Chapter I

INTRODUCTION

Background of the Study

The term 'Mathematics' has been derived from ancient Greek word "Manthanein", which mean "To Learn". According to Oxford Advanced Learner's Dictionary, "Mathematics is the Science of number, quality and space. Algebra, Arithmetic, Trigonometry, Geometry are the branches of Mathematics." According to the Dictionary of Mathematics, "Mathematics is a group of related subjects including Algebra, Geometry, Trigonometry and Calculus concerned with the study of numbers quality, spaces and their interrelationship, application, generalization and abstractions."

Mathematics is a behavioral subject which is essential to everyday life. Mathematics and life are related to each other like a relation between nail and muscle in human body. It seems that Mathematics is originated with the origin of human civilization. Mathematics is the backbone of civilization. Mathematics is the mirror of civilization with human life. Human life, without mathematics is impossible. The people who are illiterate, although use mathematics in their daily life. So, Mathematics is involved in every moment of human life. Mathematics, like language is a basic tool of communication. Daily communication involves the frequent use of mathematical concepts and skills. So, it is considered as the fundamental component of literacy. Mathematics has an important role for the development of science and technology. Mathematics helps people to understand and interpret very important quantitative and qualitative aspects of living and natural phenomena. Realizing the importance of Mathematics, Andre Hichnerwolez, the former president of 'International Commission for Teaching of Mathematics' has stated the role of Mathematics,

"In the realm of science, Mathematics has a special position. It as an independent discipline but it also provides other disciplines with a tool for their thinking. In all our efforts to understand the physical world, the trend is very frequent towards the construction of those major theories which seek to represent wide segment of the physical world as subtly as possible and do it mathematical terms".

It is desirable to check these theories of some imaginary world and this is done by assorting judiciously designed experiments and mathematical deductions.

For complete understanding of each and every discipline, Mathematics is essential. Without having mathematical knowledge, it is very difficult to understand any other disciplines such as economics, physics, chemistry, social science, psychology, and engineering etc. Accepting the need implication of Mathematics in daily life, Roger Bacon said,

"Mathematics is the gate and key of the science, Neglect of Mathematics work injuries to all knowledge, since he who is ignorant of it cannot know the other sciences or the things of the world. And, what is worse, men who are those ignorant are unable to perceive their own ignorance and so do not seek a remedy". (Eves, 1983)

It is believed that the word "Mathematics" has been derived from the ancient Greek word 'Mathematica' which means 'to learn' where as in Nepali, it is called 'Ganit' which means 'the science of calculation'. Now a days, it is defined as "the science of numbers, quality and space, of which arithmetic, algebra, trigonometry, geometry, etc are the branches" although there are number of other definitions given by different persons at different times and situations.

Mathematics has not become important only today but it occupied and kept its important place from the time of civilization. The prestige enjoyed by mathematicians in every civilized society is not all together easy to understand. Oriental literature reveals that mathematics was originated from practical experiences. It was used on building, bricks, houses, temples, statues, bridges, etc.

Plato advocated the inclusion of Mathematics in the curriculum because Mathematical reasoning broadens the mind. Actually, Mathematics has pushed and pushing forward the frontiers (external limits) of scientific and technical knowledge, discovery and invention. For all these reasons, it occupies a well-established position in the schools of all countries. "The progress and improvement of Mathematics are linked to the prosperity of the state".

Mathematics defers from other school subjects as it provides an opportunity of solving problems which evoke thinking. Training children to solve problems is meant for training then to meet and surmount difficulties and for enabling them to solve

problems offered by life itself. Meanwhile, it is also related with science, economics, engineering, agriculture, psychology, logic, philosophy, arts and geography, etc.

In this modern age, modern Mathematics has become popular as “it is the study of mathematical structures, a definite system which deals with sets and operations on their elements”. Modern mathematics can be defined only as Mathematics with a new language, a new approach and new contents. The basic idea of modern Mathematics, from which the whole vast and intricate (made up of many small parts) complexity has been woven by thousand workers, are simple, of boundless scope, and well within the understanding of many human being with normal intelligence. Language believed that a mathematician has not thoroughly understood his own work till he has made it so clear that he can go out and explains it effectively to the first man he meets on the street. But at the same time we cannot ignore that Mathematics itself is like a vast necropolis (area of land used for burning the dead) to which constant additions are being made for the external preservation of the newly dead. In this context, Bertrand Russell said;

Mathematics rightly viewed, possesses not only truth but supreme beauty-a beauty cold austere (very simple and plain) like that of sculpture, without the gorgeous (wonderful) trapping of painting or music, yet sublimely pure and capable of stern (serious and grim) perfection such as only the greatest art can show.

The use of Mathematics is perceived in different ways. For many educators, it is seen in terms of arithmetic skills which are needed for the use at home or in the office or workshop. As the basis of scientific development and modern technology, some emphasize the increasing use of mathematical techniques as a management tool in commerce and industry. National Education System Plan (NESP, 1971-76) had stated the importance of Mathematics in this way:

Mathematics like language is a basic tool of communication. Daily transactions and communications involve the frequent use of mathematical concepts. Thus, it is quite natural that Mathematics is given a very important place, second to language, in school education. Students apply mathematical concepts, skills and logical reasoning to solve different kinds of problems not only as students but also as adults later on.

It must not be imagined that the whole function of mathematics – "the handmade of the science"-is to serve science. Mathematics has also been called "the queen of science". Mathematics has a light and wisdom of its own above any possible application to science, and it will richly reward any intelligence human being to catch a glimpse of what mathematics means to itself. This is not the old doctrine of art for art's sake; it is art for humanity's sake.

Today, mathematical invention/discovery is going forward more vigorously than ever. The only thing, apparently, that can stop its progress is a general collapse of what we have been pleased to call civilization. If that comes, mathematics may go underground for centuries, as it did after the decline of Babylon, but if history repeats itself, as it is said to do, we may count on the spring bursting forth again, fresher and clearer than ever, long after we and all our stupidities shall have been forgotten.

In context of Nepal, the informal education system was started about "Vedic period" from 1200 BC. During the period four Vedas like Rigveda, Ajurveda, Samaveda and Atharba, which were composed by Hindus. At that period, Rigveda treats Mathematics and "Gurukul" was the educational system of the Veda era. During these periods they studied Ganita for Mathematics consisting of Jyotisha for Astronomy, Kalpanasutra for different groups of science and krsetra-Ganita for geometry. But in Nepal, after many years the formal and organized modern education system was started. According to historical records, it was started in 1853 AD. By establishing the British type of school at "Gol Baithak", the place of Thapathali for only families of Rana Ruler, Janga Bhadur by appointing European and Indian teachers. During that period the school introduced some subjects including Mathematics. After few years, similar type of lower secondary school was established in place of "Hanuman Dhoka" for royal families and including subjects like Mathematics, literature (Gadhya, Padhya), writing and also other books. After death of Janga Bahadur Rana, "GolBaithak" school was transferred in to present Darbar High School and it was opened for other Rana families, too. Then the curriculum was designed in favor of Calcutta University. Later Rana Prime Minister Dev Shamser opened the school to public children too on 1901. After the establishment of SLC Board in 1934, secondary school level course was systematized at the first time comprising seven subjects, with 800 full marks. There included 100 marks of compulsory and 100 marks of optional Mathematics. This program gave important

place for Mathematics in the curriculum. In similar way, the curriculum of lower secondary level was designed. But indeed, the regular basis of Mathematics education started only after the rise of democracy in 1951 AD. Likewise, College of Education was also established in 1956 AD which played a crucial role to bring improvement in Mathematics teaching. The teacher educators' workshop revised the course of study and method of teaching Mathematics at the primary level in 1961 AD. In 1963 Mathematics course was again revised in order to make relevant to the school Mathematics program and that was implemented in our country in 1964.

Introduction of Kiranti (Rai) People

For the development of human origin and history, Anthropologists are known as an authentic and reliable source of human civilization. It is believed that the development of language also commenced from 'Palaeolithic Age' (10,00,000 to 10,000 B.C.). Similarly, Kiranti (Rai) language was also existed from the same era. Anthropologists believed that Kiranti (Rai) people were migrated from Mongolia. But, without the study of Eastern philosophical literacy epic 'Baidik' it is difficult to find out even the half human development and their civilization. 'Rikbeth' is the history of ancient Aryans. According to the 'Rikbeth', An thus pologists don't believe that the development of human civilization was initiated by monkeys. Hence, the epic 'Beth' has strongly criticized the human civilization was commenced by monkey, if it is so, why other monkey could not become human beings even after million years. According to the religious book 'Mansarabar' the Lord Shiva is the creator of human beings. So, on the basis of this religious concept, Kiranti ethnic group have been living in the hilly region of Nepal. But the eastern philosophical great epic 'Beth' does not believe that Kiranti people who migrated from Mongolia. The epic 'Mahavarat' is the greatest epic of Aryans. According to the Kiranti festival in Mahavarat, The Lord Shiva was placed as a forefather of Kiranti. In addition, the Great poet 'Marbi' had been written the epic 'Kiranti Juniya' about the origin of Kiranti and their civilization. In 'Kiranti Kuniya' the Lord Shanker and Goddess Parvati had been performed the miracle in Kiranti language and their cultural dresses. Even at present the Kiranti have tradition of worshiping to the God Shivaji as 'Paruhang'. So, in this way, Kiranti language was started to speak from the ancient time. Therefore, the Kiranti people should be defined as Nepali 'Adibashi' not as 'Janjati'. The etimological meaning of

the word 'Janjati' is not meaning full of the Kiranti and their development. Thus, Kiranti people should be identified as 'Adibashi'.

Native: According to ILO's 1989 independent nations' native and indigenous people act of 1969 (agreement act 169) indigenous means:

Independent nations' those people's generations, who are living in these particular areas before they are captured or made colony by someone.

These indigenous, whose social, cultural, and economic status are partially and fully different than mainstream people.

Who assumes themselves indigenous and native.

In terms of happening the discrimination against the indigenous people UN's rapitiyar Hoje R. Martinage Kabele says that according to the definition about native and indigenous done by UN acting group in 1995, in native and indigenous, out of these characteristics, having distinct fatherland, historical continuity and mother tong as well as cultural identity and being ruled, some or all are there.

Nepalese natives means having the following indicated typical characteristics caste community.

Which caste community has different origin, own distinctive and typical cultural and linguistic tradition than so-called mainstream national community and whose present religious is based on Animism, Fatherland and Season like natural worship?

Which caste community's elder had established as first and mainstreams in modern Nepal's territory and whose own written and oral history are there.

In terms of indigenous and native, legel conscious leadership development and people advocacy by Dr. Krishna Bdr. Bhattarai: March, 2005.

About indigenous and native in 1896 Ad. Gorkha Officer Eden Mansistante has written this. "Certainly Nepalese indigenous are Mongolians. This fact has sought on their face and language. Out of Nepalese indigenous mostly producible names are Magar, Kiranti (Rai), Gurung, Sunuwar, Kumal, Yakha, Yakthumba, Murmi and Lepcha. They are certainly Mongal or Tibetan tribes"

According to Royal Nepal Academy Council dictionary's definition (page no. 469) "indigenous means these, who are living doing deforestation. Naga, Koche and Sukunda like people who are marginalized from education and unaffected with surrounding context's undeveloped people." Who reads this definition hesitance to say him /herself indigenous. In fact this dictionary has made by Bharmins that's why, it becomes so. If in this dictionary, Bharmins are defined as, "Bharmin is a person whose father isn't identified". How much Bharmins can say I am a Bharmin. Certainly they don't accept it.

His Majesty Government formed National Indigenous Development Council's acting committee has defined, "Indigenous are people who have own mother tongue and traditional costume but indigenous don't fall on system of four Hindu's caste

Indigenous indicates having following characteristics community.

- Those who have own distinct cultural identity.
- Those who have own traditional language, religion, customs, and cultural.
- Those who have own traditional geographical territory.
- Those who have own written and unwritten history.
- In which community has 'feeling of we'.
- In which community has no decision making role on estate mobilization and modern Nepalese politics.
- Who is Nepal's native.
- Who thinks themselves indigenous?

On the basis of the above given short evidences, the Lord Shiva has been being worshipped by the Kiranti as a 'Paruhang'. Actually, Kiranti (Rai) are known as 'Adibashi' having their language and cultural identification. In Kiranti (Rai) community, they have somehow different language and socio-cultural norms and values. Anthropologists and sociologists categorise the Kiranti (Rai) people according to the geographical reason.

The Kiranti (Rai) were of the Mangol origin Tibeto-Burman people. They had spread over Tibet, Burman, Assam, Nagaland, Bhutan and Sikkim. They entered Nepal through the South-East.

Aird Ed al. (1988) have written that; 'After the gods, the valley was settled by several successive waves of Tibeto- Burman' migration. These people may have come from today's Bengal, after sweeping across the hills and valleys of northeast India from Burma and beyond or perhaps they came down from Tibet, Mongolia and China. The Kirants (Rai) who arrived in about 7^{th} or 8^{th} century B.C. are nearer recorded history. These apparently fierce tribal may have been the Kirants (Rai) of Old Testament Babylon. Invading in a valley of Kathmandu and left a legacy of outstanding Kings in the vice fabric of early Nepal. When the Kiranti (Rai) dynasty succumbed to a Lichchhavi invasion from India in about 300 A.D., the Kirants (Rai) left the valley.

In the history of monarchy in Nepal, the Kirants (Rai) are the third dynasty to rule over Nepal. As the history writes, the first Kirant (Rai) King Yelambar defeated a Mahispal King, One of the king under second dynasty, the first being Gopal dynasty, and came to power. The history says that 32 Kiranti (Rai) kings ruled over Nepal thereafter.

At the present days, Nepalese costumes still designates the name of Kiranti (Rai), all the country lying between Dudhkoshi and Arun rivers; but in reality the tribes grouped under this name occupy territory still more extended and are in possessions of the country right to the eastern boundary of Nepal. According to the population census of 2058, total population of Nepal is 2,31,51,423. Out of them Kiranti (Rai) people are 8,33,451, which is 3.6% of the total population. Although the eastern frontier of Nepal is formed by the Singolela ridges, the country east of this, comprising Darjeling is people almost entirely by members of the Kiranti (Rai) race, and large number of them is to be found still further east in the state of Sikkim. According to the book of the Gorkhas (1914), "The Kiranti (Rai) race comprises the clans of the Khanbus, Yakhas and Limbus. There are few other tribes such as Danuwars and Thamis, who claims more or less legitimately, to belong to the Kiranti (Rai) family but these are of somewhat mixed origin and being of comparatively little important and will not be treated as separate races."

Thus, the Kiranti (Rai) civilization is one of the ancient civilization of Nepal and still many races comprises the clans like Khambus, Yakhas, Limbus and many more spread over Nepal and neighboring countries like India, Bhutan, Mongolia, Burma etc.

Statement of the Problem

Numbers and counting system were developed from consistent interactions with the development and abstract operations on the environment objects and events. The development of numeral system depends on culture, customs and scripts development and proper use of it. The development of numeral system in Kiranti (Rai) community has a long history. They use the counting system in their daily life using that numeral and their own traditions. There are many ethnic groups in Nepal and every ethnic group has its own religious, social and cultural belief. The ethno mathematics is the study of mathematics which takes into consideration the culture in which mathematics arises. The Kiranti (Rai) are one of the ethnic groups of Nepal. It is necessary to know the numeral system of every ethnic group of Nepal for the betterment of mathematical knowledge in people for the purpose is focused on the followings;

- What numerical scripts are used by Kiranti (Rai) to represent number?
- How numerical scripts developed in Kiranti (Rai) community?

Mathematics and Kiranti (Rai) Community

Development of mathematical discipline is one of the major achievements of the human being. The extents of development of mathematics are influenced by the extents of the development of the civilization. Mathematics may be considered as a special kind of language developed due to the need felt by the society. Moreover, the development of the art, culture and scientific achievements are the different dimensions to measure the prosperity of the human being.

The Babylonian (Mesopotamian) had a high order of civilization in the period of history called 'Potamic stage' before the end of the fourth millennium B.C., a primitive form of writing was used. They developed mathematics on the basis of daily needs, which was highly advanced.

The Egyptian civilization was also in existence at the time of Babylonian. Parajuli and Subedi (2001) state: 'Egyptian mathematics seems to have remained remarkably uniform throughout its long history.' The rules of Egypt constructed several pyramids, temples and sculptures.

Essentially nothing of a primary nature has come down to ancient Chinese mathematics. The Chinese civilization was started three thousand years later the

beginning of the civilization of Babylonian and Egyptian. Ancient Chinese had an interest on astronomy and computation which lead to develop the discipline of mathematics according to their needs.

It is believed that Hindu civilization is one of the oldest civilizations. The Hindu civilization was developed in the Indian plate centered at the bank of the Sindhu River. The development of mathematics in that part of the world of the time was focused on astronomy.

In ancient time, the eastern hilly area of Nepal is known as 'Kirant Pradesh', where the Kiranti (Rai) civilization was developed. They ruled over Nepal (Kathmandu Valley) in ancient time where the Yalamber was the first Kiranti Kings. The Kirants were the Mongol origin Tibeto-Burman people. Under Kirants there are different clans. The Rais are also the Kiranti successor and their historically prospects are also related to Kiranti civilization. It is said that the script of Kiranti (Rai) are developed from Bhrami script, so the mathematical concept of Kiranti (Rai) might have developed and influenced some how by Hindu mathematics.

Pant (2021) claims that almost all the scripts found in Nepal are developed forms of Brahmi scripts which indicate that Kiranti (Rai) script is developed on the basis of Brahmi script and the mathematics and numeral system of Rai influenced by Hindu mathematics.

The measurement and counting system of Kiranti (Rai) is noted to be different from the modern metric system. They used concept of measurement and counting can be seen in their application.

Objectives of the Study

The main objective of this study is to investigate the development of numerical system of the Rai ethnic and used by Kiranti (Rai). To achieve these main objectives were formulated.

- To identify the numerals used in representing number by Kiranti (Rai).
- To investigate the development process of numeral scripts of Kiranti (Rai).

Significance of the Study

Human civilization is the result due to the development of human consciousness. The process of civilization began from ancient stage. The history of human civilization is the combination of construction and destruction of human activities.

Nowadays, the trend to study about the art, architecture, culture, archeological excavation and historical events of a country or a certain place is increased. Such type of studies, investigation and research are related to different aspects of certain human being or settlement. This studies in these fields help to identify and explore the level of development of Kiranti (Rai) concerning numerals. Every human settlement has its own culture and customs and there is still another aspect of human development called ethno-mathematics. Generally, every ethnic group has its own script and counting system which help them for their prosperity for the further development. The study in this direction adds a new dimension of Kiranti (Rai) and their related aspects including numerals. Thus the study of numerals of Kiranti (Rai) explains to highlight the level of richness of the community from different dimension and prospect.

Definition of the terms used:

Script

Script is a line or a group of lines that is either derived from the resembled letter, form or characters used for writing.

Manuscript

A set of letters in which language is written. It is the handwritten text recorded on paper, palm, leaf, clothes etc.

Inscription

Anything inscribed on a copper or gold plate or a stone is an inscription. It is the engraved text recorded on the stone, clay, wood, metal etc. on monuments.

Primitive counting

The preliminary concept and calculation for everyday life. Early stages of counting system.

Numeral System

Word or figure representing a number is numeral. It is the symbol for writing a number. The system to express the numbers using the numerals is known as numeral system.

Word numeral system

In word numeral system the numerals are expressed by names of things. This is a system of expressing numbers by means of word arranged in the place-value notation.

Ethnicity

An ethnic group is a distinct category of population in the large society whose culture is usually different from its own. In Nepal, the native groups having own language, religion, culture with Tibeto-Burman family such as Kiranti (Rai), Limbu, Gurung, Magar etc are identified as an ethnic group.

Delimitation of the Study

Any study can't overcome all the fields. Each of them has some limitations. This study has some limitations which are listed below.

- It will be limited in Kiranti (Rai) community under Kiranti civilization.
- It is limited in the development of numeral script of Rai and used by Kiranti (Rai).

Chapter II

REVIEW OF RELATED LITERATURE

In order to get a better understanding of the subjects of one's study, it is essential and helpful to survey the literature and studies relevant and related to the subject, which provides for the best way for researcher to conduct his/her study, enabling his/her to define the limits of his/her field and to delimit and define his/her problem. Such study becomes more realistic, precise, researchable and meaningful so that the researcher reviewed the relevant literature in the field of numeral scripts of Kiranti (Rai). This chapter deals with some literatures which are reviewed from different books, different persons as well as research institutions did several researches about this field.

Adhikari (2002) has studied on "The development of numeral system of Newar civilization" with the objectives to identify the numeral system and its trends of gradual development. His research was based on primary data and secondary data consisting of the study of counting with the resources persons, related journals, related books and ancient documents etc. Similarly secondary data were collected from several libraries, museum and person's collection. And he could reach the conclusion that; All the numerals of Newar civilization were found as a developed from of Brahmin numeral. The Ciphered numeral system was used in during the Lichchhavi period of this civilization. The symbol zero was introduced during Dark Age of mathematical development.

Mainali (2002) has studied on "The development of numeral system of Limbu ethnic group and he conclude that:" Limbu have their own numeral system. They are using the numeral system from medieval age in different form. Decimal scale with position number system was adopted. All Kiranti (Rai) people adopted same numerals in writing but varies in pronunciation.

Kandel (2005) has studied on "The basic mathematical concept and process of chepang community." And he concluded that: The numeration system of chepang is a system of base-2. Chepang have own mathematics process that is a simple comulation process. They have their own traditional system of measurement.

Shrestha (2003) did his thesis for Master's Degree an empirical historical research of survey type entitle. "The measurement system in Newar civilization." With the

objective to identify the numeral system and its trends of gradual development. His research was based on primary and secondary data consisting of the study of profiles, counting with the resources persons and the study are related to journals, books, microfilms etc. secondary data were collected from several libraries, museum, and person collection. The findings of the research are as follows: All the numerals of Newar civilization were found as developed from the Brahmins. The ciphered numeral system was in use during the Lichchhavi period of this civilization. The symbol zero was introduced during the dark age of mathematics development.

Koirala, **Malakar**, **Joshi** and **Upadhaya** (2001) "Elementary process learning mathematical concepts in Nepal: A study on mathematics and process of Rasuwa Tamangs. Kathmandu; CERID. This study has done with the aims to study the basic mathematical concepts used by Tamang adults with no formal mathematics education and to identify traditional Tamang method of mathematical operations as well as to find out the implications of Tamang processes and tone up the present learning situations. This project came up that Tamang of Rasuwa have their own systems of measurement and counting and their own mathematics processes. [i.e. numeration system by base 20, length by the part of human body, area measurement by the seed grains and mental arithmetic process] and geometrical concepts are based on the shapes and structure patterns of objects existing around."

CERID (1920) conducted research entitled 'A study on maths concepts and process of Rasuwa Tamangs.' This study is done with the aims to study the basic mathematical concepts used by Tamang adults with no formal mathematics education and to identify traditional Tamang's method of mathematics operation. The study conducted that: Tamang numeration system is in base system. Tamangs have their own distinct concept for calculation, measurement and other mathematical work.

Pant (2022 B.S.) has studied several profiles of ancient Nepal and concluded that: There were twenty-seven digits in Lichchhavi script. There were nine digits for one to nine, nine digits for ten and its multiples and ten digits for hundred and its multiples. The numerals of Lichchhavi period were same to the spoken numerals of Vedic.

Rajvansi (2059 B.S.) has studied several profiles of ancient Nepal and claims that "All the scripts in Nepal are derived from the Brahmi script but there are wide differences between Rai and other script."

Chapter III

METHODS AND PROCEDURES

Methodology is a useful bridge to solve the resource problem in systematic way. It describes the methods and process applied to the entire aspect of the study. In other words, methods are the way to gather information. We must have population of the study for the designing of methods. Representative group is selected for the true experiment. Different tools and techniques are used in different phase of the study. Thus the frame work of this chapter contains population, sample, instrument, data collection procedure and data analysis procedure.

This chapter consists of the frame work of the study. It describes the procedures of the design of the study which are to be carried out to achieve the objectives of the study. This section explains the design of the study in detail. It includes a detail descriptions of the manner in which decisions were made about the types of data needed for the study and the methods of data collection. The researcher presented the definition of the population, size of the sample, the methods of the sampling, the tools and devices of the data collection. This chapter shows the design of plan and procedure of the study. It determines the size of sample, method of sampling sources, methods on techniques of data collection, instrument of the data collection and data analysis procedure.

Design of the Study

This is historical research. A qualitative research focuses on understanding the social phenomenon. It is based on verbal description. Historical research studies the things in their natural setting. It is descriptive type of research. It uses face to face interaction between researcher and respondent. It emphasizes on non-numeric (verbal) data.

Area of the Study

This study is related basically in numeral scripts developed by Kiranti (Rai) ethnic group. All the Kiranti (Rai) people are the population of this study.

Respondents of the Study

The sample respondents, who are related for the research study was determined by simple purposive sampling process. According to the population census of 2058, total population of Nepal is 2,31,51,423. Out of them Kiranti (Rai) people are 8,33,451, which are 3.6% of the total population. Among them by using

purposive sampling method 10 respondents were selected from the total Kiranti (Rai) people, which are related in different fields.

Tools of Data Collection

The researcher was used observation about the numeral scripts of Kiranti (Rai), which are written in metal and wooden block. (See Appendixes 1, 3 and 4). And also used open type of questionnaire about the development of numeral script of Kiranti (Rai). Similarly, researcher was used to collect the data from published and unpublished books. (See Appendixes 5, 6, 7 and 8), which were collected by Mr. Pharindra Rai in his research book "Mundhum of Koyee Rai and their daily mathematics use". Also researcher has taken data from journal (See Appendixes 9 and 10) which prepared by Tilak Chamling Rai.

Data Collection Procedure

The researcher selected the ten respondents purposively for the interview about the "Development of numerical scripts of Kiranti (Rai)". In which included Shiva Kumar Rai inhabitant of Bhojpur district, having research since a decade in the field of micro-biology. Nobel Kishore Rai inhabitant of Kathmandu, he is also a researcher person of CINAS.

Mr. Subar Singh Rai inhabitant of Okhaldhunga district, Ex-Indian Army Officer, age of 92 years. Mr. Lahar Singh Rai inhabitant of Okhaldhunga district, Ex-British Army, who suggested me to contact with Mr. Pharindra Rai. Mr. Kulraj Rai, inhabitant of Dhankuta district (Lecturer of SICOST and Trichandra college). Mr. Indra Bahadur Rai, inhabitant of Khotang district, who provided me a scripts of number of Kiranti (Rai) written in metal. (See Appendix 2). Mr. Tilak chamling Rai, who provided me, counting numbers from 1 to 100 in Rai numerals and multiplication table from 2 to 11. (See appendixes 9 and 10).

The researcher used open type of questions for the interview which is related to the development of numeral scripts of Kiranti (Rai) and then noted their views. After return their views finalized from the interview.

Data Analysis Procedure

When the data were collected by the primary and secondary sources as analyzed and interpreted on descriptive manner. Description has the main method of analysis and interpretation of the data. So descriptive method was used for analysis, development process of numerical scripts of Kiranti (Rai)

Chapter IV

ANALYSIS AND INTERPRETATION

Development of scripts of numerals in Kirani (Rai) Community

This chapter deals with the analysis and interpretation of collected information of the study. The collected information from the informants was analyzed and interpreted to find the development process of numerical scripts of Kiranti (Rai). It has already mentioned that open type questions were asked to ten persons. Some data were taken from published and unpublished books and journals. On the basis of above documents, Kiranti civilization of Nepal is one of the ancient civilizations. According to the history of Nepal, no formal evidence is found about the ancient Kiranti civilization and the Kiranti (Rai) eve the successor of them. Thus no exact fact is found about the primitive counting of Kiranti (Rai) people and its successors. But later on numeral scripts were gradually developed in different periods.

According to Shiva Kumar Rai numeral script of Rai is gradually developed in different periods and all Kiranti (Rai) scripts are developed form of Brahmi numeral and he suggested me to see the research paper of Nembang (2016). When I met with Nobel Kishore Rai, he replied me that he is unknown about the numeral script of Rai. But he suggested me to see the research paper of Hodgan (1885, one the foreign researcher who did his research on the different ethnic group of Nepal). Similarly, Mr. Subar Singh Rai also told me that he is also unknown about the numeral script of Kiranti (Rai) but he suggested me to see the research paper of Tilak Chamling Rai. When I met with Mr. Lahar Singh Rai, he suggested me to contact with Mr. Pharindra Rai, who have done his research on the development of numeral scripts of Koyee Rai and their use in daily life. When I met with Mr. Indra Bahadur Rai, he is also unknown about the development of numeral scripts of Kiranti (Rai) but who provided me a scripts of numeral of Kiranti (Rai) written in metal. (See Appendix 2)

According to the above all research paper, it can be concluded that there is no formal evidence about the beginning of written number in Kiranti (Rai) community under Kiranti civilization. Ashoka visited Lumbini of Nepal and erected a pillar. It is said that there are some symbols of Numeral same as old Kiranti (Rai) numeral. But there doesn't exist any evidence to support the statement.

Datta and Singh claim that all the numerals of Indian plate (South Asia) are developed form of Brahmi numeral. Evidently the Lichchhavi numeral is popularly known by Gupta numeral.

Nembang (2016 B.S.) did research about Kiranti (Rai) script and numerals and prepared carved block of wood where numerals are used in ancient form of Siringjagha script see appendix 7(i). In Kiranti civilization, there are ten symbols to write numbers and the numerals of Kiranti (Rai) are same as numerals of Kiranti. Using that numerals large numbers can be formed and this is noticed from the block of wood prepared by Rundhoj Nembang was carved for the purpose of press.

The script of Kiranti (Rai) was developed in ninth century by King Siringjagha. But there are not any preserved documents written by King Siringjagha. After the second Siringjagha (1704-1741) A.D. Some evidence can be found see Appendix 2.

Rajvansi (2059 B.S.) claims that "All the scripts in Nepal are derived from the Brahmi script but there are wide differences between Kiranti (Rai) and other script."

The script of Kiranti (Rai) language was developed in ninth century. But there are no any preserved written documents. Later on (1704-1741) A.D. Some evidence can be found see Appendix2.

Nembang (2016) did research about Kiranti (Rai) and Limbu script as well as numerals and prepared carved block of wood where numerals are used in ancient form of Siringjagha script. See appendix 7. In Kirant civilization, there are ten symbols to write numerals and the numerals of Kiranti (Rai) are same as numerals of Limbu. Using that numerals large number can be formed and this is noticed from the block of wood prepared by Randhoj Nembang see appendix 7(ii) where numerals and scripts were carved for the purpose of press.

Scenario of Development of Scripts and Numerals

It is obvious that earlier scripts and numerals were not to easy to write and use. The scripts and numerals of ancient time civilizations are difficult to evaluate. The Brahmi script, which is considered as one of the ancient script, was developed around the fifth century A.D.

It is said that the scripts of Nepal are derived from the Brahmin script. After Brahmi script, Lichchhavi script was developed (5^{th} to 12^{th} century A.D.). To the script of Kiranti (Rai) under the Kirant was developed after 9^{th} century A.D. but after 11^{th} century some evidence were preserved (See Appendixes 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10). The chronological developments of the scripts are shown in Table 1. This chart shows the extension of the various scripts.

Table 1

The gradual development of scripts

Period	Scripts	Time
Ancient time	Brahmi	Before 5^{th} Century A.D.
Up to 9^{th} Century A.D.	Pre-Lichchhavi	5^{th} – 8^{th} Century A.D.
	Late Lichchhavi	8^{th} – 13^{th} Century A.D.
Medival Age	Kiranti (Rai)	9^{th} Century A.D.
9^{th} – 10^{th} Century A.D.	Newari	10^{th} – 21^{st} Century A.D.
	Tibetan	13^{th} – 21^{st} Century A.D.
	Devanagari	14^{th} – 21^{st} Century A.D.
	Maithaili	14^{th} – 21^{st} Century A.D.
	Roman Alphabet	16^{th} – 21^{st} Century A.D.
Modern Age	No Script is	After 18^{th} Century A.D.
After 18^{th} Century A.D.	developed but	
	Newari,Devanagari,	
	Rai etc. are used	
	in changed form.	

Source: Adhikari, B.R (2002)

The development of scripts, its time and use

Chart 2

Name of Scripts	Ancient Period						Medieval Period								Modern Period			
Century	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Bhrami	*	*																
Pre Lichchhavi		*	*	*	*													
Late Lichchhavi					*	*	*	*	*									
Newari							*	*	*	*	*	*	*	*	*	*	*	*
Kirant						*	*	*	*	*	*	*	*	*	*	*	*	*
Ranjana								*	*	*	*	*	*	*	*	*	*	*
All scripts with suffix 'mol'								*	*	*	*	*	*	*				
Tibetan Script										*	*	*	*	*	*	*	*	*
Devnagari Script											*	*	*	*	*	*	*	*
Maithali											*	*	*	*				
Roman													*	*	*	*	*	*

Source: Adhikari, B.R (2002)

The ancient Brahmi Script is found in Lumbini of modern Nepal. Pre Lichchhavi script is the first used during the time of Manadeva's Changu Narayan inscription of 464 A.D. In Newar civilization, the scripts was developed from tenth century and appeared in different forms till upto now. Its first instance is the manuscripts Lankavatar (Manuscript written in Ns.28 by Ayurvenda on plan leaves.)

The script of Kirant (Rai) was developed in the starting of the medival period (see chart 1). It is said that the scripts were developed by King Srijangagha in 9th century A.D. and later on re-developed be second Srijangagha in 18th century A.D.

Hodgan (1885, one of the foreign researcher who did research on the different ethnic group of Nepal) collected some written documents were Kiranti (Rai) as well as Limbu script. These manuscripts and written documents were preserved in British India office Library in London. But the first printed letter of Kiranti (Rai) script was found in a book Hindostanica (1745). In Hodgson collection the manuscript "Mundhum Sapla" [It is believed that this Ms. was written by second Srijangagha which is the philpsophical base of Kiranti (Rai)] was found where some letter and words are written in Srijangagha script see appendix 2.

After Hodgon, Campbell (1855) did research about Kiranti scripts. He published alphabets of Kiranti which is the oldest form of modern Kiranti (Srijangagha) script.

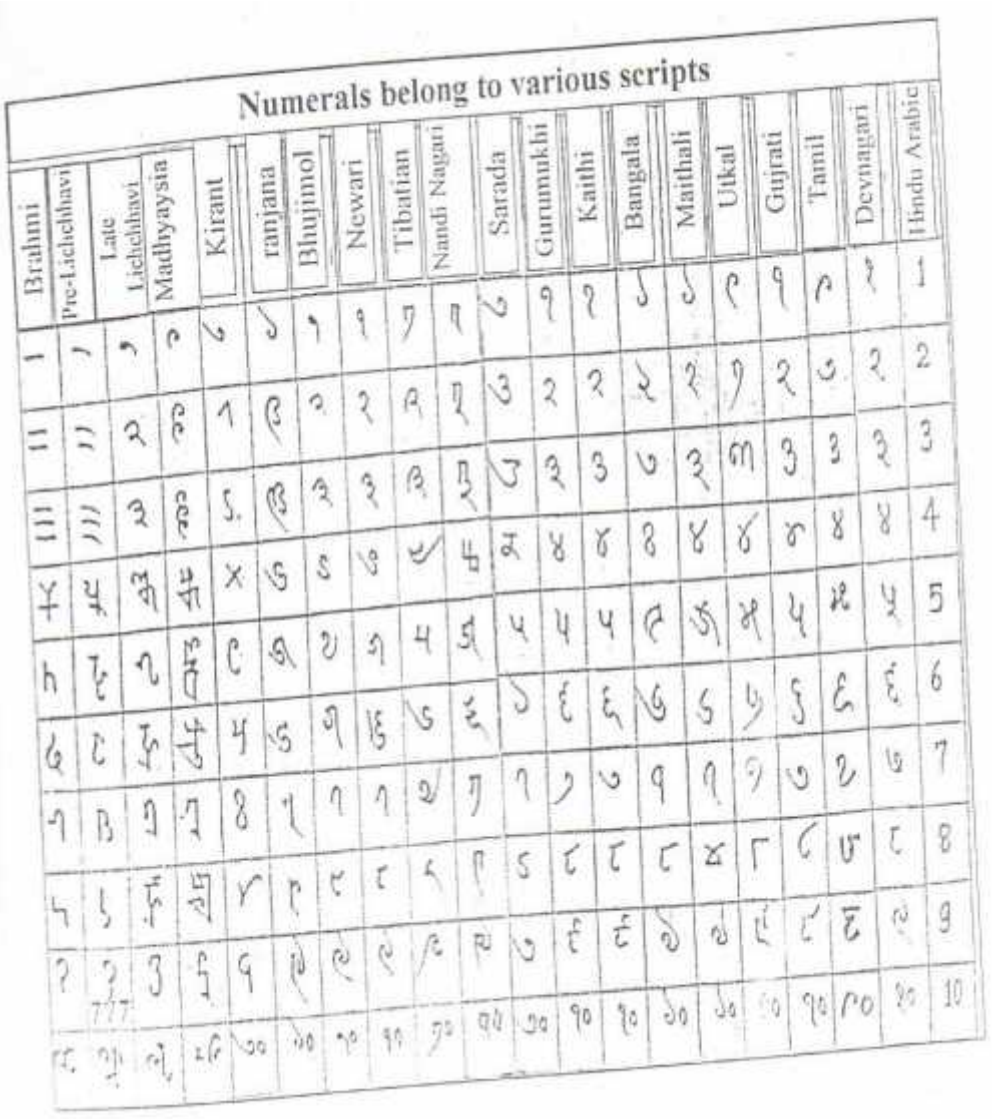
The script of Kiranti (Rai) is influenced by Devnagari script after 1928 A.D. But the proper development and change in Kiranti (Rai) script took place in the period of Iman Sing Chemjung after one hundred years of the period of Campbell.

Thus it has been explored from the above evidence the Kiranti (Rai) scripts was developed from Brahmi script and later influenced by Devnagari script.

Every script developed their corresponding numerals. Out of all numerals (which were used under different communities and civilization) some are still in use, in most developed form and some were disappeared because of lack of their proper use. The Appendix 3 presented numerals taken from different scripts.

On the comparison of the table 1 and Appendix 8, the there is no specific pattern of change in numerals, which is also observed from different inscriptions and manuscripts. Numerals are slightly changed because of hand written practice [before invention of printing machines], so it is natural to have change in the shape and size of numeral. The table given below shows the numerals that are taken from different inscription, manuscripts, different articles of Rajvanshi (2021 B.S.), Limbu-Nepali-English dictionary (2018 B.S.), the Kirant-grammer (2060 B.S.) and Block prepared by Nambang (2016 B.S.).

Table 2



From this table, it can be observed that, in every civilization the development of numerals exits in certain era and some numerals changed its shape and writing style as the time passed. Different symbols were used to indicate number in different civilization. The way of writing style is different and towards change. The sort of change in numeral is due to the fact that these were being hand written. The most ancient numeral was used by Asoka about 3rd Century B.C. in different pillars including Lumbini of modern Nepal (Appendix 8). It is believed that the numeral used by Asoka is the most ancient in south Asian region. From the Appendix 8 it can be observed that the numeral used by Asoka influenced lateral ages but the shapes of numerals were slightly changed. It is believed that the ancient age is regarded up to ninth century A.D.

The period lies between tenth to thirteenth centuries A.D. is known as dark-age in the history of mathematical development (Appendix 8). During these centuries manuscripts including scripts and numerals were only copied.

The development of numerals during the medieval period indicated towards new direction. At these periods, the shapes of numerals and writing style changed into convenient and simple form.

The numerals of Kiranti (Rai) were developed in medieval age which lies between 10^{th} and 17^{th} Century A.D. According to Bairagi Kainla, Kiranti (Rai) used language form (oral) to denote the number in ancient time. Thus at ancient time no symbols were used to denote numerals. Later in medieval period numerals came into existence in Kirant civilization. Nowadays, Kiranti (Rai) have their own numerals system (Appendix 7) and the numeral system of Kiranti (Rai) influenced by Hindu-Arabic numeral system later. The above statement is justified from the block prepared by Run Dhoj Nembang (Appendix 6) where numbers greater than 10 were written using repeated numerals as Hindu-Arabic numeral system.

Analysis of Numeral script

This topic is related to numerals and numeral script of Kiranti (Rai). Every scripts have their corresponding numerals which make language complete. Thus in this section, we are going to discuss about numerals and numeral script by comparing different dimension of Kiranti (Rai) and present mathematics.

Number Bases

Every numeral system has certain base. On the basis of that base, numeral system is formed and large numerals can be written by using the multiple of base or a certain rule.

According to the history of Nepal, ancient time is regarded as up to 9^{th} century A.D. The Kiranti (Rai) scripts were also developed at the end of ancient age (around 9^{th} Century). But it is difficult to find out the evidences of Kiranti (Rai) in ancient age. Thus there were no formal evidence of Numerals and number base of Kiranti (Rai) numeral system in the ancient period, so, it is difficult to evaluate.

The period between 10^{th} to 13^{th} centuries A.D. is known as dark-age in the history of development of mathematics and numerals were widely used in different civilization from that time. It is believed that the Kiranti (Rai) numerals were also developed of those times but no evidence was found to support. In the medieval age (10^{th} – 18^{th} Century A.D.) the numerals and numeral system of Kiranti (Rai) were developed. Hodson (1885) collected different manuscripts of Kiranti (Rai) where word numerals were widely used. But at the end of medieval period some evidences were found numerals.

In the modern age (after 18^{th} century A.D.), the style of writing were slightly changed but the scale is decimal which is continued till now. Dutta and Singh (1962) claim that, 'all the numerals of South Asia are developed from the Brahmi numeral'. Generally the numeral system of the South Asian region are based on base ten, it is due to the effect and impact of Brahmi numeral and numerals system. Thus in Kiranti (Rai) numeral system the effect of Brahmi and Hindu Arabic numeral can be observed and the system is based on decimal scale.

Position Number System

The symbol for representing number of ancient time of Kiranti (Rai) Language is difficult to evaluate but the development of script of Kiranti (Rai) language certainly lead the corresponding numerals. The 'Mundhum' is the philosophical base of Kiranti (Rai), which influence the every aspect of Kiranti (Rai) activities. But there were no any formal evidence in Mundhum or any ancient legends about numeral.

The Kiranti (Rai) Script (Sirijangagha Script) was developed around 9^{th} century A.D. by king Sirijangagha where some symbols for representing number were used. But at that time word numerals were widely used. For instance Nembang (2016) prepared the block of wood written in Sirijangagha script where large numbers are expressed using the concept of decimal scale. He prepared multiple tables (Appendix 6).

In the wood-block carved by Run Dhoj, the symbol of zero is indicated by hole. Thus the concept of zero might be exited in 11^{th} century A.D. (because Run Dhoj was taken old style of Sirijangagha script in his wood-block) and the

introduction of concept of zero or place-value in Kiranti (Rai) counting system indicates that it has positional number system.

Thus the symbol for representing zero might be developed in dark-age (between 11^{th} to 13^{th} century A.D.) in the developed of mathematics which influences the total numeral system of Kiranti (Rai) about the scale and its positional system. For instance see Appendix 6 where large numbers are expressed as the multiple of base ten.

Word numeral system and style of writing

Before the invention of numeral (symbol), word numerals are widely used in Kiranti (Rai) community. Similarly the ancient Hindu Mathematician and astronomers used word numeral to indicate number to fulfill their needs. But later proper numerals were developed and replaced the word numeral system.

Kirant (Rai) script was developed about 9^{th} century A.D. But there was no any evidence of the use of numeral. In Hodgson Manuscript (volume 79 to 84 are related to Kiranti (Rai) Script) there is the place for counting and the numerals are written by words like Thik (one) to Thibong (ten) and multiple of ten up to hundred but not other word numeral. Hop or Pong (0) means vacuum, absent, birth, origin or creation etc.

Thus from the above evidence before the development of numerals, word numerals were widely used with positional value. In Hodson (1844) manuscript there was no symbol to indicate number. Thus the tradition of counting exits widely before Hodson (1844) in oral form in Kiranti (Rai) community. But there were no any evidence when the numerals come into existence. But later the numerals were widely used from the time of Run Dhoj Numbang who prepared inscription about numerals and it's multiple up to infinite but it is said that all those numerals that were carved in the block of wood by Run Dhoj were taken from ancient and medieval period. The above statement is also justified by Bairagi Kainla (one of the scholars of Kiranti (Rai) Script). But in the book Tum Yakthung Ninwafu Sapla published by Bajbir Thalang (1928 A.D.) some numerals were written to indicate number.

Thus the ancient word numerals were replaced from 18^{th} centiry A.D. by using proper numerals. Then from 18^{th} Century A.D. the wide application of numerals can be seen in their daily life.

The style of writing numerals was slightly changed in Modern age as compared to medieval age. Run Dhoj Nembang used (α) symbol to indicate numeral four which is believed to be taken from ancient numeral. But now a day's numeral four is written as a symbol (χ). Similarly there were some changes in writing style (shape and size). Compare the numeral given by Run Dhoj Nembang (Appendix 7) and present day's numeral (Appendix 9) use in Rai numeral system.

On the basis of above research rearcher could found that, the script of Kiranti (Rai) is influenced by Bhrami script, so the numerals are also influenced by Bhrami numerals. The development of primitive counting is not found. The numeral systems are based on decimal scale. The ciphered numeral system of letter numerals is in use since the ancient-period. There is no formal evidence about the beginning of written number system. The numeral system of Kiranti (Rai) adopted ten basic symbol and with positional number system. Wood numeral system were widely used before the development of proper numeral (system to indicate number). The script (Sirijangajha) was developed by king Sirijangha and re-discovered by second Sirijangajha. Thus the numerals are written in Sirijangajha script. All Kiranti people [different clan] used same numerals but vary in pronunciation.

Kiranti (Rai) have their own numeral scripts. They are using the numeral scripts from medieval age in different form. Numerals were widely used before the proper use of numerals. Decimal scale with position number system was adopted. All Kiranti (Rai) people adopted same numerals in writing but varies in their pronunciation.

Chapter V

SUMMARY, FINDINGS, CONCLUSION AND RECOMMENDATION

After making analysis and interpretation of data in Chapter IV, this chapter has been devoted to summary, finding, conclusion and recommendation for further study. The first section of this chapter presents the summary of the research, the second section presents its findings and the last section presents the recommendations based on the findings of the study. Summary of the study, major finding conclusion and recommendation have been considered in sequence under sub-headings.

Summary

Civilization represents the development of human consciousness and different aspects related to it. There are many civilizations in the world. Among them, the Kirant civilization of Nepal was developed in ancient age. It is said that there were thirty two Kiranti kings who ruled Nepal (Kathmandu valley), But later they left the valley by the invasion of Lichchhavi dynasty and region of present Nepal.

The Rai also known as Kiranti are the indigenous people of Nepal. The Rai tribe is first in size among Kirantis. Traditionally the area of Kiranti (Rai) is known as – Kiranti or Khambuwan [The land of Rai] and Limbu is known as Pallo-Kiranti or Limbuwan [The land of Limbu] and it is believed that Limbus are younger brother of Kiranti (Rai).

The Kiranti (Rai) have their own traditional cultures and scripts. But due to the lack of preservation they are going to loose their scripts. Mandhum is the philosophical base of Kiranti (Rai) which gives direction of their every activity in their life. Because of the lack of evidence it is very difficult to evaluate the ancient Kiranti (Rai) civilization but later in medieval age the some documents and monuments are presented by foreign researcher under different tribes of Kiranti (Rai) people. It is said that all the historically monuments of Kiranti civilization were lost when they left Kathmandu valley because of the invastion of Lichchhaci.

At the end of medieval age, the development of Kiranti (Rai) language and scripts were existed.

Hodgon (1885), Campbell and Spring (1959) did a lot to preserve the ancient Kiranti (Rai) script and its culture.

The documents and manuscripts collected by foreign researcher show that Kiranti (Rai) cultures and scripts was in most developed from in the past but because of lack of researcher it is difficult to evaluate.

The study of several inscriptions, documents and manuscripts of this civilization reveals the existence of indigenous developments in numerals and unique trend of evaluation. The numerals are noticed from the scripts used in the inscriptions and manuscripts.

On the base of the empirical study of these evidences and other secondary data about the developmental process of numeral system of Kiranti (Rai) and the analytical study of Kiranti civilization, some significance findings can be draw. The findings of this study are as follows:

Findings

- The script of Kiranti (Rai) is influenced by Bhrami script, so the numerals are also influenced by Bhrami numerals.
- The development of primitive counting is not found.
- The numeral systems are based on decimal scaks.
- The ciphered numeral system of letter numerals is in use since the ancient-period.
- There is no formal evidence about the beginning of written number system.
- The numeral system of Kiranti (Rai) adopted ten basic symbol and with positional number system.
- Wood numeral system were widely used before the development of proper numeral (system to indicate number).
- The script (Sirijangajha) was developed by king Sirijangha and re-discovered by second Sirijangajha. Thus the numerals are written in Sirijangajha script.
- All Kiranti (Rai) people [different clan] used same numerals but vary in pronunciation.

Conclusion

There are various ethnic groups in Nepal which have their own traditional mathematical system. Some ethnic groups with mathematical ideas have still remained undiscovered. The present study of Kiranti (Rai) counting system. They used to do mathematical work using their own numeral and still using because Kiranti (Rai) have their own script. But nowadays, the script of Kiranti (Rai) is gradually changing into modern and advanced form.

Based upon the above findings, the conclusions can be drawn as follows:

- Kiranti (Rai) have their own numeral system. They are using the numeral system from medieval age in different form.
- World numerals were widely used before the proper use of numerals.
- Decimal scale with position number system was adopted.
- All Kiranti (Rai) people adopted same scripts in writing but varies in their pronunciation.

Recommendations

This study was limited in several aspects and the finding of the study may have covered in limited area. So considering these limitations, the following recommendations have been made,

- This study on the numeral script of Kiranti (Rai) suggests that further studies of different aspects of cultural ethno-mathematics be carried out.
- It is necessary to have the study on numeral script of other ethnic groups of Nepal as well.

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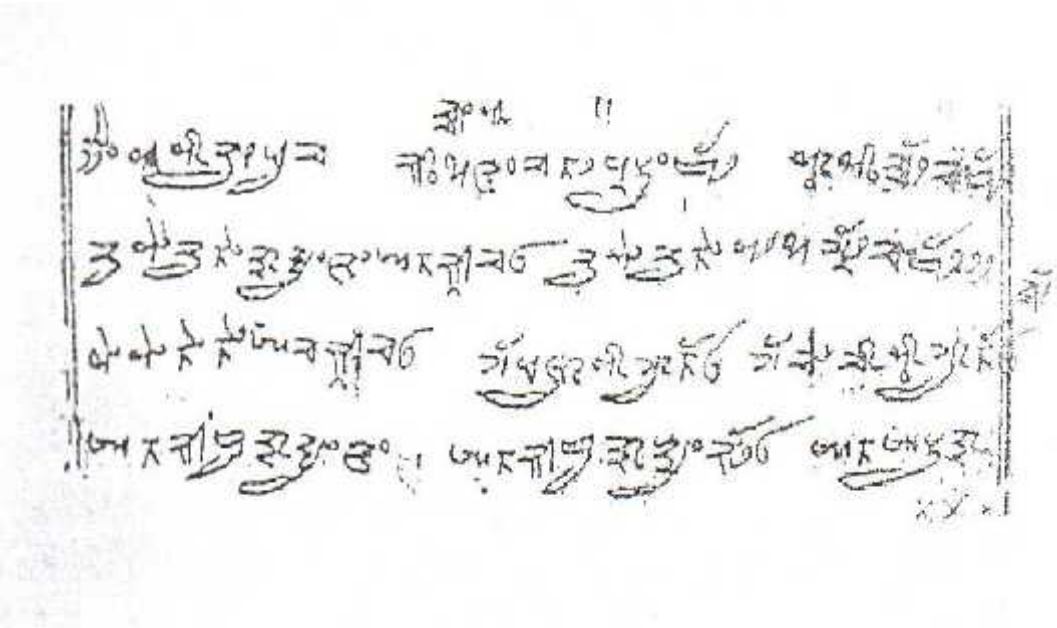
Appendix 1

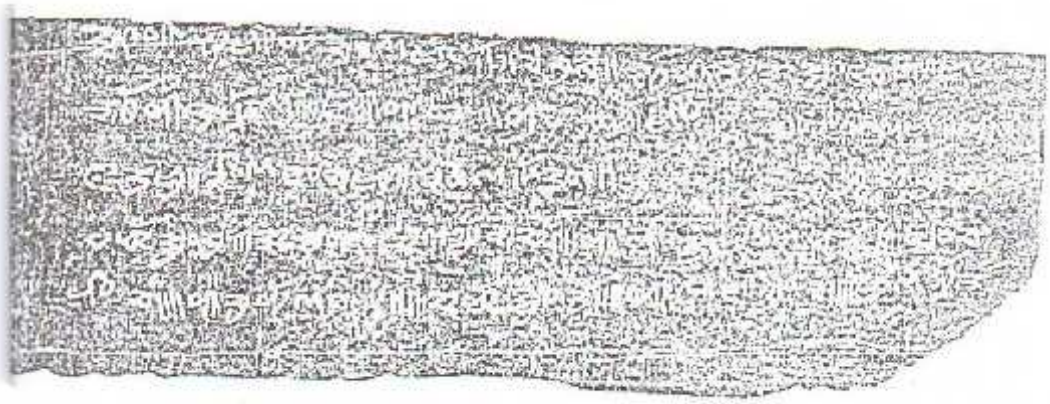
Ancient Kiranti (Siranjagha) Script



Source: Adhikari, B.R (2002)

Appendix 2

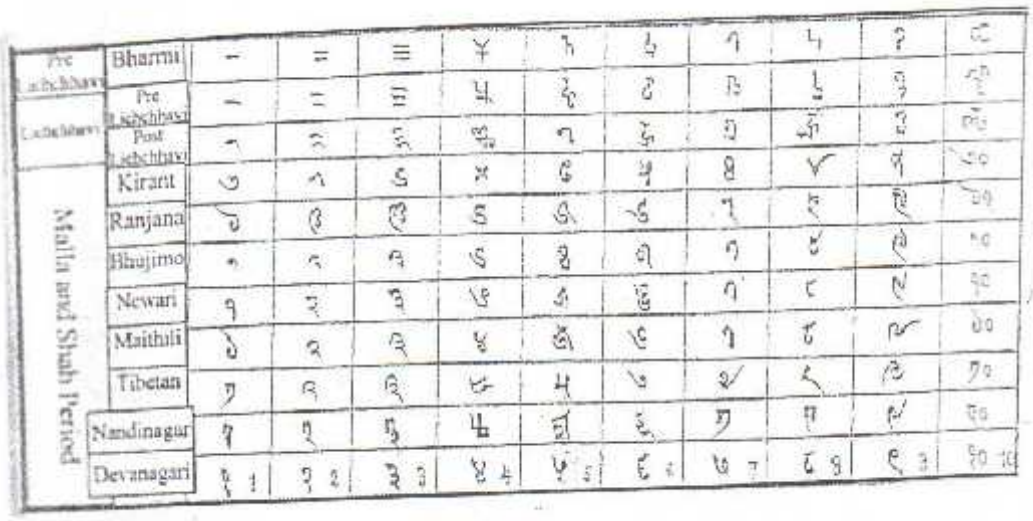
Ancient Kirant (Rai) Script



Source: Rai, Indra Bahadur, Metal Script

Appendix 3

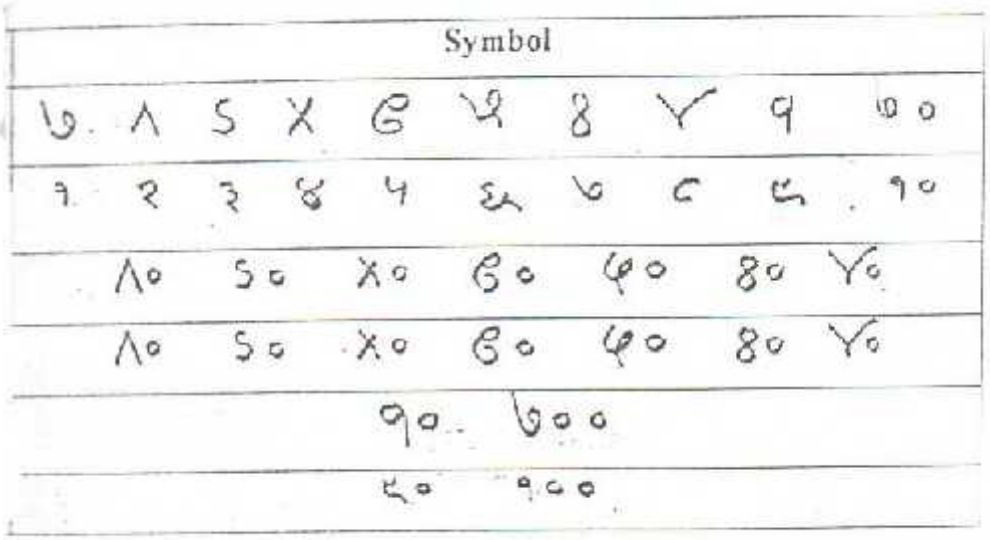
Some Numerals of Nepal



Source: Adhikari, B.R (2002)

Appendix 4

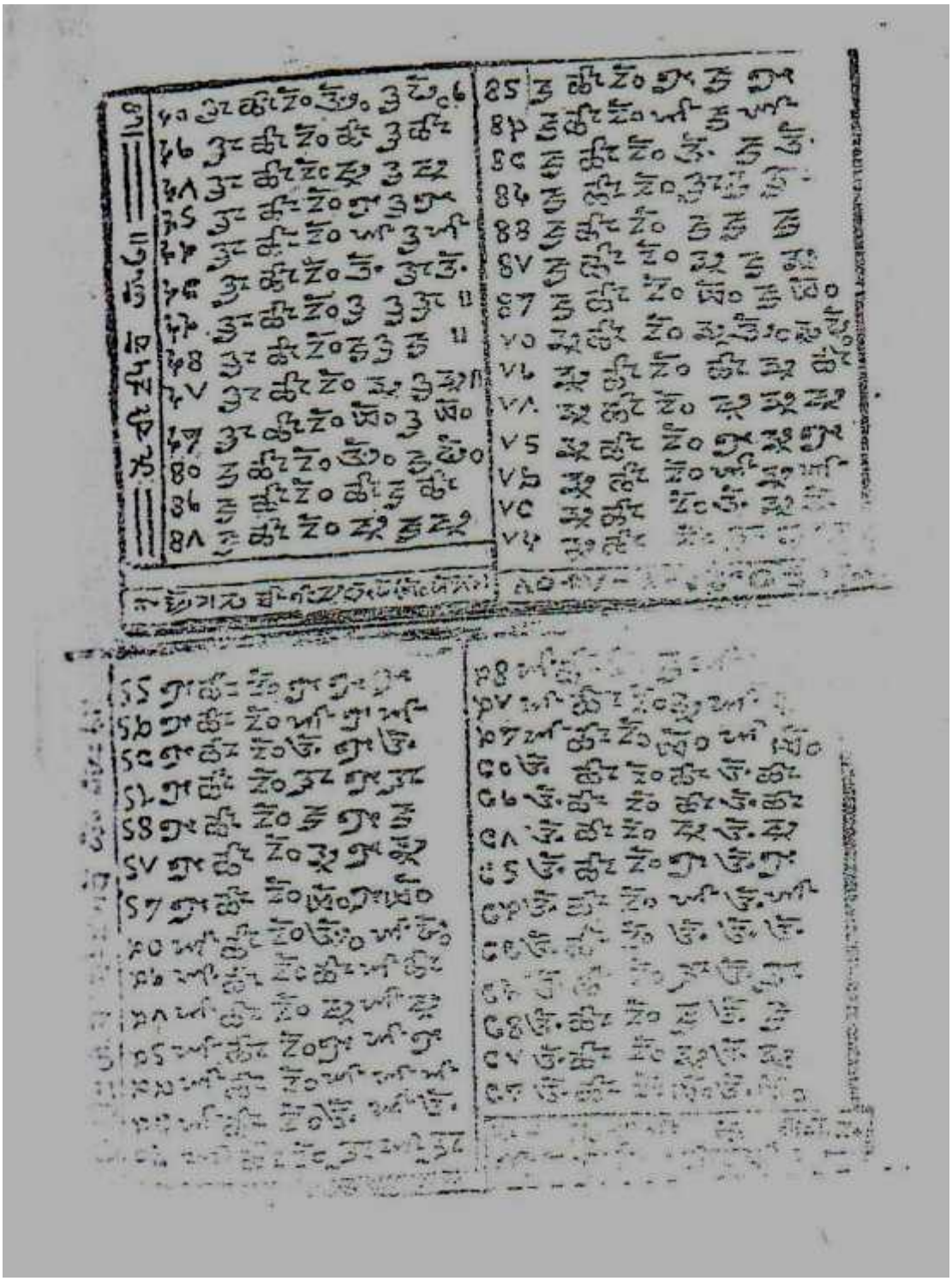
Ancient numeral of Kirant (Rai) and corresponding Devanagari Numeral



Source: Adhikari, B.R (2002)

Appendix 5

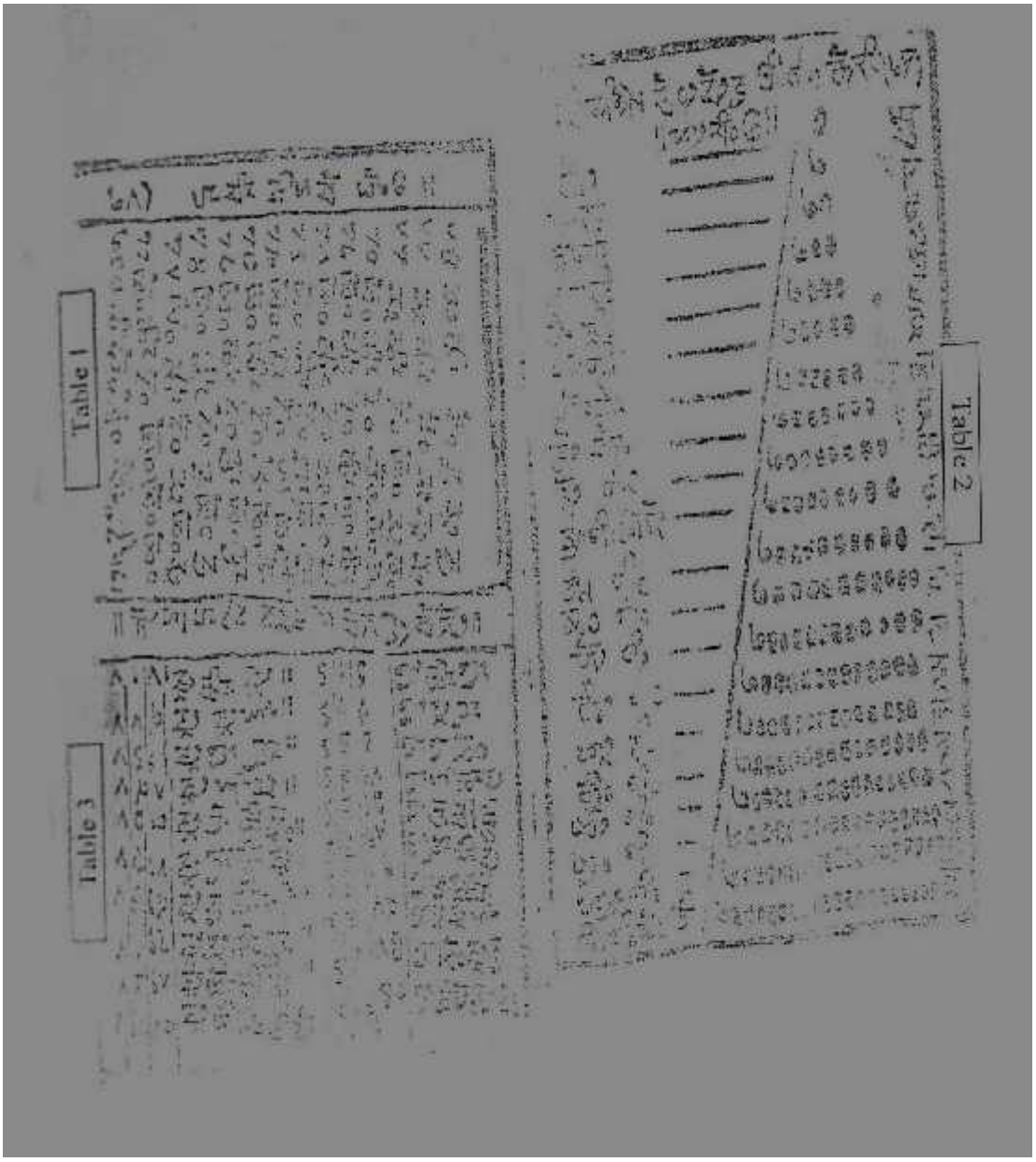
Numerals of Kirant (Rai) and their corresponding pronunciation



Source: Rai, Pharindra (2001)

Appendix 6

Inscription of Run Dhoj Nembang

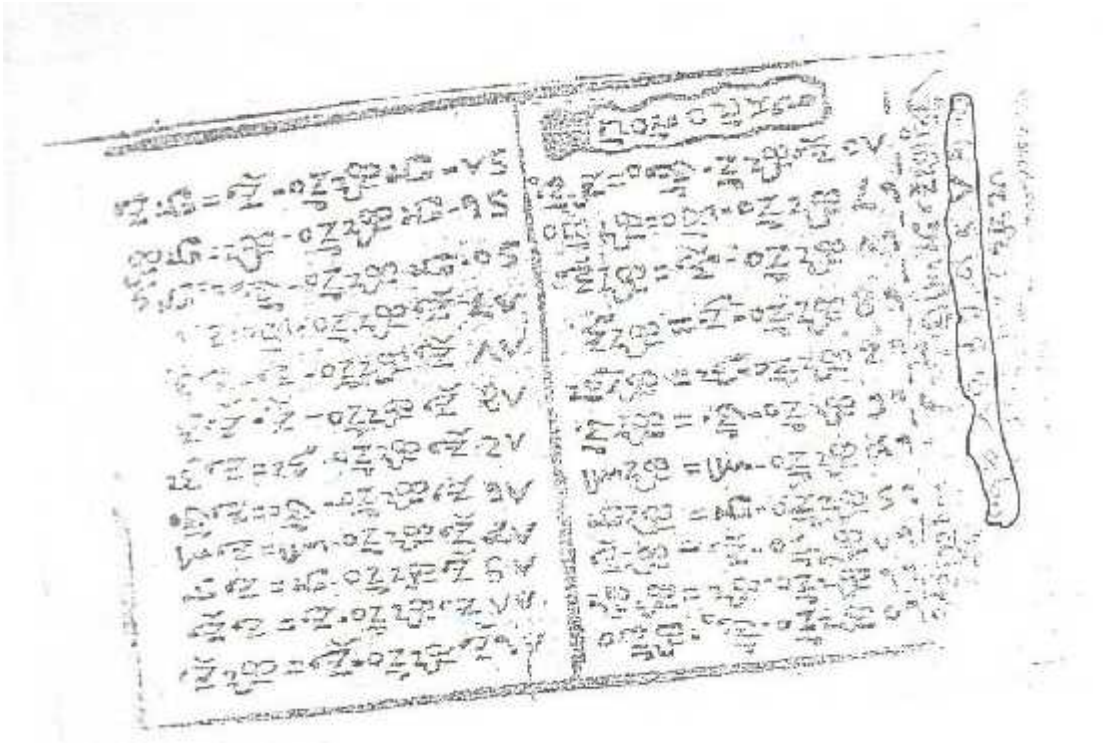


Source: Rai, Pharindra (2001)

Multiplication table of 2 prepared by Run Dhoj Nembang using Kirant (Rai) numeral in a block of wood (table 3) and table 2 shows the numerals written in multiple of 10 up to infinite.

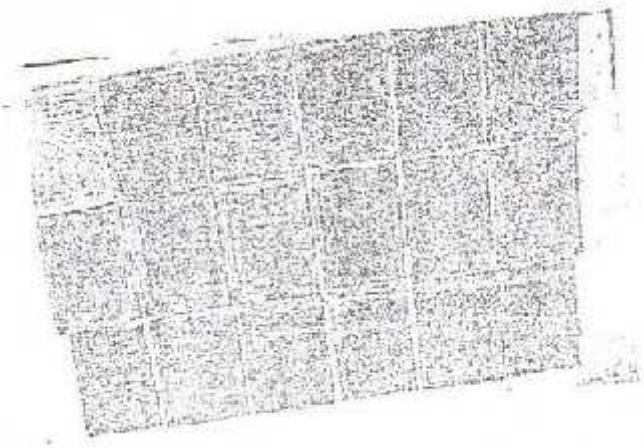
Appendix 7

Inscription of Run Dhoj Nembang



Source: Rai, Pharindra (2001)

The above inscription was written in ancient Sirijangajha Kirant (Rai) script in a block of wood. The circled symbols are the numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

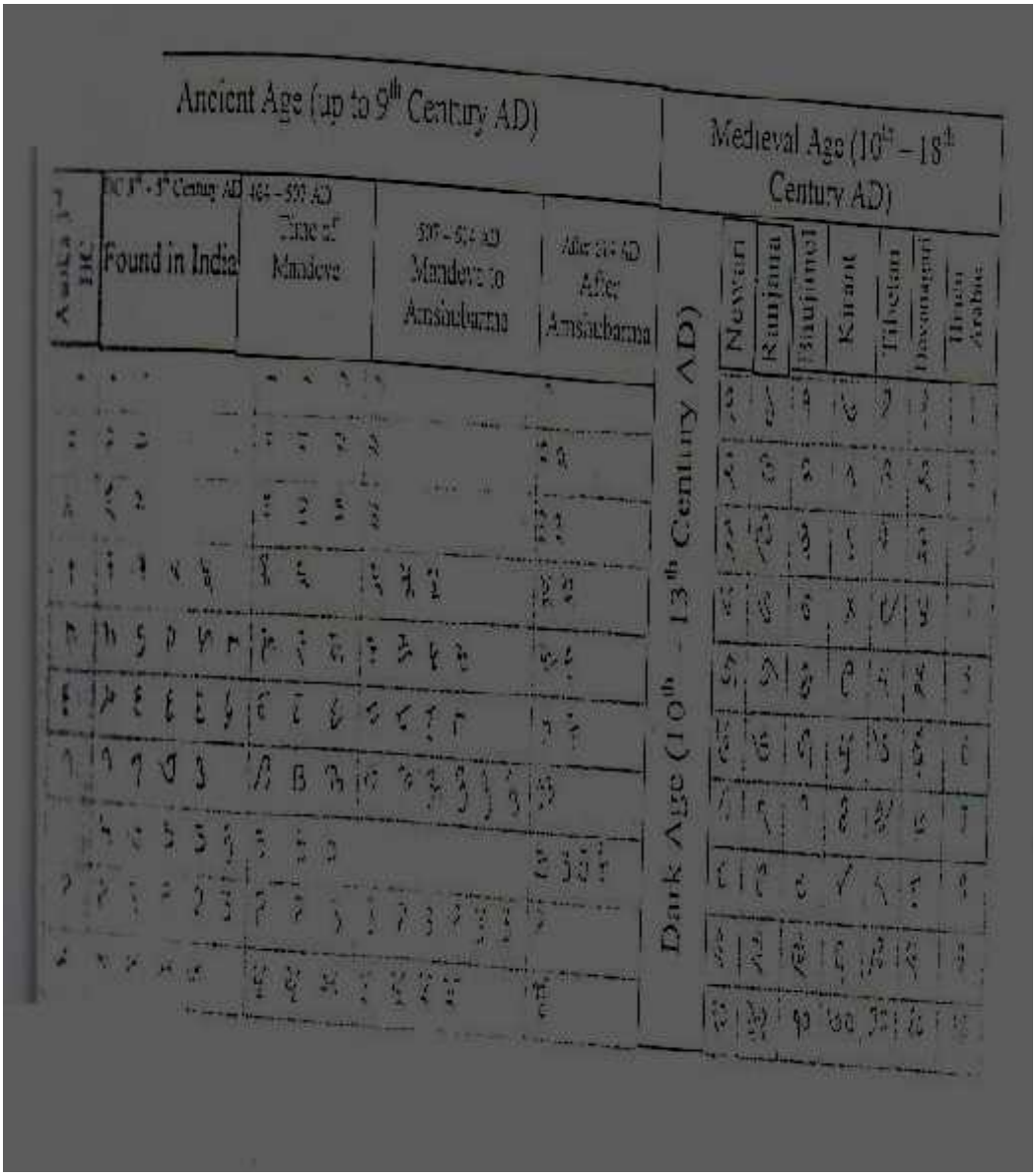


Source: Rai, Pharindra (2001)

The above inscription was prepared for the purpose of press by srijangha.

Appendix 8

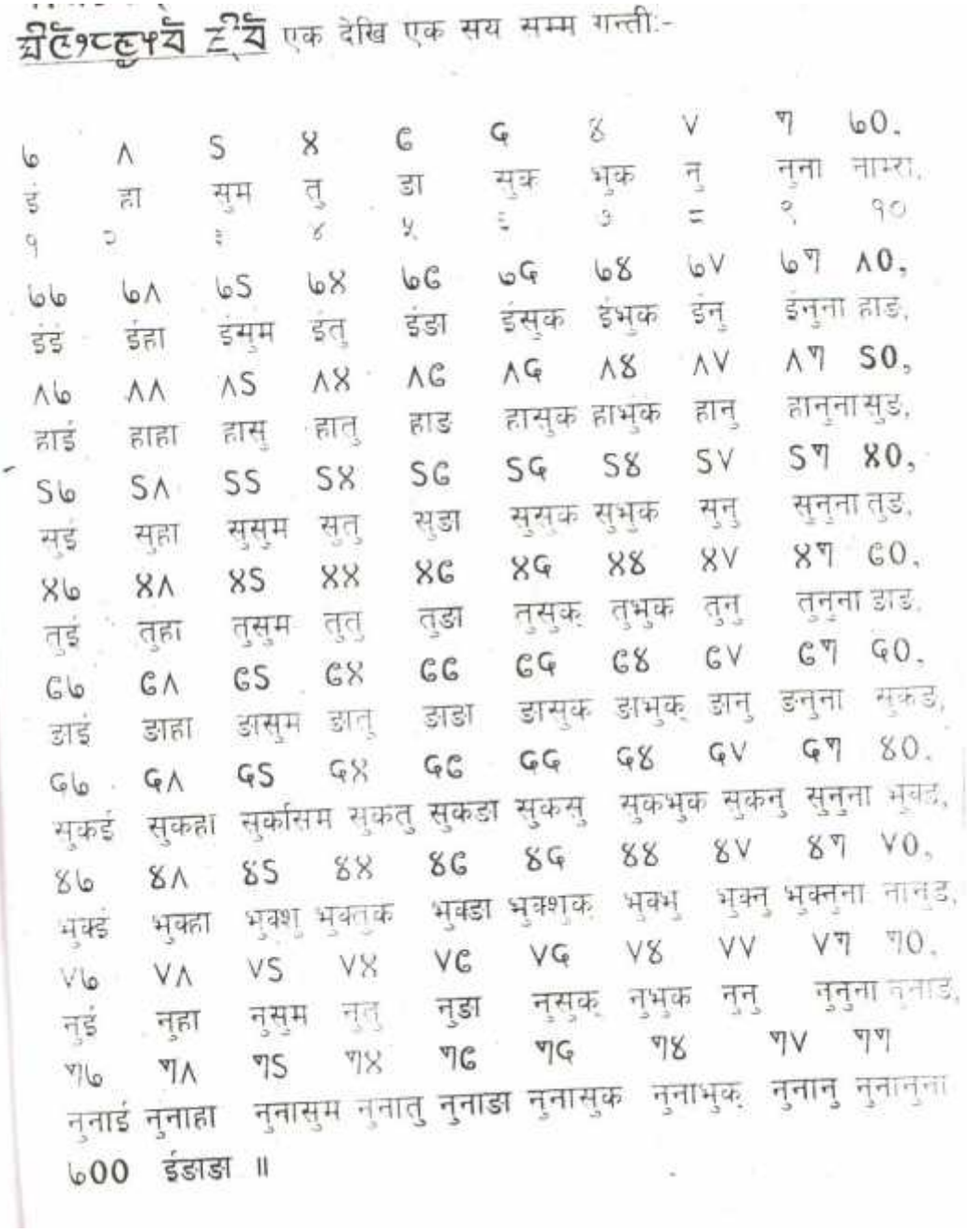
The Trend of Gradual Development of Numerals



Source: Rai, Pharindra (2001)

Appendix 9

Counting numbers from 1 to 100 in Rai Numerals



एक देखि एक सय सम्म गन्ती:-

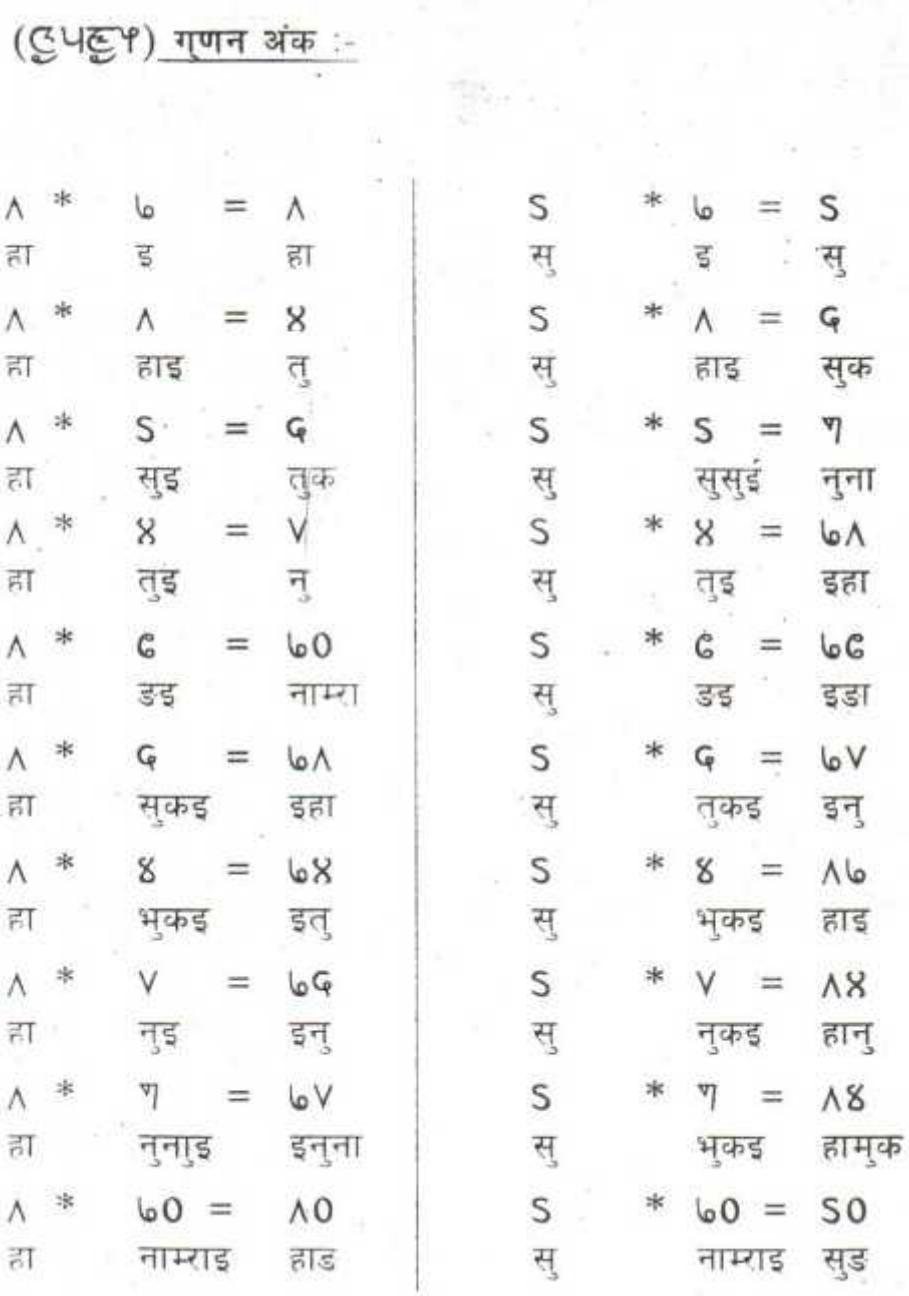
६	∧	ऽ	४	८	८	४	∨	९	६०.
इं	हा	सुम	तु	डा	सुक	भुक	नु	नुना	नाम्रा,
१	२	३	४	५	६	७	८	९	१०
६६	६∧	६ऽ	६४	६८	६८	६४	६∨	६९	∧०,
इंइं	इंहा	इंसुम	इंतु	इंडा	इंसुक	इंभुक	इंनु	इंनुना	हाड,
∧६	∧∧	∧ऽ	∧४	∧८	∧८	∧४	∧∨	∧९	ऽ०,
हाइं	हाहा	हासु	हातु	हाड	हासुक	हाभुक	हानु	हानुना	सुड,
ऽ६	ऽ∧	ऽऽ	ऽ४	ऽ८	ऽ८	ऽ४	ऽ∨	ऽ९	४०,
सुइं	सुहा	सुसुम	सुतु	सुडा	सुसुक	सुभुक	सुनु	सुनुना	तुड,
४६	४∧	४ऽ	४४	४८	४८	४४	४∨	४९	८०,
तुइं	तुहा	तुसुम	तुतु	तुडा	तुसुक	तुभुक	तुनु	तुनुना	डाड,
८६	८∧	८ऽ	८४	८८	८८	८४	८∨	८९	८०,
डाइं	डाहा	डासुम	डातु	डाडा	डासुक	डाभुक	डानु	डनुना	सुकड,
८६	८∧	८ऽ	८४	८८	८८	८४	८∨	८९	४०,
सुकइं	सुकहा	सुर्कासम	सुकतु	सुकडा	सुकसु	सुकभुक	सुकनु	सुनुना	भुवड,
४६	४∧	४ऽ	४४	४८	४८	४४	४∨	४९	∨०,
भुक्इं	भुक्हा	भुक्श	भुक्तुक	भुक्डा	भुक्शुक	भुक्भु	भुक्नु	भुक्नुना	नानुड,
∨६	∨∧	∨ऽ	∨४	∨८	∨८	∨४	∨∨	∨९	९०,
नुइं	नुहा	नुसुम	नुतु	नुडा	नुसुक	नुभुक	नुनु	नुनुना	नुनाड,
९६	९∧	९ऽ	९४	९८	९८	९४	९∨	९९	
नुनाइं	नुनाहा	नुनासुम	नुनातु	नुनाडा	नुनासुक	नुनाभुक	नुनानु	नुनानुना	

६०० ईडाडा ॥

Source: Rai, Tilak Chamling (2055 B.S.)

Appendix 10

Multiplication Table from 2 to 11 prepared by Tilak Chamling Rai



(दुपहुरी) गुणन अंक :-

∧	*	७	=	∧	S	*	७	=	S
हा		इ		हा	सु		इ		सु
∧	*	∧	=	४	S	*	∧	=	६
हा		हाइ		तु	सु		हाइ		सुक
∧	*	S	=	६	S	*	S	=	৭
हा		सुइ		तुक	सु		सुसुइं		नुना
∧	*	४	=	V	S	*	४	=	७∧
हा		तुइ		नु	सु		तुइ		इहा
∧	*	६	=	७0	S	*	६	=	७६
हा		डइ		नाम्रा	सु		डइ		इडा
∧	*	६	=	७∧	S	*	६	=	७V
हा		सुकइ		इहा	सु		तुकइ		इनु
∧	*	४	=	७४	S	*	४	=	∧७
हा		भुकइ		इतु	सु		भुकइ		हाइ
∧	*	V	=	७६	S	*	V	=	∧४
हा		नुइ		इनु	सु		नुकइ		हानु
∧	*	৭	=	७V	S	*	৭	=	∧४
हा		नुनाइ		इनुना	सु		भुकइ		हामुक
∧	*	७0	=	∧0	S	*	७0	=	S0
हा		नाम्राइ		हाड	सु		नाम्राइ		सुड

Source: Rai, Tilak Chamling (2055 B.S.)

गुणन अंक :-

(दुपहुरी)

४	*	६	=	४	८	*	६	=	८
तु		इ		तु	डा		इ		डा
४	*	∧	=	∨	८	*	∧	=	६०
तु		तुहाइ		भुक	डा		तुहाइ		नाम्रा
४	*	ऽ	=	६∧	८	*	ऽ	=	६८
तु		सुम्इ		हाहा	डा		सुम्इ		इडा
४	*	४	=	६९	८	*	४	=	∧०
तु		तुइ		सुक	डा		तुइ		हाड
४	*	८	=	∧०	८	*	८	=	∧८
तु		डइ		हाड	डा		डइ		सुहाड
४	*	९	=	∧४	८	*	९	=	ऽ०
तु		सुकइ		हातु	डा		सुकइ		सुम्ड
४	*	४	=	∧∨	८	*	४	=	ऽ८
तु		भुकइ		हाभुक	डा		भुकइ		सुक्ड
४	*	∨	=	ऽ∧	८	*	∨	=	४०
तु		नुइ		सुहा	डा		नुइ		नुडा
४	*	ग	=	ऽ९	८	*	ग	=	४८
तु		नुनाइ		सुसुक	डा		नुनाइ		नुक्ड
४	*	६०	=	४०	८	*	६०	=	८०
तु		नुम्राइ		तुड	डा		नुम्राइ		डाड

Source: Rai, Tilak Chamling (2055 B.S.)

गुणन अंक :-

([illegible])

᥇᥆ * ᥇ = ᥇᥆ नाम्रा इ नाम्रा	᥇᥇ * ᥇ = ᥇᥇ इइ इ इइ
᥇᥆ * ᥈ = ᥈᥆ नाम्रा तुहाइ हाङ	᥇᥇ * ᥈ = ᥈᥈ इइ तुहाइ हाहा
᥇᥆ * ᥉ = ᥉᥆ नाम्रा सुम्इ सुङ	᥇᥇ * ᥉ = ᥉᥉ इइ सुम्इ सुसुम
᥇᥆ * ᥊ = ᥊᥆ नाम्रा तुइ तुङ	᥇᥇ * ᥊ = ᥊᥊ इइ तुइ तुतु
᥇᥆ * ᥋ = ᥋᥆ नाम्रा ङइ ङाङ	᥇᥇ * ᥋ = ᥋᥋ इइ ङइ ङाङा
᥇᥆ * ᥌ = ᥌᥆ नाम्रा सुकइ सुक्ङ	᥇᥇ * ᥌ = ᥌᥌ इइ सुकइ सुकसु
᥇᥆ * ᥍ = ᥍᥆ नाम्रा भुकइ भुङ	᥇᥇ * ᥍ = ᥍᥍ इइ भुकइ भुक्भु
᥇᥆ * ᥎ = ᥎᥆ नाम्रा नुइ नुङ	᥇᥇ * ᥎ = ᥎᥎ इइ नुइ नुनु
᥇᥆ * ᥏ = ᥏᥆ नाम्रा नुनाइ नुनाङ	᥇᥇ * ᥏ = ᥏᥏ इइ नुनाइ नुनानुना
᥇᥆ * ᥇᥆ = ᥇᥆᥆ नाम्रा नुम्राइ इङाङा	᥇᥇ * ᥇᥆ = ᥇᥇᥆ इइ नुम्राइ इङाङा नाम्रा

Source: Rai, Tilak Chamling (2055 B.S.)