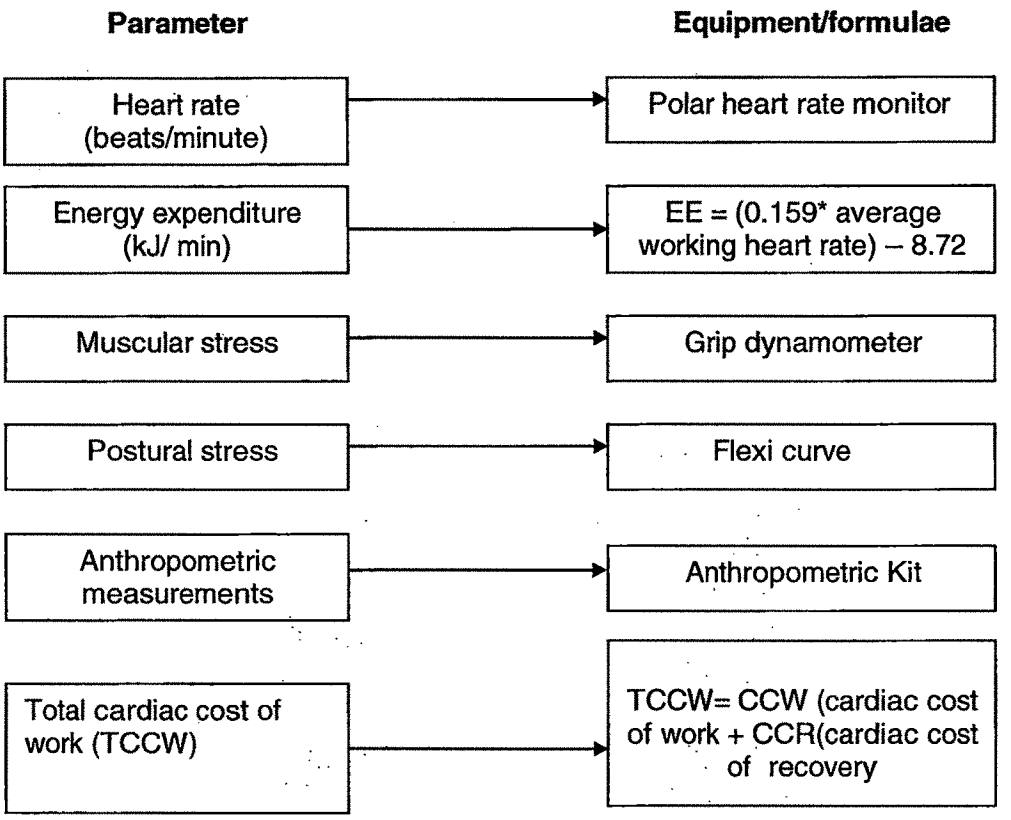
Determination of weeding efficiency: For determination of weeding efficiency one metre square area was selected randomly and the number of weeds/m^2 before weeding operation was counted. Three such readings at different places were taken to calculate the average. After that subject was asked to start the weeding. The counting of weeds was done when the subject was in rest condition. After operation with weeder, an area of one meter square was randomly selected and number of weed per meter square after weeding operation was counted. Three such readings were taken at different places and average was calculated. From these data weeding efficiency was calculated using the following formula:

$$\textbf{Weeding efficiency (\%)} = \frac{(W1-W2)}{W1} \times 100$$

Where W1= weed count in $1m^2$ before operation

W2= weed count in $1m^2$ after operation

Equipments/formulas used for measuring various parameters



3.8 Analysis of data: The data collected through survey were categorized, coded, and then tabulated.

3.8.1 Categorization: It was done to convert raw data into categories for meaningful analysis of the survey data. For the present study, variables were categorized in the following manner.

1 Age (in completed years): It was categorized into four mutually exclusive categories with equal intervals.

1 21-30

2 31-40

3 41-50

4 51-60

2 Educational level: This refers to the number of years of formal education attained. It was categorized as

1 Illiterate

2 Primary

3 Middle

4 Matric

5 Senior secondary

3 landholding size (in kanals): This refers to area under cultivation.

1 2-10

2 10.1-20

3 above 20

4 Posture used for weeding

1 Squatting

2 Bending

3 Both (squatting and bending)

5 Number of hours of weeding operation in a day: It was categorized into following categories:

1 1-3

2 3.1-6

3 6.1-9

6 Number of helping hands: This refers to the number of persons (family members/hired help) who help respondent in doing weeding. Categories were as under:

1 One

2 Two

3 Three

7 Total number of days of weeding work: This variable was categorized into four categories as following:

1 < than 20

2 21-40

3 41-60

4 > than 60

8 Health status of the women farmers: This variable was assessed on terms of the frequency of falling ill and the body type (using ponderal index). The frequency of illness was categorized as following:

1 Once a month

2 Once in 3 months

3 Once in 6 months

4 Once in a year

Body types: The body types are a scientific classification of a person's body shape determined by physical characteristics. Genetics determine our body types and hence the body shape we develop from birth through to adulthood. There are three basic categories of body types:

Endomorph: Endomorph body types are often characterized with big bones, round face, large trunk and thighs and a naturally high degree of body fat, especially around the midsection.

Ectomorph: Ectomorph body types are characterized with a thin, linear appearance. They often possess narrow waist, hips and shoulders. The ectomorph also has a low body fat percentage.

Mesomorph: Mesomorph body types characterized with broad shoulders, narrow waist, naturally large muscles and fast metabolism due to the amount of lean muscle.

The following formula was used for calculating the ponderal index given by Singh, 1994.

$$\text{Poderal index (PI)} = \frac{1000\ X\ \sqrt[3]{weight\ in\ kg}}{stature\ in\ cm}$$

The score was interpreted as given below:

Score	Body type
≤21.5	Ectomorph
21.5-25	Mesomorph
≥25	endomorph

Statistical analysis of the data: The data were analysed using descriptive and inferential statistics.

Descriptive statistics: Frequency distribution tables were constructed and percentages were calculated. For the description of the data, mean and standard deviation were also used.

Inferential statistics: Karl Pearson coefficient of correlation was computed to see the significant relationship between the independent continuous variables and dependent variable of the descriptive study. In case of categorical variable chi-square was calculated. Analysis was done using spss software.

As the experimental study was conducted using split splot design experimental data were analysed using procedure for analysis of split plot design (Gomez and Gomez, 1984). F-ratio was calculated to see the significant difference among the weeders under assessment studied. For paired comparisons, i.e., to see the significant difference between the means of two weeders for a particular parameter, say, working heart rate, averaged over all main – plot treatments (all eight women subjects), critical difference was calculated.

The formula is as under:

Critical difference (c.d) at 5% = standard error (s.e) x √2 x t at 5% level of significance at degree of freedom of error b

Where standard error = $\frac{\sqrt{errorbM.S.S}*}{\text{no. of r x no. of main plot treatments}}$

* error b M.S.S = error b mean square

r = replication =3

main plot treatments = 8 = women subjects

If the difference between two means was greater than critical difference, the difference was interpreted as significant and in the opposite case; the difference was interpreted as not significant.