# Nepal Academy of Science and Technology (NAST)

## An Inventory
## Indigenous Technology of Nepal

*Final Report*

(Submitted to Ministry of Science, Technology & Environment)

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# Foreword

Indigenous Technology would be remembered for its glorious past, survived and served the societies for centuries. Nepalese ethnic groups and societies either developed or derived technologies to produce consumer goods or to make forays into agricultural practices to produce various edible commodities. In the present era IT could not withstand to or compete with modern technologies and its growth slowed down or in some cases completely halted due to various factors. The products manufactured by using modern technology has a big advantage over that by the IT, the former afford research and development and comply strictly with regulatory considerations mandatorily, quality control and other scientific monitoring of the products done de rigueur.

The indigenous technology has however, is worth some specific value and needs attention of the concerned authorities of the Government of Nepal. The government must give a lease of life to the surviving enterprises and support revival of representative indigenous technology by providing generous subsidy and incentives to this sector. Five year Plans of Government of Nepal has formulated strategies in the successive Plans to preserve Indigenous technology, however, the real concern has yet to be shown. A comprehensive and long term proactive policy is a prerequisite for the betterment of this sector. Notwithstanding, the onslaught of modern technology, some of production units manage to survive and doing moderate business and still popular as a brand, in many instances the old production units are being improvised with modern technologies by the help of government agencies like Cottage and Small Industries Development Committee and NGO's.

A very interesting example to underline the importance of indigenous technology would referred here is Khadi, clothes made by threads prepared by charkha in many households in India. At least one Khadi Gramodyog Cooperative, has been established in every district headquarter to encourage people to prepare cotton threads and the cooperatives provide all sort of assistance in this regard, they train people, provide materials and procures threads directly from the producers. The Khadi Boards also propagate the idea of locally available resource utilization by demonstrations and also promote the concept of self reliance. The Khadi Boards by and large incur heavy losses but the project continues for the sake of restoration of ideological and historical values.

In Nepal, significance of Indigenous technology have been understood much earlier and documentation with regard to technological aspect and present status have been carried out previously by some national agencies. Nepal Academy of Science & Technology had formed a working group on indigenous technology way back in year 1983 A.D. The 'Group' submitted report on the subject in the month of July in the same year. Similarly, Research Centre for Applied Science and Technology(RECAST), Cottage and Small Industry Development Committee and other agencies have also contributed in this sector. The Ministry of Science, Technology & Environment (MoST&E) coordinated with stake holder organizations to assess the status and find out the credible solution to the problem faced by the entrepreneurs. The task force unanimously approved inventory of IT as a primary move in this direction, hopefully this will be followed by more action oriented programmes.

This report has incorporated many facts established in previous studies on the basis of secondary data. In addition, representative industries in and around Kathmandu valley frequented to understand social and economic aspect and also to include details of technology and other factors associated with the enterprises practicing indigenous technology or traditional technology. The terms indigenous and traditional are delicately associated with each other, the previous implies native origin of something, while, the later articulates something that may have adopted and handed down from generation to generation and in the process becoming indigenous in nature over the time.

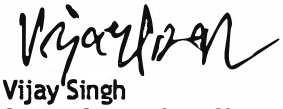
Earlier human settlements explored resources to fulfill the basic needs food, fabric and shelter, and in order to do so skillfully a number of indigenous technology blossomed. Arts and crafts followed afterwards, expressing perceived thought and images of various shades of life, values of life and

desire of life. In the process civilizations evolved with religious and cultural values. On the basis of literatures on indigenous technology, we have categorized some groups for convenience viz.

- Agriculture
- Food Beverages
- Construction Materials
- Energy
- Fabrics
- Handmade Nepalese Papers
- Ink;Dyeing/Printing
- Metallurgy
- Pottery
- Tannery
- Transport

A brief profile of technology in most of the group categories has been included in this inventory to reflect current status of this sector in the country and recommendations have been made in order to make opinion of policy makers and concerned authorities. Recommendations made by Working Group on indigenous technology have been reproduced in this text has both accountability and relevance till date.

Finally, I would like to express my regards to the vice chancellor and the secretary of Nepal Academy of Science & Technology for their support to complete this assignment. I would also mention my thankfulness to the concerned authorities in MoST&E to facilitate support in this endeavour. To compile this text concerned organizations in both government and private sectors visited by our team to seek relevant informations etc., we would like to thank all of them. We have included the names of such organizations and resource persons who helped us to collect materials and allowed us to photo shoot at the locations.



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# Acknowledgement

Most of indigenous technology of Nepal evolved in medieval era and pioneered deftly to support necessity of the society. Every region and each ethnic group in the country had have some specific technology and relied on them for life dwelling. Application of such technology in agriculture, food processing, construction, metallurgy and many more adopted successively to fulfill social requirements. In 20$^{eth}$ century, post European industrial revolution, influx of various consumer goods changed the lifestyle of the people in the country, and in no time technology itself brought in to produce A-Z on mass scale eclipsing our indigenous small and cottage industries. Despite the overwhelming impact of modern technology, indigenous technology still survives particularly in and around Kathmandu valley.

In order to recognize entrepreneurial skills and genius stature of the old generations, and to pay tribute to their service to the society, we must retain and display such technology in its originality. A comprehensive policy is required in tandem with an implementing cell either in Ministry of Science, Technology and Environment or in Nepal Academy of Science & Technology. Traditional technology of every region should be documented in all possible format, and study be conducted to explore the possibility of revival by providing genuine support.
To accomplish assignment of inventory of indigenous technology of Nepal , we have relied more on secondary source of information, field visits to find out present status of industries was confined to Kathmandu valley. I think that this assignment has been completed in a short period, and may lack some content, thus, a further more extended study on the subject is suggested.

Prof. Dr. Chabilal Gajurel, author of many books on indigenous technology, arts and crafts of Nepal, consented us with his valuable suggestions on the topic, appreciating his dedication for the subject I would like to thank him invariably. Ministry of Science, Technology and Environment provided funds for the present study and documentation, and representative of the ministry participated in our consultation meetings and provided us with his valuable suggestions. I would like to thank the ministry for its support.

To collect information on the subject, members of our study team visited various organizations and also travelled all around Kathmandu to interact with entrepreneurs, I would also like to thank the organizations and the persons who have helped our team. We have included the names of all such organizations and representatives of the industry in the annex section of this inventory.

Last but not least, I would like to thank the members of the Team and Project Monitoring Committee, appreciating their respective roles to complete this assignment.

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## Contents

## (A) Agriculture

Prior to the advent of newer technologies the existing indigenous technology played a big role to improve this sector by developing area specific tools and derived compost, manure etc., derived from animals and plants as well. Similarly, appropriate Post harvest and preservation techniques were developed to check the loss in yield and enhance shelf life of the many agricultural produces. Plant pesticides were developed by employing simple techniques to save the crops from diseases, such pesticides also developed for the preservation of grains stored for longer period of time, more so in the high humidity condition during rainy season. Improvement in irrigation, water conveyance increased cultivated land area manifold that helped growth in production of cereals, pulses etc., as a result the country had surplus agro-products.

### (a) Fertilizers (MAL)

Fertilizers are very important commodity in the agriculture sector. Now-a-days, chemical fertilizers are extensively used for higher yield of the food crops. However, age old traditional knowledge of organic manures, mainly compost have been extensively used all over the country, and the practice of production of manure by simple indigenous method is still very common among the farmers. The growth component i.e. chemical constituents of the traditional fertilizers revealed much later, but the value of compost/manure was a well established fact. Commercial production has also been reported but as stated this is a part and parcel of each and every farmer household. Pit or pits dug in the backyard of the houses and everything organic is dumped into and the heap is covered and allowed to decompose by microbial action, and after an appropriate time usually before cropping the manure is transferred to the field to enrich soils. Compost is an organic manure rich in organic matter. It is obtained after decomposing plant waste (roots, leaves and stem), food waste, human and livestock excreta, straw and lime into humus after a prolonged time period of weeks or months. The process of composting requires a heap of wetland matter (green leaves & food waste).The wetland matter breaks down into humus rich in organic matter under proper aeration and by turning the mixture. Worms and fungi break up raw material. Aerobic bacteria manage the chemical process by converting raw materials into carbon ioxide and ammonium salts. The ammonium salts further converted by bacteria into plant nourishing nitrites and nitrates through the process of nitrification. Plant gets nitrogen from nitrites and nitrates. It also act as pesticide for controlling insects and diseases. It indiscreetly control soil erosion and improves soil fertility.

Benefits of compost:

- It provides essential nutrients to crops.
- It improves water holding capacity of soil.
- It improves physical, chemical and biological properties of soil.
- It gives proper aeration to soil and helps in drainage.
- It improves number of microorganisms in soil.
- It is easily available to farmers and could be prepared when necessary.

Organic Manure: Rich in nitrogenous material, ammonia, ammonium salts and urea

- Produced by the droppings of domesticated animals; cattle, pigs and other organic wastes
- Goat, sheep, chicken droppings
- Oil cakes
- And, black earth found few feet under the top soil mainly in Kathmandu valley
- Organic manures are better of all fertilizers thus, this procedure will endure forever

Inorganic Manure: Traditional knowledge of the potential of these waste materials practiced since a long time, however, the scientific basis of them as a growth regulator established much later, ash directly mixed with the soil, while bones are crushed to powder and added to the soil

*Fuelwood Ash*

*Animal Bones*

Sodium Nitrate, Phosphorous Carbonate and Potassium Nitrate are basic substances, readily dissolve in water releasing Na, P and K respectively. Acidic soils get neutralized by the activity of these chemicals.

Demand of fertilizers has increased manifold, use of chemical fertilizers has been rising rapidly. However, production of chemical fertilizers has not started yet and shortfall of supply is an acute problem for the farmers. In this regard, Social impact and other implications has been noticed time to time. Increment in the production of traditional manures is an important alternative option. Farmers should be encouraged to carry on this practice as the procedure of making is simple and cost effective. Moreover, marketing hassles do not exist at all, products consumed locally.

**Black Earth (Kalimati),** extracted by digging areas near the riverside. This earth was supplemented in organic manure to make it rich in nitrogenous compounds. This practice existed in Kathmandu valley, which however declined and hardly exist now. The extraction of this earth was associated with fatal accidents, in many instances people trapped inside and died. The safer ways of extracting such earth can help revive this traditional practice at least at some selected sites.

**(b) Irrigation Techniques**

Irrigation is a most important prerequisite for the production of crops and other cultivars. In Nepal, canals have been made to extend irrigation facilities to the farmers in some regions, however, percentage of such agricultural land is very low and the water distribution system is erratic. For a very long time indigenous technology have been applied by the peasantry to conserve water and lift or transport the fluid to the fields to irrigate crops during the dry spell. These age old techniques have virtually ceased to exist because of easily accessible technology of boring and pumping ground water. The water table is receding fast, and during the summer season ground water availability has been noticed to decrease to a very low level. Thus, water conservation and harvesting techniques must be revived for the food production and other purposes.

By using very simple and locally available materials, farmers constructed some devices to transport water from river or ponds to their field, some of them are listed here,

Karin

- Raw Materials,
- Rocks
- Bamboo
- Rope
- Wooden Chute

Construction of Karin Technology

- A Wooden saucer shaped chute prepared with one end slightly shallower than the other
- Both ends tied to a bamboo pole with ropes
- Chute held up vertically to the pole, shallow end tied away from the tip of the pole
- The bamboo pole is rested on a forked stand
- End of bamboo pole towards the fork attached with heavy stone weights
- The bamboo end attached with chute is tied with a long and strong rope to pull down the chute in the water reservoir to fill water into it
- The rope released soon after and water is carried up to upper level and released consequently
- Stone weight lifts the water filled chute quickly to a desired elevation
- Pulling the rope down and releasing it repeatedly transport enough water to a marginal field

Other such technology

- Huchuru
- Dhos
- Dhekul

(c) Plant Pesticides or Botanicals

Protection of crops from the pests has been a matter of great concern for the farmers since very long time, and people devised knowledge based simple methods of pest control methods by using prospective plants and some other abundantly available materials. A number of plants examined and identified to be used selectively to control pests. In the previous century a number of chemical pesticides synthesized and was found to be very active against pests, and the trend of using such chemicals rapidly increased all over the world to enhance production of agricultural products, mostly cereals. In Nepal, use of synthetic pesticides introduced much later, probably started with the use of DDT, to eradicate malaria endemic. Import of various other chemical pesticides followed suit for plant protection and continues till date. Despite the furore over detrimental effects of chemical pesticides, such chemicals still used irresistibly to increase productivity. However, it is an established fact that chemicals used to control pests have many negative implications, thus, the old practices of pest control methods by using botanicals have been increasingly popular. Some commonly available substances other than botanicals have also been evaluated in order to establish anti pest activities, and found to have inhibition activity.

Most active plants recognized, are

Melia azadirachta (Neem)
Melia azadirach (Bakaino)
Artemisia sps. (Titepati)
Capsicum (Khorsani)
Pyrethrum sps.
Epatorium sps.(Banmara)
Adhatoda visia (Asuro)
Nettle (Sisnoo )
Tobacco (Surti)
Xanthoxylum sps.(Timur)

Many more plants have been identified to protect various cultivated crops and other useful plants, simple technology developed to prepare formulations from plant parts and administer them properly.

Some plants are used in combination for better results. Scientific basis of action of botanicals have been established, active chemical constituents of plants destroy pests or inhibit pest activities. Unlike, synthetic pesticides, natural active chemicals do not destroy non target organism and are non persistent.

*Methodology:*

Plant parts dried, chopped and powdered by using common devices. Some plant parts boiled in water to extract chemical constituents and others simply mixed with water after usual processing. Generally, water solution containing active compounds administered by spraying, but direct application of powdered plant parts are also common.

There is a very good scope for the future of this technology, comprehensive study on this subject have been conducted by some concerned organizations, and dissemination of this knowledge and demonstration of proper application methods in villages has been bearing fruit reportedly. More definite works would generate awareness among farmers, and they will be encouraged to follow indigenous technology, based on the utilization of locally available resources for the plant protection. Also, providing a fine environment friendly and simple option for the pest control.

## (B) Food & Beverages

Fermented edible stuffs and beverages are a specialty of the Nepalese people mainly in the hilly region since long time back. Fermented food items are made by simple procedures, each household in the rural areas have been familiar with such processing. Moreover, the technique is so simple that it can be constructed easily at any place with the help of house hold tools and other commonly available materials.The famous food items like 'gundruk', 'sinki' and 'sinamani' are made from leaves of vegetables and radish respectively. The vegetable leaves otherwise not of much value is processed to bear a great taste and can be stored and used during a period of scarce availability of vegetables. In rural areas, people still produce these items and supply surplus produce to the nearby markets, these items are available in markets of Kathmandu valley.

Wines of different grades are produced by fermentation process. Other alcoholic beverages are also made in the hilly region and Kathmandu valley as well. The practice of brewing is very old in the northern part of the country, harsh cold climate has been a big factor or provocation to consume liquor very often. The quality of beverages are in fact area and community specific, and also guided by the availability of raw materials including ingredients. Nepalese market is flooded with the multinational and national variety of various brands of wines even at remote places. However, the local alcoholic wines and beverages still has a big share in this trade.

**(a) Gundruk**

*Raw Materials:*

Leaves of Rayo, Tori(Mustard), Radish, Cauliflower

*Devices:*

Ghyampo or Gagro (Earthen vessels of different sizes)

Mugro (Wooden hammer)

*Methodology:*

Step 1. Raw materials(leaves) thoroughly washed, pounded with mugro

- and, or thrashed with proper device and the juicy exudates are discarded

Step 2. Earthen vessel cleaned and dried under the sun

- Bottom layer of the vessel covered with straw and squeezed leaves are placed layer by layer over it
- Each layer pressed hard with a stick or a hammer
- The vessel is completely stacked by the leaf layers in this way
- Then, narrow upper part of the vessel , the neck is filled with straw to cover the inside leafy mass completely and the vessel is kept under sunlight for a weeks time
- As the fermentation process starts up, formation of froth is observed on the sealed mouth of the surface
- A brown coloured liquid flows down the content and onto the outer surfaces of the vessel
- In cold weather conditions, hot water is added into the vessel to hasten the process of fermentation
- The completion of the whole process signaled by a pleasant odour from the ingredients inside the vessel the content of the vessel is then spread over a clean dry mattress for drying for 2-3 days/nights (popular belief: morning cold dew makes the preparation tastier)

- Well dried preparation (i.e., Gundruk, with a pleasant odour) placed into dry earthen pot and covered properly

**Caution:** Optimization of overall process is very important, any inappropriate step may trigger decomposition of the leafy contents

This technology has a very good chance of gaining strength, this item can be introduced to the densely populated terai region in the south of the country, and vocational training should be conducted to encourage people to prepare this item properly.

**(b) Sinki**

*Raw Material:*

- Radish
- Straw

*Devices:*

- Chopping knife
- Spade

Methodology;

**Step 1.** Cleaned and washed radishes are chopped to small pieces

**Step 2.** Circular pit of approximate dimension of circumference 4' and depth 6'-7' dug

- The inner wall of the pit plastered with clay mud to smoothen the surface
- Bottom of the pit thickly covered with straw
- Circular inner surface is also covered by straw pads or bundles , vertically placed all around

  (straw cover acts as insulator)
- Cut radishes uniformly placed up to about 1' from the bottom of pit
- Radish mass inside the pit pounded forcefully with a heavy wooden tool
- More radishes added and compressed, the process repeated for a number of time
- Each batch of pounded radishes covered with 4"-5" thick straw layer and addition of some amount of water
- The final and uppermost layer also covered with thick straw layer and which in turn completely covered by clay

  (This mechanism exert great inward pressure and raise temperature to a very high degree)
- The system left intact for a week
- A typical odour from the mass indicated progress of fermentation inside the pit
- The fermented radish mass dug out carefully put under the sunlight for 2-3 days
- When the mass or sinki completely dried, the desired preparation transferred to conical bamboo baskets for safe storage

**(c) Sinamani**

*Raw Material;*

- High grade radish
- Straw

*Devices:*

- Ghyampo or Gagro( Earthen vessel)
- Mugro(Wooden hammer)

*Methodology:*

- Preparation of sinamani is almost identical with sinki (Sinamani prepared by whole radishes)

  (Sinamani popularly known as Alo(fresh) sinki)
- This preparation is used while still soft and fresh
- This variety of fermented radish is not dried in the sunlight

Modernization of preparation technology and raising hygiene level by proper packaging etc. would find market for these items inside the country and in the other countries too. These items whet the appetite and also added in the preparation of other food items to make them delicious.

**(d) Wines**

Fermentation process is also termed as brewing, effected by yeast. Sugars are converted to alcohols in the process. Alcohols are very important chemical compounds, having enormous industrial and medicinal applications.

In Nepal, production of alcoholic items dates back to many centuries mainly for human consumption for intoxication and soothing of the brain.

Yeasts used by the brewers in Nepal are,

- Manapu, small white cakes
- Mana, from wheat, greenish granular pieces, Kathmandu valley
- Khamir

  and, also
- White variety of yeast from rice powder, confined to a community in 'Lubhu'
- From rye powder, reddish brown round balls, in some hilly region

These fermentation ingredients mentioned herewith highlights the indigenous character of the brewing technology in Nepal. By using different raw materials i.e., grains and yeast variety of wines and other byproducts are made all over the country.

**Wine**

*Raw Materials:*

- Kodo(Rye)
- Marcha(Yeast)
- Sakhar(unrefined sugar cakes)
- Rice

*Devices:*

- Dhiki, an appliance for pounding grains gently
- Janto, stone discs to crush the grains
- Earthen Vessels, Potashi, Hansi, Dubli
- Ghyampo (tall wide mouth earthen vessel, bulged in the middle)
- Copper vessel, Phosi
- Ovens and fuelwood

- Straw mats, Pilacha
- Bhigunt, hemispheric bowl

*Procedure:*

The whole process of wine making can be divided in five steps,

- Pounding, cleaning and crushing of rye
- Baking of broken rye
- Fermentation of baked rye
- Fermentation of 'Poka'
- Distillation of wine

Sundried mass of rye pounded in the 'dhiki' to remove outer crusts of the grains

Husk freed by winnowing by usual domestic devices

Grains grounded in with 'janto', a traditional grinding appliance, for better fermentation

- 'Hansi' or baking pot, a typical round bottomed clay vessel perforated with circular pores at the bottom to allow the steam to enter into the pot
- Copper vessel 'phosi', half-filled with water placed onto oven to boil water for a long time
- Round straw mat 'pilacha' is introduced into porous baking pot to rest on the porous base, followed by a cover of straw layer
- Soaked half grains of rye is properly mixed with hand and placed over the straw cover inside the baking pot
- A hemispherical bowl 'bhigunt' is put on the opening of 'hansi' in an inverted position, and the fringes of the vessel opening are plugged by suitable materials to prevent leakage of steam
- The engineered 'hansi' vessel is then placed over big 'phosi' vessel containing boiling water
- After some time, second charge of rye is added by removing inverted ball, which is replaced
- Proper baking of the first charge is confirmed by a simple observation, i.e., tickling of droplets of condensed water from the bowl
- Similarly, third charge of the rye introduced and even fourth and fifth charge of rye baked in this way

  (However, general practice was found to be introducing the whole rye mass at once)
- The boiled rye is evenly spread over properly cleaned flat floor
- After cooling of boiled rye mass, proper amount (1:3 proportion) of 'Mana' or 'Khamir' is added and mixed properly with hands
- Cleaned sun dried or steam dried 'ghyampo ' rested on a thick straw disc
- Mixture of rye mass with yeast is introduced into the vessel, nearly half filled and water is poured up to the neck of the vessel and is mouth is covered with an inverted hemispheric clay bowl
- The 'ghyampo' is then covered completely with suitable materials to prevent aeration of the system
- The vessel kept standing for 8-9 days, and then the content inside is stirred to homogenize the system and allowed to stand for another 8-9 days
- Boiled rice softened by fermentation flushed by water

- Rice or broken rice grains kept soaked in water overnight and baked
- Half baked rice grains removed from 'hansi', washed and baked again

  (Repetition of baking done to prevent from being charred or overly baked)
- The baked rice is cooled and mixed with the proper ratio of yeast

  (Yeast: 'Manapu' in newari and 'Khamir' in Nepali)

  (Generally, a small piece of khamir is enough for four mana of rice)
- Baked rice 'haja' is transferred to well dried clay vessel, called 'kashi' and covered completely and allowed to stand for 4-5 days
- Process of fermentation soften the rice content and it tastes sweet, a peculiar smell of brewed liquor emerges from it, this is called 'poka'

  (Semi-solid 'poka' is consumed in combination with chyura(beaten rice) by the peasants)
- The rice poka added to the standing rye content of the 'ghyampo' and the whole mass is vigourously stirred and allowed to stand further for another 10-12 days
- Requisite amount of sakhar solution is added into the vessel afterwards
- Flattened soft rice ( or syabaji) is also added in some cases for fine blending of wine
- (Poka made of syabaji is also used to blend special grade of wine)
- The concoctment inside 'ghyampo' left standing for final phase of the blending for about a month
- Finally, a clear liquid layer of alcohols found , and solid residue settles on the bottom of the vessel
- Phosi, a copper vessel is half filled with fermented liquid and placed onto an oven
- Potashi, a clay vessel with circular flat bottom perforated with concentric pores, is placed over the phosi
- Chwanu, a metallic vessel with a tapering bottom with an opening at the pointed end, is in turn put on the potashi and act like a condenser

  Dubli, round clay vessel with a spout to collect distillates and transfer them at intervals, is placed inside potashi

- Chwanu, is filled with cold water for its action, the water content is replaced 4-5 times during the process
- Opening of all the vessels are sealed by rags and other suitable substances to make them steam tight
- The lowest vessel containing ferments, heated to attain boiling point temperature
- In this way, distillation of volatile alcohols initiates, and distillates condensed in phases and collected accordingly

Grading of Wine:

- First distillate, 'Muti' , high quality liquor, foamy white, highly flammable
- Second distillate, 'Juji', low grade liquor
- Third distillate, 'Lila', poor grade wine
- After third fraction the leftover residue is known as 'Kat', used to a feed supplement for pigs
- Sometimes the Kat is used to produce wine of very low grade having poor quality by adding sakhar, and even ammonium chloride is added to intensify its taste. Such wine is very harmful to health and it should be banned at all.

The production of wine has both pros and cons and it's a big issue for the society. Consumption of wine is on the rise and the market is flooded with various brands of wines and alcoholic beverages, the local wines made by indigenous methods are also available in the most parts of country. In Kathmandu valley and hills, the practice of brewing wine have been very common. Each household of some ethnic group in these parts had have the skill to make alcohols, mostly on the eve of festivals or family functions. Commercially, local wines are produced everywhere while the production in private households has reduced now.

**(e) Khalpi(Cucumber Chutney)**

Khalpi is a local name for a cucumber made pickle, an appetizer that tastes very sour. It is a very tasty ipreparation and can be preserved for a very long time by careful packaging. The process of khalpi making used to be a household chore, and was prepared with a passion. Now the changed life style of people restrict such practices and they rely more on market for such items. Commercial production of pickles including khalpi with some variation in traditional method has been practiced and varieties of pickle are available in markets.

*Raw Materials:*

- Cucumber
- Seeds of rayo and mustard
- Mustard oil, red chilli, salt and turmeric

*Devices:*

- Winnowing circular disc(Nep: Naglo)
- Suitable utensils for processing
- Earthen pots or glass jars

*Production Methodology:*

- Fully ripe cucumbers cut open and interior pulpy mass removed
- Remaining fleshy part of the fruit cut to small pieces which in turn marked with slight incisions
- to allow the ingredients to pass into interiors homogenously
- Pieces placed over tray and dried in sun light properly, removing water content completely
- A recipe is made by mixing ingredients i.e., rayo, salt, turmeric and red chillies proportionately and the mixture powdered in a mortar
- Cut dried pieces of cucumber thoroughly kneaded with the powdered recipe of spices
- Afterwards, turmeric pieces transferred into earthen vessel
- Mustard oil poured into the vessel up to the level of cucumber cut pieces to submerge them to prevent air($O_2$) contact

Process completes in about a week, but could make faster by placing the vessel over a warm traditional stove without flame and also by sun drying. To enhance the taste further, spices like timur (Xanthoxylum sps), methi, cumin seeds, asefoetida (hing) etc. added in the recipe. Powdered rayo powder mixed thoroughly in slightly excess as it's higher oil content acts as preservative and/or the whole content of the container submerged by adding excess mustard oil. The preservatives help in keeping pickles quality constant for even a year. Use of glass jars as containers have shown better results than the earthen pots, it may be due to the fact that air tight lid of the jar prevents air entry and secondly, through earthen vessels porous surface air molecules enter inside by diffusion.

Chemical preservatives are commonly used in the food processing now but such chemicals have some side effects, thus, use of mustard oil and other such natural preservative in our indigenous foods might be a better option. Khalpi and other such subsidiary food items have a very good prospect in Nepalese market, with some modification and standardization, varieties of pickle with

upgraded quality may also find markets in SAARC region. Another important advantage of such products would be resource management at the local level, difficulties in dealing with perishable commodities may be overcome by establishing area and product specific production unit.

## (C) Metallurgy

Metals and metal alloys are very valuable commodity for the human civilization . Coming out of stone age, human civilizations happened to know the metal and its versatility. History of metallic works or metallurgy is very old in Nepal, and there are several chronological proof of it. Places of worships, historical buildings and edifices are genuine examples, where artistic metallic objects have been mounted for decorations. Beautiful idols and statues are placed all over at such places. Many metallic devices are used to perform manual works, in agriculture, in industry, for construction and for household uses viz. metal wares such as cooking utensils and vessels, have been manufactured from an early date in time.

Indigenous metallurgy had been a very complicated and labour intensive process, while at present the trend has changed and raw materials for metallic work, metal itself imported from outside. Iron is a most common and useful metal, found deposited in the earth's crust. Natural metals are present in a combined state, compounds, e.g. Ferric oxide etc. and termed as 'ores' and is extracted and purified to isolate metal in pure form to manufacture desired objects. When two or more metals are mixed with each other by melting them a metal with completely new set of characters are found is termed as 'alloy', a generic name for such metals. In Bhojpur, Palpa and some places around Kathmandu valley indigenous method of extraction, purification and casting etc. have been traced. Copper, an another valuable metal also been used for very important uses traditionally. Copper coins was minted at some locations as monetary units, copper have been used to cast idols and statues for its great stability. Copper can endure all climatic conditions and stand unscathed for a very long time period. Metallurgy (related to iron and copper) have been practiced for quite a long time. Weapons like gun etc. made by purifying metal ores indigenously. Systematic mineralogical survey was embarked in 1929 A.D. in Nepal. Bhojpur in eastern Nepal was famous for manufacturing of khukuri, curved big knife. People used to extract ores and purify it indigenously to manufacture metallic objects. The practice however, no more exist.

**(a)** Iron( Nep:Phalam)

Indigenous methods of extraction, purification, casting(utilization) to make various kinds of tools, mostly for the uses in routine agricultural processes, some of them mentioned here are,

Kuto, Kodalo, Chande, Hansia (scythe), Hoe, Bancharo (Axe), Khurpa, Chakku(Knife), Kainchi (Scissors), Chulesi, Khukuri, Karda,Tarwar(Sword), Khunda etc.

*Extraction & Purification:*

*Raw Materials:*

- Iron Ore(Dhou)
- Wood charcoal

*Devices:*

- Hammer
- Chisel
- Air bellows
- Furnace
- Open wooden pipe(Doond)

*Production Technology:*

- Ore extracted from earths crust by using common tools by digging marked sites
- Ore carried and piled up at a suitable place
- Ore dressing done by pounding it to granular mass, stuffed into hollow wooden pipe and
- flushed with water by moving the 'doond' swiftly to free water soluble fraction and wash
- away impurities

- The 'doond' then placed in tilted position for some time to drain out remaining water inside
- A furnace having usual dimension of 4'x 4'x 4' made using stone slabs and plastered with mud
- After dressing ore sun dried and charged into the furnace for smelting
- A small circular pit dug at the base of the furnace and a layer of charcoal stuffed in a regular
- pattern
- About a 6" thick layer of ore spread over charcoal bed
- Again a layer of charcoal spread onto the ore layer, alternate placement repeated up to upper section of the furnace
- Four bellows, two each on lateral sides inserted into interior of the furnace by making holes to blast air current for proper ignition of the charcoals
- Fire lit at the bottom of furnace and the heating and blowing operation continued for 24 hrs
- Burning of stuffed charcoal layers generate intense high temperature effecting melt down of iron particles, and depositing the melt in the pit at the bottom
- After completion of the process hardened lump of iron collected , heated and hammered repeatedly for further purification

Iron melts at a very high temperature ca.1600$^0$ C, and to attain such a high temperature people developed very simple and indigenous methods to accomplish such task. The major constituent Ferric oxide ($Fe_2O_3$) reduced in presence of red hot carbon in a few steps, in early days people had nothing to do with scientific explanations but they mastered the metallurgical technology by application of knowledge management.

**(b) Copper(Nep:Tama)**

Copper is a very useful metal, has an advantage over iron that this has greater tenacity, endure under any condition for a long time. Copper had been used to make coins, utensils and statues. Use of Copper and bronze dates back to the 6$^{th}$ century A.D. in Nepal, various places of worship and other historical sites around Kathmandu valley have traditionally decorated with copper articles. Traditional metallurgy had attained a degree of excellence and still flourishing in some areas. Patan township in the valley reputed for all forms of metal craft, idols and statues of deities and other legends made with great finesse, in terms of grace and beauty. Manufacturing and trade of idols, statues and other curio objects are briskly done in Lalitpur district and hold a very good market value inside the country and also in foreign countries.

Indigenous methods of extraction, purification and casting have undergone many changes now, first two skills are rare but various copper objects are still made by the metal imported from outside. Despite the existing odds, we include salient features of our traditional technology in this inventory.

*Raw Materials:*

- Copper ore
- Charcoal
- Cow dung

*Devices:*

- Melting crucibles
- Hammers
- Iron chisels
- Leather bellows

*Production Technology:*

- Deposits of copper ore mined by boring and digging prospective sites by 'Khaniwalas', labourers acquired expertise in mining
- Hard copper ore mounds broken with hammers and carried to the suitable site for the next operation

  (High grade of ore appears distinctly red, while low grade appears blackish in colour)
- The ore pulverized by hammers to granules and mixed and knead with cow dung and moulded to flat circular cakes and allowed to dry for some time under sunlight
- Dry cakes placed inside the crucibles
- A pit dug and packed with layers of wood charcoal
- Crucibles with dry cakes placed over charcoal bed in the pit
- Charcoal ignited with fire and blast of air passed by using leather-bellows to ensure proper burning of charcoal and to maintain steady temperature
- At a very high temperature range copper ore melted and settled down at the bottom of t5he crucible
- Other melt impurities (copper wastes) drained out through a hole at the side of crucible made by a pointed iron rod
- Pure copper content cooled and hammered to get metallic copper in desired shape and thickness
- The drained copper wastes locally known as 'Sija Khi', recovered to make drums played by thumping by fingers by 'Kulus, professional drummers

Explanation: Traditional methods of extraction and purification are very rare now, primarily due to finished copper sheets imported from outside and secondarily use of copper vessels have been sharply reduced in the Nepalese households, stainless steel has replaced most of the traditionally used metallic objects.

(c) Metal utensils/vessels

Brass and copper utensils have been produced since a very long time by using indigenous technology, mostly in the Kathmandu valley and some other parts of the country. In Valley, 'Tamrakars', a native community manufactured metal wares to fulfill demand of the society. For years requisite materials have also been produced by harnessing local resources, starting from extraction to the ultimate products made by metals and metallic alloys. Brass is an alloy of zinc and copper, having superior quality for vessels and other useful utensils.

*Raw Materials:*

- Brass sheet
- Copper sheet
- Zinc patru (cutting wastes)
- Brass patru( cutting wastes)
- Borax(Suhag)
- Sulphuric acid ($H_2SO_4$)
- Citrus fruit acid
- Sand
- Soldiering agents or flux

*Tools & Devices*

- Hammer
- Pliers
- Big stone anvil
- Long iron anvil
- Crucibles (Bhoncha)
- Air-bellows(Khalati)
- Oven(Kwa Jhya)
- Thick iron rods

*Production Technology:*

- Copper and zinc patru put into a melting crucible (in1: 4 ratio) and heated strongly over an oven till the melting of both components
- Melt of two metals mixed in crucible and resulted in formation of an alloy called brass, exhibited sharp deviation in properties from that of parent metals
- Synthesized alloy brass heated to 900 $^{0}$C-1000 $^{0}$C, melting the alloy completely
- Liquefied content of brass transferred to circular disc mould by holding crucible by forked tong
- After cooling and condensation circular discs of brass collected for further processing
- Circular ingots of brass heated and hammered repeatedly on an iron anvil to prepare brass sheets
- Sheets are cut to sizes as required to prepare vessels

*Vessel parts made in three steps:*

- Upper, middle and lower parts of the vessel made separately by heating and hammering cut strips of the brass alloy on iron and stone anvils
- Heating done by using charcoal fire place attached with air-bellows
- Alternate teeth-groove incisions (0.5"-1") made on joining edges of the three vessel parts in such away that parts locked with each other by dented incisions, which later assembled firmly by welding using flux(2:1, brass-zinc powder mixed with borax)
- Finally, tootned seams of the vessel heated gently to melt flux and seal the joints completely

*Cleaning/Finishing*

- Joints rubbed with sharp files
- To remove black scars from the surface, the vessel immersed into citric acid juice or waste liquor from brewery for 2-3 days
- Alternatively, Surfaces smeared and scrubbed by dilute acid solution
- The pot then scoured with sand particles and clay dust to shine the surfaces
- Further finishing done to adorn the surfaces with spots by light hammering i.e. 'Dam Halne', to make vessel attractive and colourful

Overall procedures represent a generalized indigenous technology to produce hollow metal vessels, however, there have been many changes in the old format of the manufacturing with the induction of modern applications. Moreover, imported materials e.g. brass alloy used for the production of the vessels. Demand of brass vessels have been decreased in favour of newer materials like stainless steel.

(d) Gold Plating

Shrines, monasteries and temples had been decorated by consummately gild masterpieces for centuries. Silver, copper and higher grade brass are suitable metals to retain thin gold cover, and strikingly resemble with lustrous yellow gold. Merchandising consumer goods to Tibet brought in enough gold in the country and technology of gold works started in order to craft desired objects either of pure gold or gold plated metals. Gold withstand extreme weather conditions, and its attractive colour has made it an ideal and desirable commodity. Pure gold items can not placed here and there for security reasons, therefore fake gold plated crafts have been used instead. At the other hand, to afford gold ornaments is not possible for everyone therefore fake gold plated ornaments had have a parallel market.

Indigenous technology of gold plating practiced since many centuries in Nepal, and such ancient masterpieces can be observed in museums, historical and religious monuments as well.

*Raw Materials*:

- Silver
- Copper
- Brass (Higher quality)
- Gold
- Hingul (Containing mercury ore)
- Majito(Rubia cordifolia), A creeper herb
- Hakip stone(Agate stone),Very hard

*Gilding Technology*:

- Preparation of amalgam of gold in mercury
- Gold heated and hammered to extremely thin sheets
- Sheets cut into very small gold pieces
- Gold pieces placed into a mortar and some mercury along with salt and sour
- Concentrate (chuk) also added into the same mortar
- Mixture in the mortar ground with a pestle by intermittent addition of small amount
- of mercury
- Ultimately desired amalgam of Au-Hg readied
  ( 3:1 ratio of gold-mercury)
- Articles of silver, copper etc. whatever to be gilded, rubbed vigorously with vinegar or simply by cut citrus fruit
  (Alternatively, cleaned by rubbing with a mixture of common salt and vinegar)
- Also, Overly burnt bricks having hard and rough porous surface used to scrub the sides of the article to smoothen it
- Later on, metal articles washed with water and dried well to free from remaining dirt
- Article(s) coated with gold-mercury amalgam with suitable brush
- When coated articles appears whitish in colour, coated objects heated on cow dung fire
- With white vapour fumes and cracking sounds mercury volatized
- Emission of fumes ceases and metal article appears reddish rather than yellowish
- Majitho dry twigs boiled in a vessel to extract the chemical constituents, and the objects treated with extract
- Post treatment, objects attained golden yellow colour sans characteristic lusture of gold
- Article rubbed with agate stone till lusture restored

*Explanation:*

Mercury is a poisonous substance and workers susceptible to mercury poisoning during while going through the gilding process. Though they used to cover faces by strip of clothe as a protective gear,a precautionary move, it was not so safe and their mouth got whitened by the action of mercury vapour. Immediately after completion of the work goldsmiths used to wash mouth with a high quality wine to flush mercury rudiments or traces as a safety measure. Mercury was isolated from the 'hingul', used to paint buildings in deep red colour, and during this step of the technology workers were exposed to the lethal mercury poisoning. Traditional gilding does not exist now in its medieval form, the process has been upgraded.

(e) **Kaans (Newari: Kayen)**

Kaans is an alloy of copper and tin, and used for making lighter and cheaper kitchenware, mostly, dinner plates. Technology of producing kaans and making utensils thereby, has been a very old practice in Nepal and exist till date with some convenient modifications. Kaans has in general, two varieties

- Thakayen, for Casting purposes
- Dakayen, for Dinner plates

The traditional making of dinner plates of Kaans metal had been practiced from very old times, and there was a flourishing market for such items, since it was lighter and cheaper that the other metals. But with time market has shrunk for these items, and technology too has changed, application of old indigenous methods do not exist in its original form and format,

*Raw Materials:*

- Tin (Stannum, Sn)
- Copper(Cuprium,Cu)
- Brass moulds, circular moulds of varying diameter for casting disces

*Tools & Devices:*

- Heating ovens
- Air-bellows
- Iron hammer
- Wooden hammer
- Clay crucible
- Tongs
- Iron files
- Stone anvil

*Production Technology:*

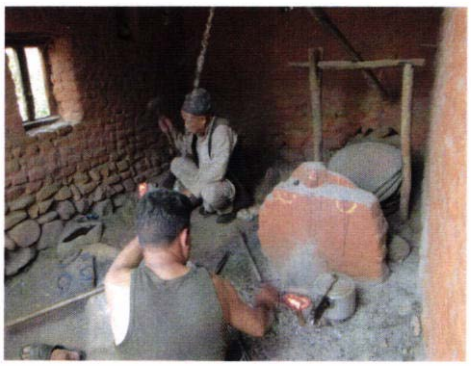
- Copper and tin (in1:4 ratio) pieces put into crucible and mouth covered with lid
- Crucible heated strongly by placing it over a bed of ignited charcoal in an oven
- Continuous air supply continued to ensure steady oxidizing flame by attaching air bellows to the sides of the oven
- The process monitored carefully until the point of complete melting of the content of the crucible
- Mixture melt in the crucible transferred to clay circular moulds 'Pallas' for casting in regular and workable shapes
- Later on , circular disc of Kaans, an alloy of two metals taken out from the moulds to made household objects, such as plates

- The alloy discs heated and hammered on an iron anvil by artisans done on both sides and by rotating the metal disc to expand the disc in desired shape and thickness (usually 10"-12" in diameter)
- Stone moulds used for final shaping of edges of the plates, red hot circular discs bend to forge as required by using light hammer
- Tempering of the plates done by a paste, prepared by mixing 1000 g of grey-coloured clay with 500 g of common salt (NaCl), inner surfaces of the plates pasted with the salt-clay mixture and left to dry in air
- Finally, inner surface of the plate heated uniformly by rotating it using two iron rods, after heating properly plunged into a cold water trough and pulled out immediately, this act known as 'giving the pine' and part of final step of the 'tempering' process
- Finishing and polishing done by using different iron files attached with wooden lathe device

*Explanation:*

The process of tempering enhance stability of the alloy, and thus, plates withstand impact and do not crumble easily. Kaans meatallic alloy also used to make domestic utensils other than dinner plates, such as, bowls, cookers, lamp stands etc. by metal casting, proportion of copper and tin to yield kaans are different than that of kaans for plates. Exact status of manufacture and trade of the volume of kaans in Nepal is unknown , but the object of this alloy still have a presence in the market.

**(f) Iron Tools (& Khukuri)**



Extraction, purification and production of various utility tools from iron had been developed indigenously. The trend has changed over the time and now only manufacturing and repair work done here and there, mostly in remote areas. Agricultural works demand a number of tools, similarly construction sector requires suitable devices. Indigenously produced tools and devices constitute only a small market share in this overwhelming trade. However, Khukuri a curved knife, used as a weapon and also for other routine works, still holds a good market value. The original Khukuri manufacturing unit famous since hundreds of year was in Bhojpur of eastern Nepal. Now, the production is not confined to a particular area, there are some units in Kathmandu valley, we visited one in Patan Industrial Area. All forms of khukuris are produced in bulk including well decorated and attractive pieces, exported to offshore countries like Australia, United Kingdom and United States. On line trade of khukris are also going up with time, according to the industry source. Application of modern technology has been introduced in the indigenous technology of khukuri manufacturing for many good reasons. Presently 22 persons are employed in the Patan unit.

*Raw Materials:*

- Iron
- Brass
- Coal, Wood, Leather, Adhesives, Lac
- Drum sheet

*Devices:*

- Grinding disk
- Drilling machine
- Bench grinding machine

Other important iron tools to mention,

- Spade, Axe, Sickle etc.
- Case Study at Pharping, Scope at only local level

*Raw Materils:*

- Iron
- Coal

*Devices:*

- Air-bellows
- Iron anvil, Forked tong
- Hammer

## (D) Milk Products

Some of indigenous milk products have been very common to the Nepalese household usually involved in animal husbandry and farming. The methods to prepare these items are simple and demand of the products are high. So this sector has the great potential to expand and employ manpower all over the country.

**(a) Mahi**

*Raw Materials:*

- Milk of cow, buffalo or chauri cow
- (Yoghurt or Curd)

*Devices:*

- Theki , wooden container of soft wood
- Madani, churn- staff

  (Madani is an important device for making 'mahi' , this is made of hard bamboo piece (taru baans or wood). The lower end of handle or staffis hooked up with four straight blade known as 'pora'.Upper end of the handle is fastened with 3-4 fold of ropes . The madani is held upright in the theki by clamping it with a fixed object.)
- Neti, ropes
- Ghurna, handle bars
- Pikra, wooden seat

*Methodology:*

- Milk is filtered and boiled
- Poured into wooden container(theki) or earthen pot(ghainto) or earthen bowl(Kataro) and covered
- Milk condenses to curd in 24 hrs, in winter season 2-3 days
- To produce large volume of 'mahi', milk is mulched and stored in a big earthen vessel for a few days, this practice is not good because fermentation of milk takes place ambiguously
- Curd is transferred to a big wooden container and requisite amount of clean water is added
- Churn-staff is inserted in the vessel and held in vertical position by fixing it upright
- Ropes free ends are fitted with wooden handle bars(koela),to hold and rotate the ropes easily
- Churning of curd content done repeatedly by pulling the strings clock wise and anti clockwise alternatively
- The action of churning separates butter and when the process of separation completes, more water is added to bring floating butter to the uppermost level of the vessel
- Butter is removed from the water phase
- Final phase of the production of 'mahi' i.e., separation of butter substance takes 15'-30', in winter much more time is taken and sometimes to speed up the process mild hot water is added
- Mahi is obtained as a major byproduct is very good soft drink of low calorific value
- Mahi is sweetened, salted and added with flavor ingredients according to the consumers preferences
- In summer, the demand for this drink soars , more so in the high temperature zones

Butter, the main product on the basis of its price value is converted to ghee, animal fat having high calorific value by melting and gently boiling for some time.

Both ghee and mahi are objects of high demand, and this indigenous technology is going to survive.Ghee is found easily and it can be stored for a longer period. Contrarily, bench life of mahi is very short and this product is not easily available. There is a need of improvement in this technology to produce this drink and find out the ingredients to make it more stable.

**(b) Chhurpi:** Dried Caesin

It is a popular chewing stuff in the hilly region of the country produced in the northern Himalyan region. This is made by sour milk of Chauri cow or Yak. Chemically, chhurpi is named casein after a milk component , a compound of calcium. Yak Milk is very rich in this compound and so this solidified cakes are also termed as dried casein.

Chhurpi has two varieties,

- From Curd or Yoghurt

  Dhaukho, sour in taste

- From dilute Yoghurt or Mahi

  Durko or Chhurpi

Hygienic condition of the overall chhurpi making technology is poor and questionable, thanks to the cold climatic condition of the alpine region, growth of microorganisms are restricted and outbreak of diseases are prevented.

*Raw Materials:*

- Yoghurt: Curd
- Mahi
- Phatkiri, an alum,double sulphate of Potassium(K) and Aluminium(Al)

*Devices:*

- Wooden containers
- Bags, usually made of clothes
- Threads of long hairs of Yak

*Methodology:*

- Milk of Yak allowed to ferment and condense to yoghurt
- Mahi is prepared from the yoghurt
- Phatkiri alum is added to mahi container to coagulate Caesin content
- The whole concoction transferred to the bags and hung up with ceiling to heighten gradient for faster filteration
- Solid mass of the bags squeezed hard with hands to remove remaining water content
- Bag left hanging for a few days
- The isolated mass in the bag starts solidifying and becoming areas hard
- The solid mass is transferred on a clean wooden board or to a clean stone slate
- The mass is spread uniformly on the surface and cut to small cubes with the help of sharp knives areas
- The chhurpi cubes are pierced with chauri hairs and held together in threads and allowed to dry in the shades
- Pieces are hardened more and more while drying and attain a smoky colour

This is a very popular product, chewed like betel nut. This item may find a good commercial space in the terai region and its export to India is also not so unlikely. The production technology can be made more hygienic and the product itself be modified to be more tasty by adding natural flavouring agent. Some basic training can be arranged for the workers and producers involved in the production of casein cakes by the concerned government agency.

**(c) Curd(Nep:Dahi)**

Curd is a well known and most common food constituent in Nepal, served as final course of food usually with sweets. It is considered auspicious and a digestion ingredient. In most of the households curd is prepared and served as an instant food with bitten rice and other food items. This is generally found everywhere in the market place, dairy shops and groceries.

Fermentation of Dahi from milk had been a common practice in almost every region of Nepal, however, quality differs more or less on the basis of quality of milk and the technology applied. Bhaktpur township in Kathmandu valley has earned a reputation in this process and a section of local community had have developed an expertise in the production of very tasteful and delicious curd, and the product has a stable market till date. A brand of Bhaktapur curd named 'Juju Dhou' has become a very common name In this trade in the Kathmandu valley because of its superior quality, interestingly 'juju' is a synonym of the word 'king' in local dialect.

*Raw Materials:*

- Milk
- Sugar
- Husk

*Devices:*

- Big Hemispherical vessel
- Or, Cauldron
- Wooden box cabinet

  (fixed along with walls)
- Earthen pots
- Metal or wood stirrer with long handle

*Production Methodology:*

- Milk gently boiled over a simple traditional fuel wood stove
- Cabinet box half filled with rice husk
- Clean dried earthen pots of desired sizes filled with milk while still hot and placed in the cabinet box over the husk layer
- Each pot seeded with yoghurt culture ( very small amount of curd mixed to initiate lactic acid fermentation)
- Mouth of each pot covered with an inverted pot of same size
- Husk spread over the milk pots uniformly in a way that all the pots and remaining vacant space of box covered completely
- Finally, upper open face of the chamber shut by closing upper joint
- The pots allowed to stay at rest in the chamber for 4-5 hrs
- Microbial action effects coagulation of milk to curd, porous matrix of earthen pots absorb most of the water content of milk
- The Preparation sweetened by adding sugar while boiling the milk and further upgraded by adding 'kesar', 'hazelnut' etc on special occasions and according to customers requirement

*Explanation:*

Yoghurt is a coagulated product of milk by lactic acid fermentation through Lactobacillus bulgaricus and Streptococcus thermopillus. May also contain cultures of Lactobacillus acidophilus and Bifidabacterium bifidum . It is a general belief that curd or yoghurt of some reputed local brands contain some undisclosed strain culture to produce special grade yoghurt.

Yoghurt is made of buffalo or cow milk . Milk is an important raw material for a number of valuable commodities. At many occasions people experience acute scarcity of milk and milk products in every region of the country. Thus, a strategy to increase production of milk and applications of appropriate technology to produce various milk derived products would be in the larger interest of the people.

## (E) Construction Materials

Construction materials like bricks, tiles and materials like lime mortar etc., have been developed centuries ago, and the fact is well evident by the presence of old structures at various historical sites in the country. Lime mortar used before the advent of cement to fix bricks or stone fragments. Old buildings and edifices are existing examples of such indigenous technology originated in a very early stage, more than thousand years old bricks recovered during excavations at some sites within Kathmandu valley.There are many edifices in the Kathmandu valley made of such materials built in Malla period. Bricks of ancient times found to be much bigger than the present day specimens (of 8.75" x 4.25" x 2.25" dimension). Old excavated samples measured to be 14" X 9" x 2.5" and 15.6" x 10.6" x 2.2" respectively. The brick samples bear very old inscriptions underlines the fact that clay derived construction materials like brick, tiles etc., have been in use since a very ancient past. In Kathmandu valley 'Awale' community expertised the technique of brick making, however, scenario changed in recent times with the increased demand this industry has attracted more people and many medium and big installations established to produce bricks and other construction materials

### (a) Brick

History: Ansuvarma Period

Many historical buildings viz. Taleju temple, building having golden window in Patan etc. are made of such bricks are still intact, there is no sign of wearing and tearing.

*Materials:*

- Soil, Sand, Panch mato(soil having specific charecteristics), Fuel Wood:Coal, , and Water in plenty
- Wooden firmament, sizing knife

Production Technology:

- Good quality soil dug out at a site closer to bhatta or brick kiln constructed to fire raw bricks
- Sand brought from nearby river or sand dunes
- Heap of soil wet by abundant water for some time
- wet clay mass trampled properly and kneaded well
- Inside of wooden mould sprinkled with water to wet the inner surfaces .
- Pancha clay or fine sand spread inside the mould and sand smeared clay roll forcefully inserted into it
- Extra clay bulging from the open side of the mould slashed by a suitable device like knife
- Inverted wooden mould stuck on ground with a bang to release raw brick and the process repeated successively by a labourer
- Bricks arranged and piled up in rows and left standing for enough time to dry up bricks completely
- Dried bricks further arranged to construct rectangular open top kiln of length=15'-20', breadth (at base)= 8'-10' and height= 15'-20' for firing bricks
- After construction of kiln fire lit at fire places(6-12), loaded with sufficient fuel wood or coal

- Process of firing to bake clay bricks continued for 4-5 days under careful observation and necessary action to ensure proper baking of bricks at all sides and also up to the top of the kiln

Explanation:

Panch mato, bears very good characteristics and aburidantly found in Kathmandu valley. Brick clay is impregnated with this soil to improve bricks waterproofing properties. Panch mato has a very profound sealing property, roof tops and open terraces have been pasted with a layer of this clay before paving to prevent cracks and water leaking. Even in cemented surfaces cracks and withering appears with time, while the panch mato stay intact for a long time. Even use of sun baked bricks have been a very common indigenous housing tradition, for such bricks quality of soil or clay is an important factor. Sun baked bricks have been fixed with mud and houses made in such a way can still be seen around.

(b) Tile

Tiles are used roofing of the houses or parapets of the big buildings

Basic technology are identical with brick making, quantity of sand added is far more than that

in case of brick

Materials requirement is also almost same

Size of hand made tiles have been found to be 7.5"x 1.1"x1.5", more recently the size have been somewhat different than the former i.e. 7" x 3.5" x 0.5"

Tiles of different shapes and sizes observed within the country

The oldest type of roofing in Kathmandu valley is 'Jhingati', a thick and flat rectangular shaped

piece

Similarly, other traditional construction materials have been developed by natives, and still used in constructing low cost housing mainly in the rural areas, some are mentioned herewith. Prior to the R. B. C. and R. C. C. housing systems many monumental structures had been erected by using these materials, and such monuments have survived for centuries.

Dhuris, for topping tile made roofs

Kuha-Pakha(roof corner)

Khapada tiles, common in terai region

Paving tiles

Telia bricks

Liwun and Bajra, mortar

chun, by burning limestone, mortar

(c) Chun Making( Lime from Limestone, $CaO_3$)

Lime is a very useful raw material, have been produced indigenously by burning limestone properly. Lime or chun have been used as an integral component in building houses, fixes bricks and stone slabs. It is a disinfectant and used in agriculture as soil conditioner. Limestone deposits in various parts of country has been found and estimated, and cement factories established at Udaipur, Hetauda and other places as well. Cement has eclipsed the lime as the former exhibit very strong cohesive character. Lime mortar is still produced for other uses.

*Raw Materials:*

- Lime stone

- Coke/Coal /Wood
- Large stone slabs(Tau Dhuya)
- Water

*Devices:*

- Furnace (Bhatta/Lime kilns)

*Production Technology:*

- A kiln or furnace dimension 16'x14'x10' constructed to burn limestone
- 4-5 Big holes bored on the lower sides of the furnace
- Extended from the holes parallel channels dug through the inner compartment
- Channel grooves filled with fire woods and covered with stone slabs and then, wood pieces stacked over the slabs
- A layer of about 4" of coke spread over the woods
- Limestone layer of about 12" placed over the coke layer
- Yet again, layer of coke and limestone placed alternatively until the kiln compartment filled completely
- Fire lit through all holes and burning continued for a few days to ensure complete burning of material inside the kiln
- Inside volume of the inside materials reduced as burning or calcination progressed, then more limestone and coke added through the top of the kiln
- Kiln allowed to cool for about a week
- Slacking of lime carried out by pouring sufficient water on the heap of burnt lime stone
- Burnt limestone slackened instantaneously by the action of water, mass deformed and frittered to powder state
- The lime mass further powdered and sieved mechanically to remove hard unburnt pieces of limestone
- Finally, snow-white powder of lime obtained , recovered lime stored in a closet to prevent contact with moisture

*Explanations:*

Process of slacking of lime done carefully by experts, treatment with inappropriate amount of water diminishes property of the lime. Safety precautions also needed during the process, since calcined lime react violently with water with release of heat and flash fires. Limestone contains calcium carbonate($CaCO_3$) as a major component and 2-3% of magnesium carbonate($MgCO_3$) also present.

*Lime:*

- Building mortar (Lime +Sand +Water), also used for white washing
- Insecticidal property

*Lime Making From Sipi or Shells:*

In Terai region lime have been produced from the shells of mollusks in a more or less similar way. Lime from shell considered to be of very high quality, having sparkling silver colour and mostly used as betel ingredient along with catechu. The sipi shell is a form of biosynthesized calcium carbonate, purest form of the compound.

## (F) Energy

Energy requirement is ever increasing and the development of any country is earmarked by the scale of its energy consumption. In Nepal, use of water resources to generate (convert) energy in order to perform many useful works started way back in the history and water mill (Ghatta) is the most common example to mention herewith in this regard. The technology is still practiced in some remote areas to grind cereals into flour, to obtain powdered spices etc. There is a genuine scope for the proliferation of this technology in remote hilly regions of the country, and there are some inherent advantages in the operation of water mills.

A case Study (Posted on the internet by IRIN,July 5, 2007)

Water Mill(Ghatta): Ancient Rural Technology, used to grind

Grains to flour, and spice powders

Location: Dhading

Proprieter: Mr. Ram Sharma, Started this enterprise after losing his cultivable land after a devastating land slide to earn his bread and butter, he manages to earn enough to generate subsistence for his family.

*Materials Required to Set up the water mill:*

- Tree trunk for the purpose of running water through it(Dundh)
- Timber to make turbine wheel(Madani)
- Stone discs to act as grinder
- Funnel(Soli)
- Iron sheet(Pata)
- Iron rod(Dandi)

and above all,

- Water stream(continuously running water front)

Present Study site: Malpi, Panauti

Ms. Renu Rai

Use of Technology;Flour of grains, powder of some common spices

e.g., ginger, cumin, turmeric etc.

Area: Confined to local settlement

Extension can be possible with some modifications in order to enhance magnitude and trap the energy for other purpose

Next case study courtesy: Annual Report(2012),Centre for Rural Technology, Nepal(CRT/N)

Enterpreuner: Dil Bahadur Chepang, Jhatetar, Kalikatar VDC, Makwanpur

A good deal of innovative work has been reported, improvisation of traditional water mills (TWM) to improved water mills(IWM) has proved to be very helpful in remote hilly region. People have been trained and economic assistance provided to install or improve the water mills. Improvisation has added extra feature to the ghatts, in addition to traditional works, rice husking and rice polishing could be done. Moreover, generation of electricity and electrification of household has changed the lifestyle of the people living in interiors. Water mill support programme covers 33 districts in hill and mountain areas. This indigenous technology considered to be a clean source of energy and with added functionality it has become more versatile. other indigenous technology(IT) should also be upgraded to keep them alive and rewarding.

## (G) Woolen & Fabrics

The natives of Kathmandu valley had has expertise in weaving various kind of clothes and were self sufficient they excelled in weaving cotton fibers and knitting woolen articles till some time ago and the tradition is still alive in some pockets. The tainga, woolen chadar and the black cotton sari is admired by the local inhabitants and foreigners all alike. Similarly, People of other parts of country made fabrics from locally available fiber extracted from plants.

**(a) Tan(Loom)**

The term is commonly used and popularly referred to the weaving units, in fact tan is a simple machine operated manually or automatically to weave desired quality of clothing using cotton and other fibers

- Study Area: Lubhu, Lalitpur
- Clothes Making; Haku, Patasi, Shawl

*Raw Materials:*

- Cotton
- Machine used; Tan
- Tools and appliances;
- Keku, wooden appliance to clean cotton beads by ginning
- Mayeka, bow-string to make cotton bales fluffy and cleans at the same time

Cotton processed and rolled into 6"-8" soft strands called 'pyuri', which is spun into threads on a wooden spinning wheel, or charkha varies with local customs and other considerations. Spinning devices are based on principle of handling easily, more form of such tools exist. Thread is treated with gruel(granular rice and oil product) by kneading to prevent it from sticking and stretch properly. With the help of some other accessories the final process of weaving executed.

'Layapow' or weaving frame was made by bamboo traditionally, which however replaced by iron made equivalent component, there have been a number of changes in the original technology.

Bhangra: Rough and very thick cloth

In the cold hilly regions poor people wear this coarse roughly woven grayish fabric made of nettle to stay warm. Probably, the use of this clothe may have reduced or stopped by now, but its excessively warm characteristics make it suitable for blanket and sleeping bags. Making of this article have been recorded in some books on this subject. The process is briefly introduced here,

*Raw materials:*

- Allo or Chalne sisnu (nettles) Ash

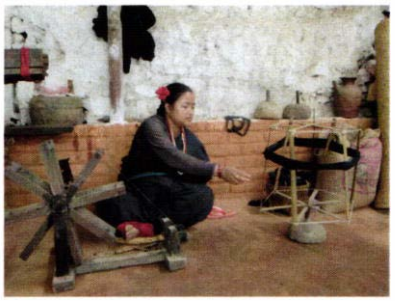
*Machine and Devices:*

- Loom (Tan)
- Wooden hammer(Mugro)
- Cauldron(Khadkaunlo)
- Spinning wheel

*Production Method*

- Stalks of nettle(white Baruwa and jute are also suitable) are peeled off and processed by fermenting or boiling with the alkaline solutions. The fibers are freed by the binding material lignin in the process. These fibers can also be used to make paper by repeated bleaching etc.
- Traditional occupation of the weavers has been subjected to the onslaught of tough competition from imported sophisticated fabrics, the number of professional dwindled greatly, however, this occupation sustaining as an additional occupation practice and also because of some ethnic groups still prefers these items associating it with culture and heritage.

**(b) Wool and Woolen Articles**



Production of various kind of woolen garments are prevalent in the country, in northern area requirement for these items are more in demand because of harsh cold climate, woolen items have been exported to the foreign market.

*Location:* Production units are concentrated in the Kathmandu valley, Tibetan settlers are involved in many of such enterprises

*Raw Material:* Wool, Luk ram is domesticated in the various parts of the country, basically for the production of wool. Different varieties of sheep locally known as Baruwal(long curved horns),Changra, Kage rams etc. are reared and wool sheared from them to make warming garments. The quality of wool depends on the age of the animal. Quality of wool can be generalized like below,

- Garve wool, very first shearing of a tender, wool is very soft and fine
- Chharve Wool, medium grade wool obtained from second time shearing
- Torbe Wool, third or fourth shearing product, rough and low grade
- Dyes, to dye the product and make them attractive

*Devices:*

- Scissors
- Wool of Luk ram
- Bhasyakawa(a brush like device to de mat the wool)
- Kholo( a form of traditional spinning wheel)
- Phang (a traditional spindle)

Various woolen items are made in Nepal, the internal wool production had been insufficient thus, this commodity was imported from Tibet in the past, now the import of wool is not confined to any one country, it is brought in as far from New Zealand.

The production methodology starts with the refining and dyeing of the wool. Traditionally, natural dyes used for the colouring of the wool, but now dyes are imported from Switzerland and other destinations.

- Famous Woolen Products of Nepal:
- Chaddar
- Khasto
- Radi, Rough woolen carpet
- Bakhu,Waist coat
- Tainga,Black woolen shawl with green border
- Pakhi, Many local dresses are made from it
- Galaincha, Woolen carpet

The production technology of these items differ somewhat, quality of the products primarily determined by the grade of the wool. Production and export of carpet grew amazingly at one time and many carpet industries have been registered. Demand of carpets still exist in the international market and there is a need to promote production of better and environment friendly galaincha. Social and economic importance of this sector is profoundly understood, this has the potential of providing job opportunities for all category of social groups.

**(c) Technology of Galaincha Weaving**

Carpets are a fine example of arts and crafts embodied in a object, its smooth and silken touch gives a very good feeling. Artistic patterns of various shades of the universe mesmerizes instantly. Undoubtedly, carpets are the object of desire in every household. Production of carpet is concentrated in the valley and in some adjacent districts. Most of the Tibetan settlers are involved in the production and commerce of this business. This is evident from the fact that tools and devices used to weave the carpets have names of Tibetan origin and these terms are frequently used by the local weavers too, all such terms are retained or assimilated. There are many small and large production units employing many people.

*Raw Materials:*

- Woolen Yarns
- Cotton Threads
- Dye or coulouring Pigment

*Devices:*

- Rectangular Wooden Frame
- Iron Rod
- Panja,a fork like wooden hammer
- Twaga,a wooden hammer
- Roksing
- Nesing
- Tibiru
- Scissors
- Brush

*Methodology:*

- A rectangular frame is prepared by sal wood( dimension 3'x 4')
- The frame is placed against a wall in a leaning position
- A loom of cotton thread is stretched out in this frame
  (The cotton thread is considerably thick known as 6,6 yarns)
- Loom is constructed according to the desired size of the carpet
- A wooden bar, Roksing is fixed at the bottom of the frame
- At the height of about one feet from 'Roksing',an another wooden bar is placed between the layer of thread(parallel to the Roksing) is called 'Nesing'
- Nesing, differentiates the cotton threads
- Yarn strand run parallel and vertical in the front and rear position in the loom
- Five strands of yarns are inserted at right angles to the loom through the space separating near cotton threads
- The yarns inserted parallel to 'Roksing' and are stretched intactly
- A woolen yarn is knotted with a front and a rear cotton thread stretched on the loom
- Such knots are made on an iron bar of 18'' lengths and about 100 mm of diameter held above the Roksing, in a parallel position
- According to an envisaged design or pattern, woolen yarns snapped leaving an open ended thread of about 0.5" yarn of different colours are used

- When desired number of knots are made all over iron bar, it is pushed down by twanga(a wooden hammer) and lined with Roksing
- The iron rod removed from the end of the frame and the woven row further compressed by another tool known as 'Panja'
- The fork like Panja used to adjust woolen knots to occupy appropriate positions with respect to the cotton thread
- 'Tibru' is used to cut extra open ended yarn which further levelled by scissors
- Next row woven by inserting five strands of thread through space in between the front and the rear cotton yarns
- and, The process repeated, finally the borders of carpet woven to complete the task

Cutting and Finishing:

Newly woven carpet stretched over a clean surface and leveled by using scissors. The designs and patterns over the carpet surfaces appears starkly only after fine cutting and leveling by experts. Cutting wastes are removed gently and carpet surfaces brushed to remove all wastes neatly. Finally, carpet exhibits beautiful and attractive appearance.

Explanation: A hand made carpet of roughly 6'x3' dimension takes 15 days to complete involving two persons. Dyeing of woolen yarns bears great importance in the manufacturing of carpets. Indigenous methods of plant derived colouring materials viz. Ramje, have been largely abandoned, replaced by synthetic dyes imported for the dyeing purposes. The synthetic dyes are proved to be harmful , but it's use has been increasing for some other advantages. However, synthetic dye free carpets have a good demand in the EU and other developed countries, also valued high in terms of cost of such items.

## (H) Paper(Kagaj)

Indigenous method of paper making has been practiced from a long time in Nepal. The paper making was confined to the northern Himalayan region which spread later western part and eastern part. Baglung, Dailekh in the West and Solokhumbu an, Ramechap and Barabise in the East are prominently figured ii the production of paper, commonly known as Nepalese paper, the ethnic groups Gurungs, Magars, Rais have been involved in the manufacturing. This paper has unique toughness as well as softness in contrast.

(a) **Nepali Kaagaj:** Nepalese Handmade Paper

This is one of the most important indigenous technology of Nepal. Production of this paper continues for some specific use.

*Raw Materials:*

- Bark of some shrubs termed lokta in local dialect,
- Daphne voluwa or papyracia
- Daphne isworthia, these plants are locally known as sikra,susu, kagat pate
- Also,Birch tree and cannabines yield lokta for the purpose
- Harvesting period; Falgun-Baisakh(March-April)
- Ashes to prepare alkaline solution by dissolving in water
- Woods of some commonly occurring plants are burnt for this purpose
- Banjh, khusro, phalant, katus etc. are some of them

*Processing Tools:*

- Ladle made of wood
- Dhoond, rectangular wooden container scooped in a single log of wood
- Mungro, wooden hammer
- Khadkaunlo, copper cauldron
- Moulds, filteration device
- Madane, cylindrical wooden vessel with stirring handle
- Khandi or Gharbuna,Casting frame

*Procedure:*

- Harvested lokta are thoroughly cleaned by repeated washing by the water and dried
- Ashes are percolated by water to collect strong alkaline solution to digest the lokta
- The alkali treated lokta washed again and minced into small pieces then boiled with alkaline solution for 3-4 hrs to soften enough to break very easily
- Softened whole mass of lokta spread over mats for some time to dehydrate them
- The resulting mass homogenously spread over a hard surface and hammered with the 'mungro', after pounding for 3-4 hrs the mass turns pulpy
- The pulpy mass transferred into the cylindrical vessel and water is added proportionately
- the mixture is stirred vigorously with the help of handle to obtain emulsion of pulp which is filtered to remove foreign particles

*Casting of pulp: Final step*

- Casting frames fitted with tightly stretched and tied coarse cloth are fixed near water source

- Pulp is uniformly spread over the cloth stripe of casting frame slowly with the help of wooden
- pot , 'the measure' having cylindrical pointed opening at one side
- Pulp layer treated with water and dried(Sun drying or by other means)
- The dried pulp sheets folded and made into bundles called 'dhep'
- One 'dhep' usually contains 200 pieces of paper sheets

Nepali kagaj or paper is very strong and durable for a long period, its economic value is still intact because customarily it is used in the writing of property deeds and other official documents. This indigenous technology has great social and cultural value, it has also got appreciation of foreigners visiting Nepal, books on this technology have been authored by the visitors.

**(b) Harital Paper:** Thick Coloured Paper

This paper is made by the further processing of plain white Nepalese paper and exactly same in the origin. It has been used for the writing religious hymns and auspicious notes related to a person or a family, the letters inscribed like calligraphs. Its life is extraordinarily longer, it is moth resistant due to the treatment with the minerals, harital(yellowish) and manashila (orange). Special inks are used artistically to add aestheticism to this paper.This is made by Brahmins, Shakyas and Bajracharya of the valley. Ancient religious scriptures used to be penned on palm leaf Or 'Tad Patra' are still intact and preserved in national museums or libraries.

*Raw Materials:*

- Best quality of white plain Nepalese paper

  (Such paper is available in northern part of the country)
- Rice; washed, dried and pulverized in a hand mill to a fine state

  (Adhesive is made for the process of Harital making)
- Harital, classical name for a mineral, arsenic sulfide($Ar_2S$)
- Mana Shila, also a mineral or ore, having insecticidal properties

*Production methodology:*

- plain white paper sheets are procured and the low grade defective sheets are withdrawn
- a sheet of plain paper spread over a smooth wooden plank
- thin layer of adhesive pasted evenly on the all four side edges of the paper sheet
- a second sheet is glued carefully to cover the first sheet completely
- then, third and even fourth sheet is glued successively in the manner so that outer one superimposes the interior one
- number of sheets determines the thickness of the processed paper
- the wooden plank with glued paper hanged on the smooth walls for some time to dry the paper glue
- Harital and Mana Shila, the minerals are finely powdered separately and mixed with rice powder adhesive thoroughly
- the wooden plank with attached paper sheets are placed on a even and hard surface
- powdered mixture of three components are gently applied to the paper and evenly spread by a suitable device so that only a thin layer remains on the surface
- the surfaces of white papers turn yellow after the treatment
- the paper sheets are dried again for some time
- the glued edges are cut away

- processed paper is cut to the requisite dimension
- usual dimension of Harital paper, 'oblong', 14"x3.5" or 10"x4", or 12.5"x6.5"
- The Harital paper is further processed by polishing to make the surfaces smooth and glossy
- the polishing, traditionally done with smooth round sand stone or conch shell
- the paper is further marked with parallel line grids by placing it over a wooden plank with thick stretched parallel threads

(c) **Neel Patra Black** or Indigo Sheets

Further modification of Harital paper for the purpose of writing with gold or silver ink, Neel Patra becomes fairly soft when exposed to the sun, presents a beautiful, black , glossy surface and well suited for writing in letter of gold or silver.

Neel Patra, is produced by a slight manipulation in the process of Harital making, some wax and lamp black(carbon) is added to the mixture of minerals, H.T. and M.S. and stirred properly before applying it over the paper surface

Economic aspect of the production of this paper may not be of much importance, as this technology does not produce an original object and it is rather a secondary product thus, it has a limited market.

However, its social and cultural value gives it a special status and its demand will not going to cease at all. The paper is pest and fungus resistant due to the application of the minerals which are imported from India. Research should be conducted to find alternative indigenous pest resistant material for this purpose. Nepali handmade paper made from lokta and argheli have a very good prospects in domestic circuits and also in foreign markets, the strengths of these products to be mentioned here are,

Nepali lokta paper are very strong due to its origin in high altitude

There is an efficient network of artists and entrepreneurs to produce paper products with value addition to attract the buyers

There are some weaknesses too that hinder the growth of this cottage industry, and the overall trade is not up to the potential. The short fall is due to lack of proper marketing and promotion strategies

## (I) Tanning (Nep: Chala Prasodhan)

Converting raw hides of domestic animals like cow, buffaloes etc. is known as tanning, a term derived from 'Tannin' , a chemical constituents found in many plant species. Raw hides are tanned and converted to leather by modern technology in tannery. However, indigenous methods had been applied to produce leather in many part of the country for centuries by Matangis or Sarkis, a community of cobblers. Products made of refined leather mainly shoes have been very flourishing trade, and local cobblers monopolized the business in those time.

Existence of indigenous method tanning may not confirmed but the leather materials are still made by professional at small or cottage industry level. Observance of indigenous tanning technology proved to have a scientific basis, an example of knowledge management based contemplative development of a technology to fulfill the need of community based society of ancient era.

*Raw Materials:*

- Hide of cow/buffalo
- Bark of Khaphal, a wild tropical tree
- Leaves of Dhaera tree
- Hirakashi(chem:Ferrous sulfate)
- Lime(chem:Calcium oxide)
- Nun(chem: Sodium chloride)
- Water
- Mustard Oil

*Devices:*

- Banka, cutting tool
- Dhiki
- Dalap, cylindrical wooden device
- 'Attals',

*Tanning technology:*

Step I.

- Brick or stone tank of about 8'x4'x5' dimension constructed and plastered with lime and mortar
- Fifty or so buffalo hides stacked one by one in the tank and sufficient water is added up to the rim of tank submerging the pile of hides
- Enough hydrated lime and common salt added afterwards, and the tank left exposed to the prevailing weather conditions
- Position of the hides changed at intervals to undergo identical treatment conditions
- Water and lime added intermittently to restore overall mechanism
- Processing allowed to continue for about twenty days and the hides cleaned thoroughly to remove remaining hairs, flesh and filth

*Explanation:*

Prolonged action of lime/salt and heat from sunlight effects softening and swelling of hides

Step II.

- Bark of Khaphal tree dried and powdered by heavy pounding in a traditional device 'Dhiki'
- Similarly, dhaera leaves dried and powdered
- Hides recovered after liming treated with the mixture of bark and leaves powdered in a1:4 combination ratio
- Hides kept in contact for two days with paste of leaf powder made by adding water

- Afterwards, bark powder applied in excess over hide pelts and this in turn stacked in a pit dug for the purpose
- Position of pelts rearranged every 4$^{th}$ day to subject them to more or less identical chemical conditioning
- Pelts kept for twenty days in the pit to complete fermentation, the process rendered hides softer

Step III.

- Hides put stacked in a porous bag and substantial amount of water also filled, mouth of bag shut and the bag tied with an object like pole or branch of a tree
- Bag allowed to hang and receive gravitational pull, resulting in flushing out residual chemical constituents along with water
- Bag allowed to hang for about two days to drip water completely, later leather strips dried in sun light for some time

*Explanation:*

Buffalo hides processed to get refined leather suitable for making soles of shoes.

Leather thus, refined exhibited soft and spongy nature having reddish tinge of colour. It also, showed delicacy to be stitched by hand.

*Processing of Leather for Upper part of Shoes:*

- Thick cow hides processed to get desired quality of leather. Fresh hides of cow looks white
- The processing is not much different to that of buffalo hides, tanned to obtain leather for cobbling shoe soles.

Step I.

- Hides treated with salt powder, then squeezed and folded
- Lime slurry made by dissolving calcium oxide in clay vessels, and the salt treated hides immersed into the vessels(50 hides in 4-5 Vessels)
- Hides reposition at intervals of two days and slurry solution stirred intermittently to make the solution homogenous
- Hides withdrawn from vessels after twenty one days and rotten remains of flesh and filth removed carefully by using 'Banka'
- Finally, hides washed and cleaned neatly by splashing water

Step II.

- 'Attals', the clay vessels containing mixture of dhaera leaves in water stacked with semi processed hides, and kept for 10-15 days with addition of leaf powder and water at intervals with stirring
- The process supposed to complete with appearance of pinkish tinge of the cow hides

Step III.

- Leather thus processed further cleaned to free from filth then dried in sun light and subjected to treatment with salt and oil
- The colour of leather stabilized further by the application of aqueous ferrous sulphate, the leather sheets turns black in colour
- The sheets rubbed with a wooden device 'Dalap' to polish the surfaces to get smooth and shining leather
- Black leather strips treated with red dye stuffs dissolved in hot water, followed by 'Dalap' action
- turn into red strips

*Explanation:*

Dyes have been exported from outside and must be incorporated much later in the leather processing.

## (J) Oils, Fats and Waxes

Indigenous technology of extraction of oils from oil bearing seeds have been one of the oldest professions in Nepal. Extraction of mustard oil produced predominantly as an edible oil all over the country. Besides cooking , mustard oil also used for lighting and some other subsidiary functions. A section of the society developed the technology and later completely dominated this trade till the induction of modern commercial expellers with a very high production rate.

Ancient technology of oil production in hills differed from that of plains, oxen driven expeller was used as opposed to hills where men operated devices have been used. Oxen driven expeller or Kolhu, probably obsolete now, had been very common. In Kathmandu valley, some industries produce oil traditionally, have also retained specific strong flavour, characteristic of mustard. Khokana, in southern Lalitpur is a brand name for mustard oil since a long time and still hold a complementary share of this business. In old times, small scale oil production units existed in every village in Kathmandu valley. Oils from other compatible seeds also produced to fulfill market demand.

*Raw Mateials:*

- Mustard(Tori), Seasame and Sunflower seed

*Devices:*

- Wooden oil Press( Nep: Kohl, New : Sa)
- Semi circular baskets made of leather or bamboo or cane (New : Pulu)
- Dhiki
- Iron pan

*Production Technology:*

- Oil seed freed of dirt and other foreign material by winnowing, and dried in sunlight for 3-4 days
- Oil seeds pulverized in some traditional device, like Dhiki
- Broken seeds roasted in a round iron pan heated with by burning fuel woods
- Small amount of water sprinkled at times while roasting the seeds to confirm optimization of the process
- To construct oil press, one of the two rectangular wood blocks of length of about 7'-8' fixed with an immovable object and another block juxtaposed to the first block in a movable position with the help of strong iron screws
- The movable block attached with strong ropes to control its movement
- And the roasted seed powder put into basket pressed hard between two wooden blocks by bringing two blocks together to a desired extent

  (Oil collected in a metal vessel placed below the wooden blocks)

*Explanation:*

- Old devices constructed for oil extraction have not been identical, differently designed oil expelling design have been reported.
- Extraction of oil from roasted oil seeds is not so common elsewhere, such processing have been practiced largely in Kathmandu valley. Roasted seed oil bears a pleasant odour and good taste.
- Oil cakes or pina, contains residual oil and used as cattle feed and also as manure in the agricultural practices.
- Traditional oil expelling techniques do not exist in its original format, many changes has occurred in due course with time. Survival of the old enterprises credited to the consistency of the quality of their products. The peculiar odour and taste of the local oil products give them an edge and a group of committed customers.

## (K) Miscellaneous

We have observed that some of indigenous technology based enterprises are still doing brisk business, mainly at tourist centres of the country, where arrival of foreigners happen in large numbers, such as Kathmandu and Pokhra. Production of artistic metal, wood and stone crafts and other souvenir, usually attract the visitors, continue to be a steady source of income, which in turn provides employment to large number of skilled and unskilled workers. Similarly, carpet and other woolen garments are also valuable export items and market of such object rather expanding satisfactorily. In addition to the inclusion of well founded sector of rewarding technologies, the present inventory has a fair representation of other indigenous technology, regardless of their economic viability at present. In this section, we have included some very common and simple technology, used and practiced in every household at one or other time in distant past. Every home relied on them to prepare essential components with regard to fulfill basic need. The devices used in such old times may seem very simple and insignificant object now and hardly seen. However, those simple tools, devices and technology played an immensely important role that helped generations for centuries. Historical retrospective of indigenous technology of Nepal need to be reassessed and at the same time future perspective be determined. These technologies reflects craftsmanship of our own people and we must give them the righteous regard. In this section many least recognized and scarcely practiced technology have been included in order to draw an introductory sketch of them. These indigenous methods of production of basic consumer goods still survives not only in distant rural areas but also in peripheral locations of the Kathmandu valley, probably people have been addicted with a distinguished taste of the classical products or raw materials to produce some other useful items are abundant in their locality.

**(a) Janto**

- Indigenous hand operated grinding device
- Two circular stone discs are set on an axis, upper disc attached with a handle to rotate the upper disc in clock wise direction
- Frictional energy works while the disc is rotated and the grains are pulverized to make variety of edible items
- Rarely used now, was a prized possession in most of the households

Location: Ktiripur

*Raw Materials:*

- Rice, Masuro and Mas
- Product
- Flour/Pulse

**(b) Okhal**

Indigenous hand operated pounding device

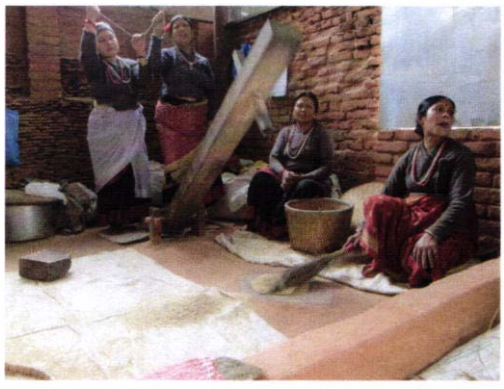
- The hand operated device, a dumb bell shaped wooden object with lower butt to stand it erectly and the upper hollow part
- The grains etc are put into this part and pounded forcefully with a heavy cylindrical wooden log

Location: Kirtipur

*Raw Materials:*

- Paddy and other food stuffs

**(c) Dhiki**



- A feet operated pounding device made of wood log of nearly dimension of 2m x 25cm
- The log is heavier at front end and the rear end is slightly tapering
- fixed to an uprightly erected wooden fork by a strong wooden or metallic bar
- placed through lateral sides across the log by making a circular whole at both sides
- A cylindrical wood piece with metal capping fixed on the ventral inner side of the wood log at right angle
- A hollow wooden or metallic conical object fixed in a way that the capped cylindrical wooden piece rest centrally in the conical vessel
- Grains etc. are placed in the hollow mortar, and the rear end of log is pressed forcefully and released harmonically
- Repeated action of pressing and releasing help in pounding of grains to make desired food items
- The system acts as a lever and is a simple example of energy efficient work

Location: Kirtipur

*Raw Materials:*

- Paddy(Taichin)
- Product
- Rice

**(d) Khuwa**


This is an important milk product used in the production of traditional sweets very popular item, very sought after item on the auspicious occasions and festivals. This indigenous technology requires very simple devices such as aluminium vessels to store and carry milk from one place to the another place. Some big open utensils to boil milk and smokeless stoves. Stirring devices with big handle and storing containers etc are needed

*Raw materials:*

Milk of cow or buffalow in pure form

*Procedure:*

- Milk is gently boiled to evaporate water content and allowed to cool afterwards
- Semi solid residue is collected

Location: Dakshinkali, Pharping

**(e) Chuk Amilo(Sour Concentrate)**

Chuk amilo or chuk is prepared to use as an sour ingredient in many popular varieties of freshly prepared achars or pickles. Achars are very common items made by common fruit or vegetable by the addition of several ingredients like salt, spices, oil and sour citrus juices. Achars are made in almost every household and served with main food to satiate taste buds. Sour juice of the citrus fruits is an important and mouth watering ingredient, however, fresh lemons are not available all the time therefore, lemons juice concentrate is prepared during periods of abundance, this highly

concentrated sour juice is known as chuk amilo or chuk. Properly prepared concentrates can be stored for long periods and used whenever necessary.

*Raw Materias:*

- Citrus fruits as
- Lemon, lime, jyamir etc.

*Device:*

- Fruit Juice Press
- Clay Vessel(container)
- Iron pan-bowl(Karahi)

*Production Methodology;*

- Citrus juice extracted by pressing cut fruit placed between upper and lower slabs of a traditional press
- Sour Juice collected in a iron pan-bowl and boiled to evaporate water content of the juice
- Juice content stirred with a wooden stirrer time and again during the process
- Colour of the content in the bowl changed to dark brown, then black
- Boiling process stopped observing colour change at that stage
- Concentrate collected in a typical clay vessel and its mouth tightly shut by covering with thick cloth or just covered with clay dish to prevent air contact
- The clay vessel stored in shade

*Chemical constituents:*

- Citric acid 7-8%
- Lemon concentrate are better compared to the vinegar, which contains dilute acetic acid($CH_3COOH$)
- Bench life of the citrus juice concentrate has considerably longer if processed carefully. Slight over boiling may introduce bitter and acrid test.

*Explanation:*

Citrus fruits are grown in hilly regions in abundance, and a resource management strategy through co-operatives can encourage local people to indulge in production of chuk amilo by using surplus fruits rather than selling fruits to middlemen and also to prevent fruits from degradation. In this way, many people will have extra earnings and be motivated to do more.

**(f) Stone & Wood Carving**

Carving of beautiful idols of god and goddesses and other objects on stone and woods have been a cherished traditional profession in the land. This art is mainly confined to Kathmandu valley and has a huge demand. Such arte facts evaluated on the basis of aesthetic values, and each and every piece speaks well for the artist who has carved them. Legendary pieces of stone and stone carving can be observed in seats of religious places. Huge stone temples with extraordinary carving over inner and outer sides are the living proof of the geniuses of the people who sculpted such masterpieces. Similarly, huge wooden doors and windows with delicate carvings reflect glorious creative acumen of the artists and also passion with the work. Carving is however, is more a skill than a technology, it solely depends on a workers act and imagination. Though use of some modern tools in carving industry has been introduced to increase rate of production presently, but formerly the works used very simple devices for the purpose.

Both form of carving has a good scope for future expansion, and would be paying rich dividends to the industrialists and the workers. Unavailability of quality stone and woods for carving works have been stated by the representatives of industry during our interaction. Patan Industrial State has well organized wood carving units producing various graceful and attractive objects. Fifteen skilled workers have been employed in one of such industry.

**(g) Transport: Cart**

Bullock or buffalo cart have been a common means of transportation in the plains of Nepal since a very long time. Many mechanized transport systems have become commonplace everywhere, but carts are still a very useful and a necessary carriage in rural areas. Wheel is the most important component of the carts, and that has been constructed and repaired skillfully in almost every village using wood and iron wood. Number of professionals wheel makers have been reduced by now, but such services still exist in the rural areas.

**(h) Wooden plough**

Plough is the most important agricultural tool, it has a very long historical background. It is still a very common devise for tilling agricultural land, the size and shape varies distinctly with area, technological adjustments guided by local factors have been observed. Ploughs are constructed by using wooden components and a sharp angular iron fragment attached firmly with heavier wooden base designed to move around freely. Operational techniques of plough also differ across the country, generally guided by altitudinal variations and the field sizes.

**(i) Paauo Candy**

Lapsi, Emili, Swetener and other ingredients

**(j) Nanglo, Dhoko, Pyang, Furniture, Fan, etc.**

A common household simple device used for wean out foreign materials from cereal, etc.

*Raw Materials:*

- Bamboo
- Ropes
- Nigalo

**(k) Pustakari, Chaku, etc.**

A sweet and delicious preparation added with ingredients to boost energy level of a person.

**(l) Clay vessels/ceramics**

Gamala, Kataro, Peski etc.

**(m) Thanka**

**(n) Mukundo**

**(o) Sukul,**

## Conclusion

Once upon a time indigenous technology flourished almost every part of the country and the society managed to fulfill basic needs by harnessing locally available materials made with the help of self made simple tools and machinery. Survival of the indigenous/ traditional technology severely challenged by the modern technology with time resulting in harsher impact on commerce and trade of the former. Some older production units still survive here and there, but they can not rely and retain prototypical format anymore.

The modern technology has great advantage over the former prototypes. Large scale production by modern machines and easier market accessibility has globalised the brands of consumer goods. Surviving indigenous technology and trends are no more cent percent indigenous. Rather, a term appropriate has been coupled with technology and promoted to a good effect by various agencies in both the government and private sectors. We noticed enterpreuners associated with indigenous technology have upgraded their installations by addition of electrical devices like motor etc to do the manual works.

There is a further need of research in order to retain the character of the products while reformatting the old indigenous technology into more and more appropriate enterprises.

Ministry of Industry of Government of Nepal should have a comprehensive plan perspective for the conservation of technologies which have been a heritage value and a part of the life cycle for many generations

Small and Medium Industry Development Committee, a government agency and Research Centre for Applied Science & Technology (RECAST), under the Tribhuvan University are two premier organization, have been conducting research to disseminate the technology with added advancement. We have found that some rural indigenous technology are still surviving in peripheral Kathmandu valley and have a very limited production. Most of industries producing reputed and costly items are concentrated in the valley townships, Kathmandu, Lalitpur and Bhaktapur . Lalitpur is a high seat for metal works, beautiful idols and statues are made in plenty, wood carving are also famous here, traditional artistic wooden doors, windows etc. have a flourishing trade.

We intended to include indigenous technology used in ayurvedic preparations, and we visited Singh Durbar Baidyakhana, the most prominent place with regard to production of such drugs. However, on expert advise we concluded that the subject need to be addressed comprehensively and independently. Faculty of Technology has conducted study on this indigenous health protocol on participatory basis involving ayurvedic practitioners. The faculty may further formulate strategies to provide necessary support in order to strengthen this sector. Ayurvedic traditional healthcare in Nepal continues to serve a large section of society, thus this inherited knowledge deserve an uniform and transparent code to uplift its accountability.

Indigenous technology of every region of the country should be comprehensively documented and present status be evaluated to assess the feasibility. The task be completed patiently by a group of professionals, and on the basis of recommendations of the task force an adaptive and protective master plan should be incorporated by the Government of Nepal.

## Annex

**I. IT Working Group Recomendations(One of the 13 subject committees,Science Academy), 1983**

13 subject committees was formed by NAST to evaluate the state and status of science & technology and concerning subjects in 1983 A.D. to recommend action plans to reform and strengthen the subjects for the development of the country. Recommendations made at that time are still relevant, thus some of measures suggested to be promulgated by the government of Nepal are reproduced here, in the sixth five year plan of the country, restoration of indigenous technology through proper perspective plan was included categorically, and this sector seeks a determined protective patronage from government of Nepal to give it a lease of life, some important actions have been recommended strongly are mentioned here,

1. To prepare the inventory of indigenous technology and to document them
2. To identify the research areas for improvement
3. To study the socio economic aspects of such technologies
4. To preserve identity of all traditional technology
5. To evaluate the degree of scientific wisdom associated with indigenous/ traditional technology
6. To strategize economic development by the country by the application of improvement of the existing technology i.e. appropriate technology
7. To prepare 'who is who' in this sector

The report incorporated integrated action plans for the revival of indigenous technology, some of them are implemented by some agencies in government and other sectors. Some of indigenous/traditional technology may have retained its original technology, but most of them have upgraded the traditional technology for the sake of survival. One most important recommendation or action plan of the report prepared almost three decades ago is to establish Live Indigenous Technology Village (LITECH VILLA) at a suitable site to demonstrate the indigenous technology in the original format. The site will be attracting internal and foreign observers and provide them a chance to be familiar with the lifestyle and the ingenuity of the older generation. In this way, older technology can be sustained at some of the major places of the country. This strategy would also help in retention of regional and ethnic indigenous technology, and such villages would create employment opportunity for the skilled entrepreneurs. Thus, a comprehensive action plan is required to rein in the setbacks and also explore the ways to sustain indigenous technology of Nepal.

Nepal Academy of Science & Technology(NAST) should incorporate IT's of the country in its activities and continue the previously conducted programmes in this regard.

**II(A) List of Some Common Indigenous Technology Based Enterprises in Kathmandu Valley**

| S.N. | Particulars | Place | Organization/Institution | Contact Person | Contact Number |
|---|---|---|---|---|---|
| 1. | Phalame Khal | Singhdurbar | Singhdurbar Vaidyakhana | Surya Giri | |
| 2. | Taan | Lubhu, Lalitpur | | | |
| 3. | Charkha | Lubhu, Lalitpur | | | |
| 4. | Khuwa | Pharping | | Santosh Bastola | 014710335 |
| 5. | Bala/Aauthi | Khokana | | - | - |
| 6. | Kolu/Oil | Khokana | | | |
| 7. | Murtima Butta kudne | Khokana | | | |
| 8. | Okhal | Kirtipur | Newa Civilization/Lahana | Rajman Maharjan | |
| 9. | Jato | Kirtipur | Newa Civilization/Lahana | Rajman Maharjan | |
| 10. | Dhiki | Kirtipur | Newa Civilization/Lahana | Rajman Maharjan | |
| 11. | Sukul | Kirtipur | Newa Civilization/Lahana | Rajman Maharjan | |
| 12. | Masala | Kirtipur | Newa Civilization/Lahana | Rajman Maharjan | |
| 13. | Achar | Anamnagar | Sahara Khadya Udyog | Indira Sapkota | 014417182 |
| 14. | Phalamko Hatiyar | Dakchinkali | | Harka B. Kami | |
| 15. | Jaand | Kirtipur | | Rajman Maharjan | |
| 16. | Wood Carving | PID, Lalitpur | Purna Wood Carving | Shanta Ratna Shakya | 015522232 |
| 17. | Bet ko Furniture | Satdobato, Sichahiti | Lumbini Bet Baas Furniture | Krishna Bdr. BK | 9849189012 |
| 18. | Stone Carving | Satdobato, Sichahiti | Stone Carving | Siddhiraj Bajracharya | 9851034572 |
| 19. | Doko | Chittpol, Bhaktapur | | Nandalal Nagarkoti | |
| 20. | Paauo | Sanga, Bhaktapur | Everest Paau Udhog | Sanjay Shrestha | 9841422030 |
| 21. | Candy | Sanga, Bhaktpur | Everest Paau Udyog | Sanjay Shrestha | 9841422030 |
| 22. | Kucho | Panauti, Kavre | | Maila Lama | 9849181604 |
| 23. | Paani Ghatta | Panauti, Kavre | | Renu Rai | |
| 24. | Khukuri | PID, Lalitpur | Khukuri House | Saroj Lama | 012222616 |
| 25. | Pyang | Pyang Gaon, Chapagau | Pyang Gaon Samrakchan Samitee | Rajitra Maharjan | 9849192526 |
| 26. | Nanglo | Badikhel, lalitpur | | Bikaram Pahari | 9808109725 |
| 27. | Pustakari Udyog | Thecho, Lalitpur | Bhailal Food Industries | Bhailal Maharjan | 015570529 |

| | | | | | |
|---|---|---|---|---|---|
| 28. | Bambo Fan | Badikhel, Lalitpur | | Ram Krishan Nagarkoti | 9843477583 |
| 29. | Chaku udyog | Thaiba, Lalitpur | | Hari Bahadur Shrestha | 9841319293 |
| 30. | Topi | Thaiba, Lalitpur | | Laxmi Maharjan | 9808558966 |
| 31. | Clay Vessels | Thimi, Bhaktapur | | Dev Bhakta Prajapati | |
| 32. | Dahi Udyog | Bhaktpur | Sainju juju Dhau Bhandar | Sabitri Sainju | 016616900 |
| 33. | Thanka | Dattatreya, Bhaktapur | Unique Thanka | Shubharaj Lama | 9849129058 |
| 34. | Ceramic | Thimi, Bhaktapur | Krishna Art Ceramic | Praphulla Prajapati | 9808176975 |
| 35. | Mask(mukundo) | Thimi, Bhaktpur | Madhyapur Mask Making | Shomraj Tamang | 9841371454 |
| 36. | Dhaka Taan | Kusunti, Lalitpur | | Devmaya Limbhu | 9803250309 |
| 37. | Koseli Shoe | Kathmandu | | | 014356711 |

## II(B) Name of Organisations Visited to Collect Relevant Materials:

1. RECAST, TU, Kirtipur
2. AEPC, Khumaltar, Lalitpur
3. Department of Small and Cottage Industry, Tripureshwor, Kathmandu
4. Federation of Nepalese Chamber of Commerce and Industry, Teku, Kathmandu
5. Department of Industry, Tripureshwor, Kathmandu
6. Pesticide Registration Office, Hariharbhawan, Lalitpur
7. National Museum, Chauni, Kathmandu
8. Heritage Nepal, Bhadrakali, Kathmandu
9. Federation of Nepalese Handicraft, Maitighar, Kathmandu
10. Federation of Nepal Cottage and Small Industries, Maitighar
11. Center for Rural Technology, Jawalakhel, Lalitpur
12. Nepal Agricultural Research Center, Khumaltar, Lalitpur
13. IDE Nepal, Pulchok, Lalitpur
14. Department of Food Technology and Quality Control, Babarmahal, Kathmandu
15. Exhibition of World Environment Day, Kamladi, Kathmandu
16. National Library, Harihar, Bhavan
17. Keshar Mahal Library, Thamel
18. Central Library, T. U., Kirtipur
19. NAST Library, Khumaltar

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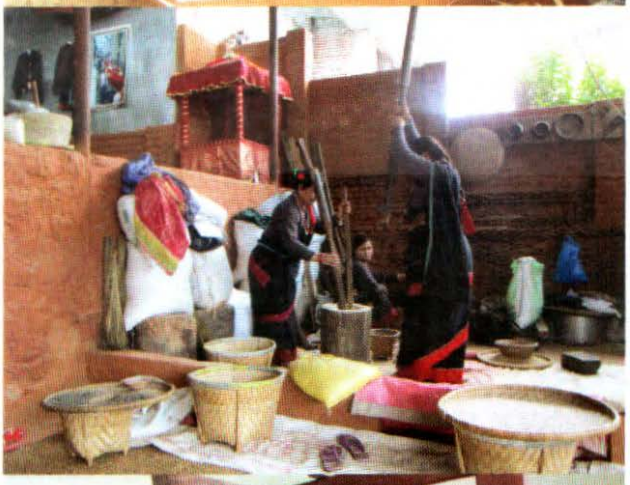
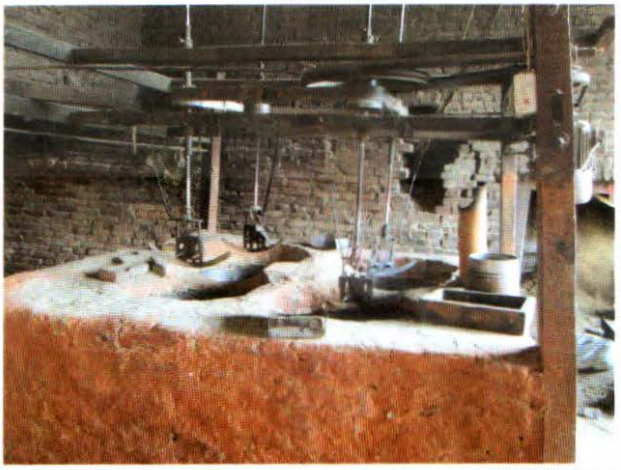
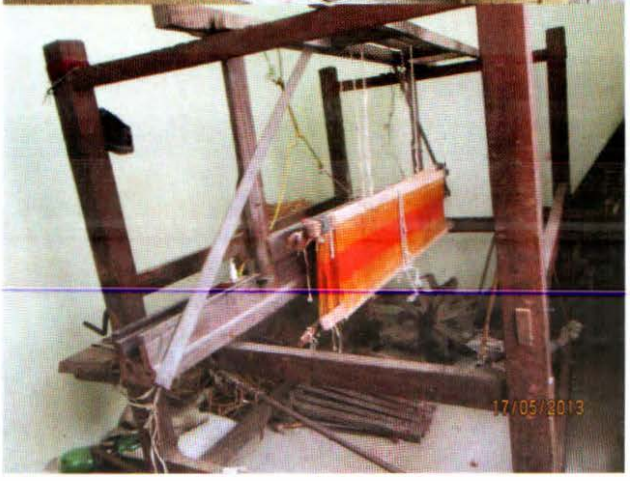
4. Indigenous technology knowledge in Nepal. A review Subodh Sharma, Kushan Bajracharya and Bishal Sitaula 2009. Indian Journal of Traditional Knowledge Vol 8(4), October 2009, pp. 569-576.
5. Hamro Panighatta Year 9, Issue 4, January 2013. Newsletter of improved water mill support programme centre for Rural Technology, Nepal (CRT/N).
6. Annual Report 2012, Centre for Rural Technology, Nepal (CRT/N)
7. Handmade paper and Paper Products: http:/www.nepaltrade.org/node/661
8. Inventory of Appropriate Technologies Used by Micro and Small Enterprise in Nepal: Ministry of Environment, Science and Technology: Research Centre for Applied Science and Technology(RECAST), T.U., Kirtipur



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