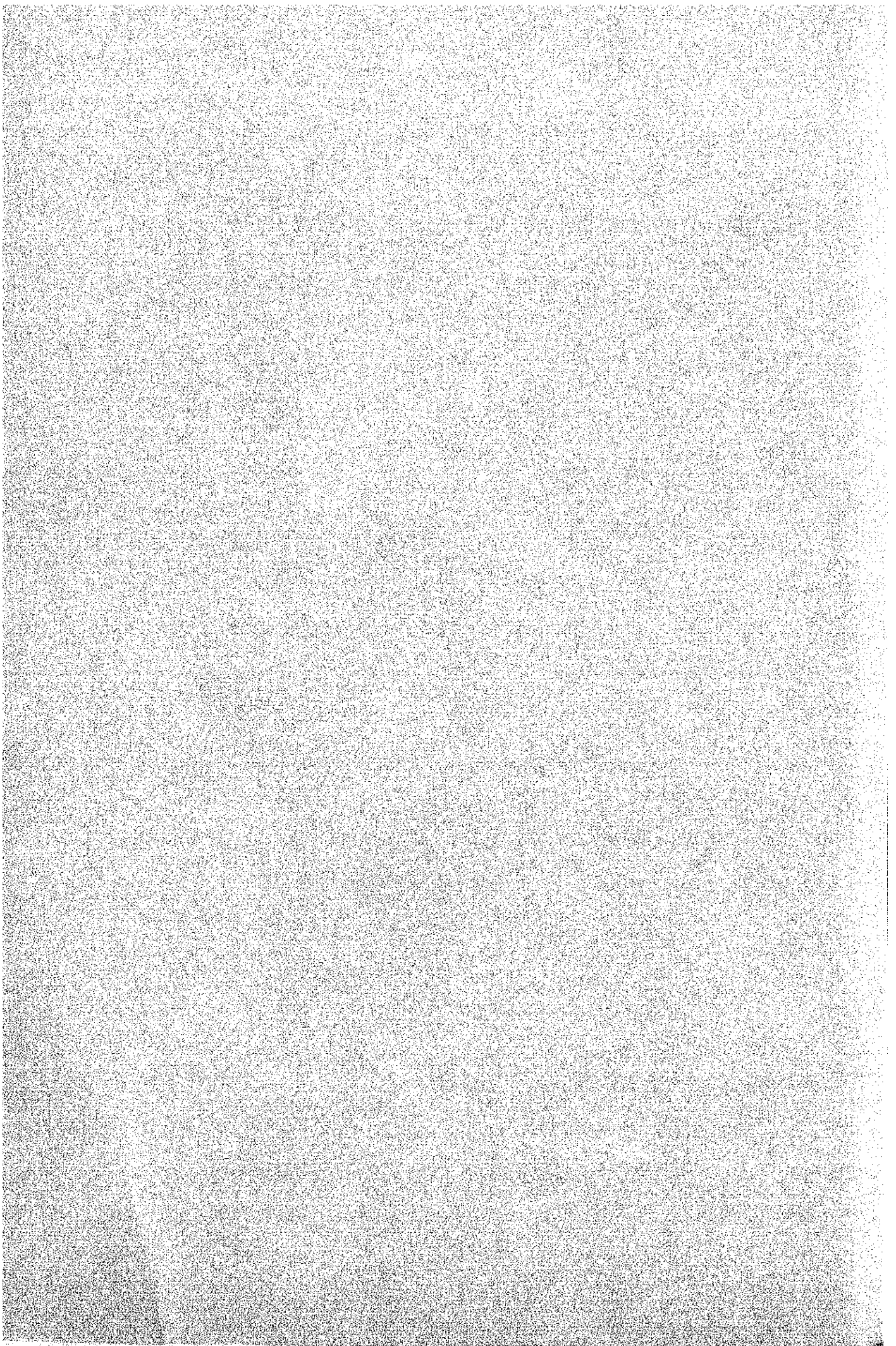


Appendix I Technical Report on Soil and Fertilizer



Appendix I Technical Report on Soil and Fertilizer

1. Summary
 - 1) Topography and the Formation of Rocks and Soil
 - 2) Technical Measures for Production Increase
 - 3) Utilization and Improvement of Local Conditions

2. Soil and Fertility Preservation in Hill Area (Long-range Plan)
 - 1) Gully Erosion
 - 2) Reforest from Mountain Top Down
 - 3) Problems about the Terrace

Reference Material

1. Summary

This survey mainly purported to determine the characteristics of local topography, soil and water and plan necessary productive measures in order to increase the possibility of stepping up agricultural production in the Hill Area. But to gain an overall picture of the formation and characteristics of the soil, we included Terai besides the Hill Area and considered rice cultivation, too, as one of our targets. Generally, the Hill Area comprises the Mahabharat Mountains and the highland in the Lower Himalayas (mountain foot) and ranges in altitude from 750 m to 4,000 m (Rockefeller Foundation team). We made an assessment of the formation, distribution and characteristics of soil by adding helicopter survey to survey based on geological maps and topographical and other data.

1) Topography and the Formation of Rocks and Soil

Here, the Great Himalayas rising more than 8,000 m lie in the north and, with steep slopes, turn into the mountain foot, namely, the Lower Himalayas where they are thwarted by the 2,000m-class Mahabharat Mountains. The part south of these mountains is said to have formerly been Terai lying on the extension of the Ganges Plains but the Siwalik Hills reportedly resulted from an upheaval, bringing about the present topography. In other words, this area is divided into three parts by the Mahabharat Mountains and the Siwalik Hills.

First, the Himalayan mountain foot comprises steep mountains. There is some seemingly level ground where these mountains about on the Mahabharat Mountains and the Sunkoshi River flows to the southeast, forming a deep valley. Between the Mahabharat Mountains and the Siwalik Hills lies the Sinduli Platform which may be rather regarded as a basin and the Kamala River, like the Sunkoshi River, also flows in the southeastern direction, forming a deep valley. Thus, the local topographical series is generally as follows: Steeply sloped high-altitude mountain foot → platform - gently sloped hills - Terai.

The main component rocks are granite and gneiss in many places. This tendency seems to be strong throughout the entire area though limestone intervenes somewhere. These rocks become sandy, silica-abounding soil through weathering. This soil contains many pieces of mica. It seems that, when this is washed by rain water, the weathered part (feldspar) goes down to become sandy soil and is acid where no limestone mingles in.

Such being the case, the Sindhuli Platform is believed to be geologically somewhat favourable but, in Terai, lime has accumulated to present neutral-alkali reaction and the soil is detrital in proportion to proximity to the hills and, toward the level lower reaches, it contains an increasing amount of fine sand and clay.

2) Technical Measures for Production Increase

It seems to be difficult for farmers to increase their cultivated areas for the purpose of increasing their food self-sufficiency. So, they must first try to increase their yield per unit area. Yet, using more water even in Terai - not to speak of the mountainous terrain - than now seems to be difficult and the introduction of fertilizer, agricultural chemicals and farming machines also seems to be extremely difficult for economic and technical reasons. After all, it is realistic to depend on the use of coarse organic matter, such as crop residues, which can be increased by the farmers' own efforts. (These may be plowed into the field as raw material or first turned into compost.) It is necessary to increase thereby the available moisture and nitrogen content of soil, that is to say, improve the fertility of soil.

1 In the Hill Area, part of the wheat/barley straws, corn stalks and other coarse organic matter produced in the field is used as feed for livestock which is traditionally important to the life of the local people, part of them is used as fuel necessary for their daily life and only a small part is returned to the field to fertilize it. This, along with the properties of the soil, seems to cause the low productivity of the soil. The competitiveness among these three factors pertains not only to the cultivated fields but also the mountain forests. Degradation seems to be occurring due to the collection of fodder for overgrazed cattle, the thinning of forests by the production of firewood and the eating of undergrowth by goats. This impression was all the deeper because it was gained in a survey conducted during the dry season. Many had pointed out erosion in the Hill Area but we were not able to understand it thoroughly, probably because of the survey time.

2 This degradation of forests must be improved as a long-range plan but effective control and guidance by the national government for a considerable length of time is, of course, necessary for this purpose. We saw that active afforestation will protect forests from strong wind and rain and help to prevent their erosion to some extent and their soil moisture will increase due to fallen leaves (mulch-effects) and that, if utilized systematically, they will be able to maintain their productivity for a long period. Of course, planting walnut and fruit trees besides fodder trees may make life easier for the farmers. We may propose that this be the starting point in increasing the productivity of cultivated fields.

3 In Tarai, rice and wheat/barley or corn are grown and there are also fruit trees but rice cultivation is central and the production of this cereal seems to be high by the standard of this area because of clay soil. Aside from compost, fresh straw may be worth trying. Increasing plowing depth and improving water percolation are necessary to increase production but both problems are considered difficult to solve.

Since the soil in this area is alkaline, irrigation water containing little base must be kept running to minimize the harmful effect of this soil. More than the present amount of irrigation water is necessary to lower the groundwater table and thereby prevent the rise of alkali. This possibility depends on the extent to which economy by the increase of water and the increase of production per unit area can be expected.

It is advisable to increase the use of water and fertility to make the alternate utilization of paddy field upland field but one will do well to lower the groundwater table first and cause the alkali content to sink to a low layer. At present, the alkaline reaction is so strong that micronutrient shortage occurs everywhere. The elimination of alkaline content must be born in mind, taking countermeasures against this into consideration.

3) Utilization and Improvement of Local Conditions

It is interesting how topography is related to the present local conditions of cereals in general, root crops, fruit trees and stock raising and we feel that these conditions are, to some extent, reasonable from the view-points of not only production but also distribution. Particularly, increased fruit production is desirable because fruit trees are a direct source for cash income. However, the fruits lack a market, their freshness counts and their transport and distribution involve difficulties because they are juicy.

At any rate, Nepal's climatical, topographical and geological conditions have greatly made the development retarded. If its climate and soil were the same and its terrain were level, the nation's production would be quite different and have many possibilities. More water would be available and fertilizer could be transported more easily. In other words, the improvement of roads potentially could cause drastic changes to these situations.

But under the present circumstances, this is probably infeasible because of the great cost involved. So, it is to be hoped that the nation will be able to develop high productivity in each of its production branches by increasing the fertility of its soil and taking advantage of its climatic and topographical features.

2. Soil and Fertility Preservation in Hill Area
(Long-range Plan)

There are great many problems that make it extremely difficult under the prevailing soil conditions to increase the productivity of crops and improve the self-sufficiency of each district. Therefore, reformation must be planned under the following three conditions:

- 1 Not to change the customs of farmers hastily.
(Survey records by Japanese experts.)
- 2 To provide rather simple techniques that the farmers can effectively use if they try to. (Same source as above)
- 3 To organize a technical system with a view to achieving maximum profit (income per unit area) by investing minimum cash and putting in maximum management. (Report by Rockefeller Foundation)

But even this has many bottlenecks and cannot be easily realized. Since, however, something must be done about it, it is necessary:

- 4 To take actions in the order of request and feasibility and do the ground work for what is believed certain to develop in the future. (Survey records by Japanese experts.)

Thus, work is already being performed in the irrigable Terai paddy field area (which is one of the survey targets) where the maintenance of production is easy and the problem of securing water has begun to be studied.

1) Gully Erosion

Erosion has been specially noted since the past. Our helicopter survey showed that only the southern slopes heavily affected by monsoon rain - particularly, steep slopes - are eroded and we could not find so many eroded slopes as generally reported. Of course, we are aware that erosion differs with the times of survey and the directions of slopes (whether they face south or north), that no terraced farms are formed on the eroded surface and that farmers quickly repair eroded parts and the place appears as if nothing had happened there. We realized that no serious erosion can be seen in the Terrace including these.

Such being the case, the forests have become thin through felling, land reclamation has been carried too far, the slopes are unprotected and, for this reason, sandy soil containing coarse grains of weathered granite is washed away in great quantities. In other words, practically nothing is being done by way of land preservation. This is, indeed, a problem. (Survey records by Japanese experts)

2) Reforest from Mountain Top Down

The second problem concerns the competition of coarse organic matter necessary to improve soil fertility (productivity) - particularly the competition with the over-grazing of livestock and the fuel on both of which the lives of the farmers depend. It is considered, therefore, that it will be imperative in the future to supply sufficient fodder for livestock, provide farmers with places from which they can cut trees for fuel and, if possible, plant fruit trees around dwelling houses.

At present, trees are cut from nearby mountains, leaving the forests sparse, shrubby and steadily devastated, and the excessive cattle and sheep ruin the area under the remaining trees. So, it is important freshly to plant trees including fodder trees and prevent their random cutting by strong control and effective guidance until they attain full growth. And thus a fresh plantation must be realized from the mountain top all way down.

This requires considerable time and patient guidance. But the acquisition of firewood and charcoal wood will become possible through this improved plantation reaching to the mountain top, livestock will multiply through the increase of fodder supply, thereby making an increased amount of milk available. The number of livestock should be in proportion to the production of grass and we considered trees and their underbrush as sources of this fodder. We believe that, in this manner, it will be possible for coarse organic matter from the farm to be used with cattle excrements as manure for the farm.

With this reforestation, the supply of fallen leaves and edible wild plants will increase and it will be possible to store more rain water underground than ever. Furthermore, trees covering the ground will alleviate the impact of downpour, thus minimizing the wash-away of not only fallen leaves but also dirt and reducing erosion after all. Besides, fruit trees will not only produce fruit for the farmers and their families to relish but, if conveniently located, they will also bring them cash income. Thus water will become abundantly available throughout the mountain, eventually restoring production and life for the local people.

3) Problems about the Terrace

In Nepal where flatlands are scarce, terraced farms are constructed on mountain slopes to expand cultivated areas and the terraces reach all the way up to the mountain top. The maximum gradient of cultivated slopes is about 30°. If erosion repeatedly occurs there, either improvement was made on terracing methods of the past or terracing itself was denied there. Since terraced farms have thus been used for a long time, the farmers must have devised something reasonable for themselves.

Some of the water infiltrating from the level surface of the farm evaporates from the sidewall of the terrace. It seems that, at this time, potassium and lime are deposited on the side, thus contributing to the hardening and pH rise of the side soil and that the underground temperature falls through the evaporation.

It is said that there is the custom of taking off weeds growing on the sidewall and using them as manure for the farm below. The reasoning is that this is done because terrace sides contain much base and fairly fertile, thus facilitating the spread of roots. However, except for special instances where pH of soil is low but the % of weeds is high, perhaps it is just that these farmers do this out of the principle of using fresh grass as manure. This must be determined through further investigation but the case may be that they expose a new surface by scraping weeds and fertilize the sandy soil which is almost without coarse organic matter. From the meaning of soil fertilization, one will do well to consider actively introducing pasture plants (Nepier grass, Japanese bush clover (*Lespedeza bicolor*) and vines, as named by experts) for terrace sidewalls. Some tall grass at the edge of the upper terrace can reinforce the terrace farm as they spread their roots and, if they are occasionally cut and turned into compost underground, they will help to fertilize the soil and collect water for it. Such fresh organic matter as this contains much water and becomes alkaline through decomposition. So, it may serve to neutralize the soil.

1. Rain water
2. Infiltration
3. Deposition of CaCO_3 , MgCO_3 , etc.
4. Evaporation
5. Fall of underground temperature
6. Sidewall
7. Turning into compost underground
8. Holding of water
9. Fall of pH
10. Increase of putrefaction
11. Grass on sidewall
12. Fall of soil fertility

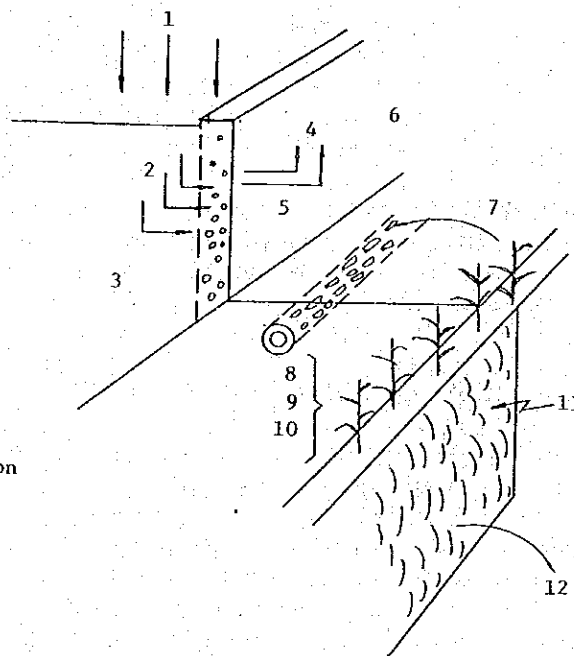
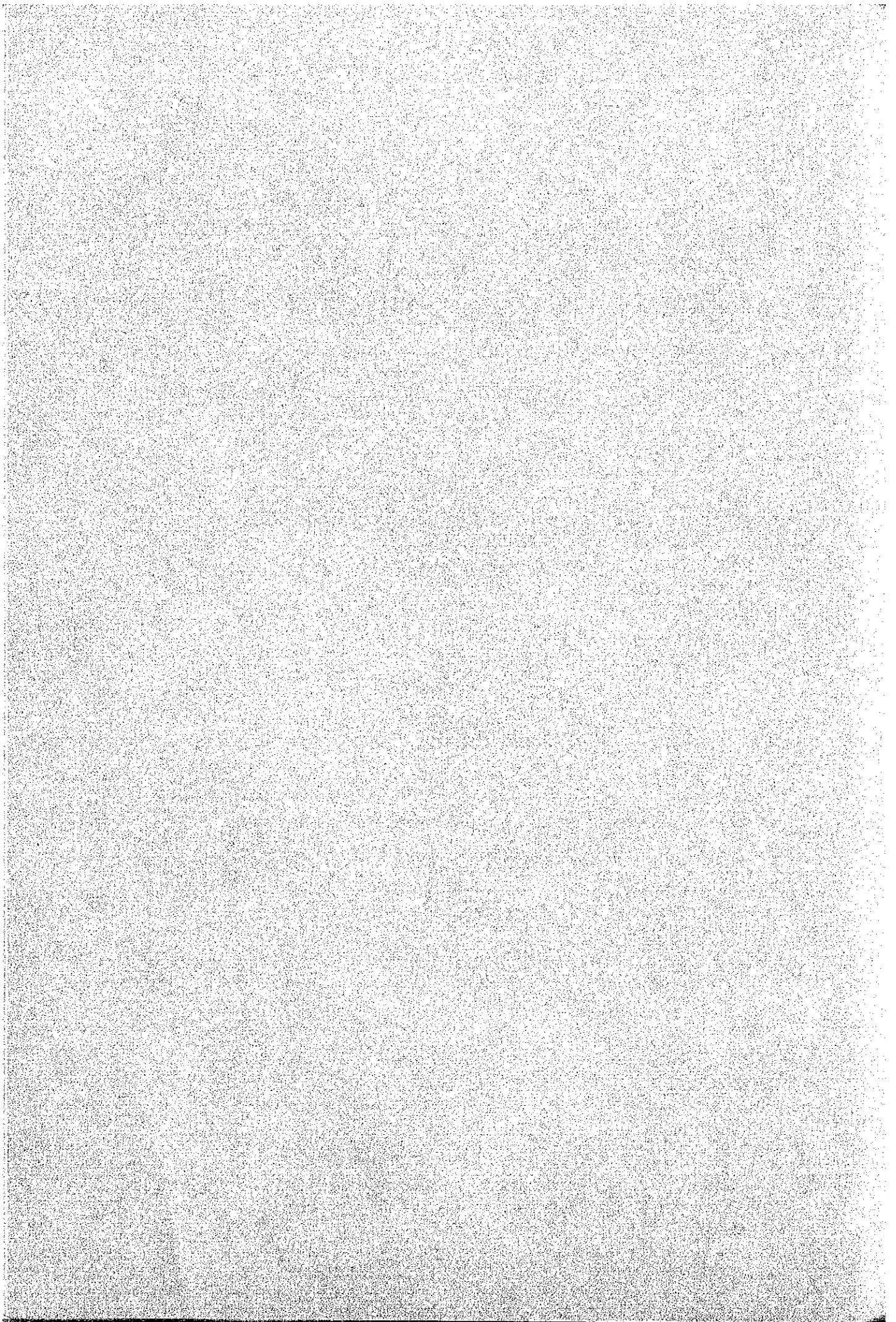


Fig. 9 Behavior of Nutrinents and Water in a Terrace

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Appendix II Technical Report on Animal Production



Appendix II Technical Report on Animal Production

1. General Discussion Concerning Hill Agriculture
 - 1) Definition of Hill Agriculture and Problems
 - 2) Importance of Forests (and Natural Grasslands)
 - 3) Number of Livestock Considered Suitable from Feed Supply System - Particularly Relations between Number of Ruminant Animals and Forest Ecosystem -
2. Present State of Livestock in Hill Agriculture
 - 1) Livestock and Domestic Fowls
 - 2) Procurement of Feeds
 - 3) Feeding and Management
 - 4) Livestock Hygiene
3. Measures for Developing Hill Agriculture
 - 1) Restoration and Preservation of Forests (and Natural Grasslands)
 - 2) Measures for Livestock
4. Measures to be Taken by Individual Farmers and Administrative Organizations to Achieve Steady Development of Hill Agriculture (with Respect, Particularly, to Livestock)
 - 1) Individual Farmer
 - 2) Panchayat
 - 3) District
 - 4) Zone and Government of Kingdom

Reference Material

1. General Discussion Concerning Hill Agriculture

The two districts of Sindhuli and Ramechhap included in the target area of our survey occupy 40% of the entire Janakpur Zone but account for only 24% of the zone's population as they are rather sparsely populated by the zone's standard. The altitudes in the target area range from 400 m to 3,000 m. The terrain is very steep, as a whole, sizable flatlands and slopes exist only in a few places, such as the Sindhuli Basin. The local climate ranges from the tropical to the cold temperate. Five months of the year are rainy and the remaining seven are dry. There are no important industries except agriculture and 98.6% of the population engage in agriculture or forestry. The rate of cultivated land is only 6.7% and the per-farmer cultivated area is 0.5 ha. but, according to a JADP survey, the utilization rate of cultivated land is as high as about 150%. The staple crops are maize (corn), rice, wheat, finger millet (*Eleusine coracana* Gaertn.) and potatoes. As livestock, cattle, water buffaloes, goats and sheep are raised in numbers that are out of proportion to the area of cultivated land. Few roads are motorable and goods are transported exclusively on the human back. In this report, we shall refer to the local agriculture as hill agriculture.

The author's assignment is to orient stock farming (which it would be more appropriate to call livestock element, as described later) in conjunction with the development of hill agriculture. But before entering into the detailed discussion of livestock, I must characterize hill agriculture and clearly define the role to be played in it by livestock. We shall, therefore, first generally discuss what hill agriculture is in light of past JADP reports, related documents and the results of our recent survey.

1) Definition of Hill Agriculture and Problems

Hill agriculture is a self-sufficient agricultural system based on the local topography, geology and climate and into which the farmers' traditional system for culturing food grains and beans and the system for raising livestock fed on their straw, stalks and broken grains and the fodder obtained from the nearby forests (and natural grasslands) are closely interwoven together. And the production by the combination of these elements seems to have already been perfected in its own way.

In this hill agriculture, cattle provide motive power in farm work, give milk and produce manure while water buffaloes mainly give milk and also meat and produce manure. Livestock in hill agriculture supply people with protein of superior quality, fat-soluble vitamins and minerals as well as some calories, thereby making them mutually supplementary with the miscellaneous cereals which are the main source of necessary calories and completing the local food system. Therefore, livestock in the Hill Area are important for the existence of local inhabitants.

Similarly, forests (including natural grasslands) are important for stock raising in that they complete the feed system by providing the superior protein (nitrogen) of tree leaves as a supplement to such roughages as straw and stalks when feeds are short during the dry season. Thus, fodder trees and grass are to livestock what animal products are to man; they are important for the existence of the livestock.

Theoretically, hill agriculture may be divided into the subsystems of soil, plants (crops and forests) and livestock but there is no point in discussing each subsystem singly. It would be better to think that there is hill agriculture but not crops, stock farming or forestry that functions independently.

2) Importance of Forests (and Natural Grasslands)

Generally, forests are important in connection with the supply of firewood and charcoal, headwater conservancy and land protection and are usually outside the agricultural system in the narrow sense. But in this particular area they are also decisively important as a source of feeds for livestock and completely incorporated into the system of hill agriculture.

The forest ecosystem has already been destroyed by the excessive collection from fodder trees everywhere that is close to a village or anywhere in the recesses that people can reach for this purpose. Thus large tracts of devastated forestland can be spotted from the helicopter. Excessive collection from fodder trees causes the dearth of forest trees of the next generation. And the loose keeping (hanashigai in Japanese) of livestock ruins local vegetation.

In Nepal, the preservation of forests means the lasting supply of feeds. To harmonize the collection from fodder trees with the preservation of forests, forests can be restored by planting trees forming the forest ecosystem because, fortunately, these specifically agree with the fodder trees.

Fodder production and the achievement of shading effect by means of imported "fodder trees" may be possible in villages and around farms but this will be of only secondary importance after all.

3) Number of Livestock Considered Suitable from Feed Supply System - Particularly Relations between Number of Ruminant Animals and Forest Ecosystem -

Some Nepalese experts argue that, in the Kingdom of Nepal as a whole, there are too many unproductive ruminant livestock in view of the amount of feeds that can be supplied. The suitable number of livestock may be determined by either of the following two methods:

1. determining the number at the national level by considering the state of utilization of livestock in view of the number of farming families, the total area of cultivated lands, crops and the area of forests and natural grasslands and 2. determining the suitable number for the farming unit in view of the state of utilization of livestock at the family level and the state of the family's procurement of feeds.

(1) National Total of Ruminant Livestock

According to K.K. Panday, the Kingdom in 1969 had 6,226,000 head of cattle (3,198,000 females and 3,028,000 males), 3,482,000 water buffaloes (2,977,000 females and 505,000 males), 2,108,000 sheep and 2,241,000 goats. The cow's milk production amounted to 185,000 tons and the production of the water buffalo's milk amounted to 229,000 tons. Meat production from male water buffaloes was 24,100 tons and meat production from sheep and goats was 3,000 tons each. Panday analyzes that 14 million head as the total number of ruminant livestock is excessive in light of the feed production in this country.

He estimates that, of the 3,028,000 bulls (or bullocks), 750,000 are economically useless as they are not directly used as draft cattle. This estimate presupposes that a pair of bullocks tills three ha. and is used jointly by two farming families. Refuting the frequent justification of the possession of an excessive number of cattle as an effort to produce manure, Panday explains that it is more logical to return the plant body itself to land than to return organic matter to land as manure.

He points out that the Nepalese form a vicious cycle of population increase → increase of cultivated lands → increase of the number of livestock → destruction of the ecosystem by possessing unproductive livestock in spite of the shortage of feeds. One cannot but agree to this analysis in the long run. But here one must carefully note what is stated in Appendix 1 about the breeding efficiency of large livestock.

In the future when the improvement of livestock progresses and the farmers' consciousness changes, it will be possible to decrease the number of livestock and, at the same time, keep up or even improve productivity (national total livestock production).

(2) Analysis at Farmer Level in Hill Agriculture

Data gained by the JADP Mountain Agriculture Development Planning Team in its house-to-house survey on farmers in the two districts of Sindhuli and Ramechhap indicate that

- 1 there is one bullock for every 0.891 ha. and, since two work as a pair, one pair is possessed for every 1.782 ha.
- and 2 there is one cow for every 0.743 ha.; thus 3 there is one adult for every 0.405 ha. (pooling 1 and 2).
- 4 There is one male water buffalo for every 4.455 ha. and
- 5 there is one female water buffalo for every 2.32 ha.

One pair of draft cattle for every 1.78 ha. by the JADP survey is considerably more than what is proposed by Panday. At the farmer level it is difficult to estimate the area (ha.) a pair of bullocks can till and the number of farming families that can jointly use it. Because it involves complicated physical, biological and social factors including the tractive force of cattle, the traction resistance of farming implements, facts about the peak of farm work, the relations between the shape of farms and work efficiency, practices of farm work including the joint use of draft cattle, and the farmer's concept concerning the ownership of cattle.

For convenience' sake, let us assume as the immediate standard that a pair of draft cattle is used to till two ha. in the districts of Sindhuli and Ramechhap. The effective utilization of draft animals will advance in the future with the change of farmers' consciousness but this will take some time.

The area charge is one large animal for 0.30 ha. if it is determined by ignoring the feeds for young cattle, young water buffaloes, goats and sheep and the feeds necessary for the production of cow's milk and water buffalo milk, using the requirement of maintenance feeds as the basis and counting water buffaloes in terms of cattle and pooling them together. Let us next determine the state of annual feed procurement. Assuming that

- 1 the animals are mainly kept loose without feeding them during the five months that form the rainy season,
- 2 during the seven months forming the dry season, they are fed with straw and stalks from the farms as well as leaves from fodder trees in the forests and also kept loose (though the grazing capacity is small due to the poor growth of grass) and 3 crude feed equivalent to 3,000 kg (air-dried weight) of millet stalks for every hectare of farm can be obtained, the amount of fodder that can be procured from farms is 75% of the requirement in the dry season and the remaining 25% must be procured from fodder trees in the forests and loose keeping.

2. Present State of Livestock in Hill Agriculture

1) Livestock and Domestic Fowls

(1) Cattle

1 Species

Cattle in the Hill Area are *Bos indicus* (zebu), which is not strictly a breed. Rather, it would be appropriate to call them Hill cattle. They are small but the hump in the male is fairly developed though it is not so large as the hump in the Indian haryana breed. Even the female shows clear horn peaks. Their furs are basically black or dark brown (some with white spots) which distinguishes them from the white or grey cattle of Terai. With undeveloped breasts, they are of the draft type. Hill farmers seem to have no preference about fur color; this is convenient when planning breed improvement in the future.

One can observe that the forms and fur colors of cattle change continuously from the Terai Flatland to the Hill. Farmers settled at newly cleared places in the Terai forests can be inferred to hail from the Hill Area because their cattle are the Hill type.

2 Breeding

We were told in the Sindhuli Basin that the sexual maturing of the Hill cattle is late, as with cattle in general in Southeast Asia and South Asia, and the female does not have its first delivery until it is more than 40 months old. Farmers expect one delivery in two years after that. Generally, males seem to be owned only by very rich farmers or by panchayats but some are owned by ordinary farmers. The service fee for each successful conception is 10 to 20 rupees depending on the "grade" of the bull. There is no pedigree recording or systematic selection but they seem to select superior, strongly built bulls out of their experience. (This is especially the case with rich farmers and panchayats.) Ordinary farmers are primarily concerned about inseminating capacity itself. What they want is to improve the breeding rate for their group and do not qualitatively discriminate bulls. This attitude is a problem in breed improvement. Males provided for draft use are castrated at the age of three. Judging by the mass loose keeping seen in the upper reaches of the Rata Nadi and the Kamla Nadi, the castration of males seems to be strictly practised. There was one seed bull for every 20 or so adults.

3 Utilization

The butchering of cattle, holy animals in Hinduism, is banned by law.

Draft: Cattle are raised primarily for draft use. The farmers keep females to get these males and milk them. The males are castrated at the age of three and two bullocks of similar build are used for farming as a pair. They are reportedly used for eight to 10 years (cropping years); this means that they are used until they are $[(8 \sim 10) + 3]$ years old. Many are said to be used until they are 12 years old. Draft cattle are effectively used even on narrow terraced farms. The "plow" is tipped with a narrow iron piece and simply scratches the field; it cannot overturn soil. When selling draft cattle, they are marketed as pairs after a year of on-the-job training in farm work subsequently to their castration at the age of three. There are no oxcarts in the Hill Area, as in Terai. Nor is the carrying of goods on the backs of cattle in practice there. Cows are not used for a maximum of seven or eight deliveries and usually kept until the age of 12 or so.

Milk: According to the Benchmark cum Evaluation on JADP, there is no great difference between Terai and the Hill Area in the milk production by cows, which is said to be 324 kg in 180-day milking. Cow's milk is limited in amount and often mixed with water buffalo milk to make ghee.

Manure: The local manure consists of the mixture of feces and litter accumulated and thoroughly decomposed. Farmers are seen distributing compost over terraced farms in a regular gridiron pattern. Generally, no chemical fertilizers seem to be used. The manure probably is not as effective as it should be, because it is not applied to the ridges but simply scattered. Farmers traditionally understand the importance of manure; we frequently heard the explanation that they keep livestock to get manure.

(2) Water Buffaloes

1 Species

This area is on the boundary between the distribution of the swamp buffalo (for draft use) and the distribution of the river buffalo (for milking) and both types seem to exist there together.

River buffaloes, the milking type, are black or brown. Many are medium-sized and lack white spots on the brow, the tips of the limbs and the tail end. Generally, the breasts are not well-developed. There are various horn shapes continuously varying from small, well-rolled horns resembling those of the Murra type to fairly large triangular horns and one can imagine that considerable crossing with the Murra type took place in the past. According to a description by the Indian Conference on Agricultural Research (ICAR), there is a Terai type in Terai area, Uttar Pradesh, but photographic comparison seems to show that buffaloes with the traits of the Terai type are a minority in the Hill Area. (Rather, it may be more appropriate to consider the Terai type as one of the above-mentioned continuous varieties.)

Swamp buffaloes have furs of light brown and carry white sock-like spots in the lower parts of their limbs. Their skin in the axilla and the inside of the thigh is pink. There are new-moon figures on the neck and the chest. Some have thick, large horns extending sideway upward.

At Nepal Tok, river buffaloes, swamp buffaloes and the intermediate type mix together in a group. This indicates that they cross indiscriminately.

As seen above, the body variation of water buffaloes in the Hill Area is so wide that one cannot clearly identify a dominant species or type. Tentative milking may reveal that milk production greatly differs by varieties. We confirmed that, in part of the Hill Area, swamp buffaloes are not milked. But generally, river buffaloes and the type intermediate between the river type and the swamp type are kept mainly for the purpose of milking. This situation clearly requires urgent improvement.

2 Breeding

The symptoms of estrus are generally unclear in water buffaloes, compared with cattle. This is a problem in the mating of water buffaloes. In this area, they give milk better than cows but, considering calf taking and milk yield after that, more difficulty is involved with water buffaloes than with cows. It seems that, in part of this area, they practise keeping water buffaloes in the manner of single litter milking. Seed males of water buffaloes are larger and more violent than males of cattle; they are, therefore, kept only by rich farmers and panchayats.

The number of males in a group is smaller, compared with cattle. In the national statistics the ratio is; 1 male va. 6 females. Farmers usually expect one delivery in two years.

3 Utilization

Water buffaloes are used first to get milk and next to sell young males for meat and produce manure. They are not religiously restricted, as cattle are. So, they are completely qualified as livestock and economically valuable.

Milk: As we heard in the Sindhuli Basin, water buffaloes each produce 1.75 ~ 3.50ℓ a day and are milked all the year round. They are milked twice for the first six months and once for the next six. Farmers prefer those with large absolute milk yields and do not mind if they grow large. Rather, they like large ones because they produce much manure. According to government data, milk output in the Hill Area of Janakpur Zone is 600ℓ in 300 days while that in the Terai Plain of the same zone is 750ℓ.

Manufacture of ghee: Milk (water buffalo milk or the mixture of cow's milk and water buffalo milk) is boiled and left to cool. Then, it is fermented for 24 hours in a wooden pot carrying yeast. When fermented, it is moved into a pot designed for stirring. There, cream is separated by turning a four-vane rotary stirring rod with a rope. If there is much milk, it is placed in a long cylindrical bucket-shaped container and cream is separated from it by stirring it vertically with a stirring rod to which a disk is attached. Cream thus separated is sterilized by heating it in what looks like a frying pan and protein and other elements of the cream are removed, leaving what is known as ghee, which has increased preservability. Butter milk left after separating cream is used as a drink. It is somewhat sour. Everyday, the day's lot of milk is placed into the fermenting pot without washing it, thus enabling strains of lactic acid bacteria to be maintained. The fermented milk is consumed as dahi. When we tried butter milk and dahi, we liked the smell of the fermented milk very much. (We later had an opportunity to compare it with yogurt produced by a dairy plant at Hitohda and found it almost as good as the yogurt.) Many roadside tea shops keep boiled water buffalo milk in a pot to mix it with tea but it seems that the people are not in the habit of drinking it without boiling it.

Sale of young males for meat: Males are sold for meat after being castrated at the age of three. Water buffalo meat is important among the meat resources in this country. The way meat is produced in Nepal as a by-product of milk is essentially the same as in the dairy industry in advanced nations.

This difference between cattle and water buffaloes in the contribution to the economy and the difference between them in the reproductive and breeding characteristics (see IV-2-3) are noteworthy not only in the future of hill agriculture but also in the nation's agricultural development program. The positive improvement of Hill cattle may increase milk production but beef cannot be used as meat anyway.

(3) Pigs

Few farmers keep pigs. The native breed is black, has small ears and resemble the wild boar. The number of young in a litter is said to be large. Pigs are mainly kept loose, taking good advantage of their polyhagia.

In a depression in the Hill Area, we saw ADO-introduced Yorkshire (Large White breeding pigs) and their offspring. They were kept in a floored piggery in the back yard and the piglets were growing satisfactorily. Of course, they had not attained the full standard size of a select breed because their feeds were limited in both quantity and quality. Yet, these are said to be popular at the local market since they grow faster than the native breed and produce better meat. Pork pigs are presently used for consumption only in the Sindhuli Basin but said to bring considerable profit because they are scarce. This is so-called money-base pig farming and the farmers buy necessary feeds from others. The expansion of the market and the procurement of feeds will become problems in the future.

(4) Goats

Goats in the Hill Area, which are a small breed, are somewhat smaller than goats in Terai, which are also a small breed. These Hill goats grow more slowly than the Terai goats and the number of their young in a litter is small. So, local farmers think that they need improvement. However, the stock raising division of the agricultural experiment station at Khumaltar believes that they properly equal Terai goats in reproductive capacity and that the number of their young in a litter is smaller because they are less nourished than their Terai counterparts.

Their furs are variously colored - including black, brown and white - and both males and females have horns. The breasts of females are fairly well developed. Breeding is possible throughout the year. The number of young in one delivery is often just one; thus their reproductive capacity is smaller than that of Terai goats which usually bear two. They are used for meat and their milk is not used. (It is said that people in Terai do not milk goats except to get milk to be used in the incantation for the sick.)

In Terai Area, the Jamunapari breed was formerly introduced and its effect can still be seen in the form of local goats. However, hardly any effect of the Jamunapari breed can be seen in the Hill goats. In both Terai and the Hill Area, no systematic selection or improvement is in practice and goats do not receive as much attention from their keepers as do cattle and water buffaloes. This situation must be corrected in the future.

Goats are important as animals handy for the utilization of materials because they are not only small but breed efficiently and can be fed on roughages. Terai goats and Hill goats have productive characteristics that resemble those of the small prolific goats distributed to the east, reaching Okinawa and the western islands of Kyushu via the damp tropical areas in Southeast Asia. Since their numerical productivity, a major trait of meat animals, is high, they should be considered an advanced breed though they are small. It is important to study whether or not their prolificacy will be impaired if they are crossed with an improved breed.

(5) Sheep

Sheep in the Hill Area are mongrels resulting from promiscuous crossing. Sheep were very scarce at the altitudes of the area covered by our recent survey. According to farmers, there are more sheep than goats at Bhandar. Most are small and have white wool with brown or black spots. Some of their wool is coarse and some fine. It is sorted out and the fine wool is used for homemade clothing while the coarse wool is used for carpet making.

If the home production of carpets is to be developed as a local industry in the future, wool production must be improved in both quantity and quality to supply this industry.

(6) Chickens

Most farming households keep indigenous chickens. We saw hens almost always accompanied by chicks. The indigenous chicken has red feathers resembling those of the jungle fowl but is larger. It is said to lay about 70 eggs a year. Chickens are kept loose and not housed. Hens with chicks are cooped.

The white leghorn, the New Hampshire and the Australorp were imported in the past and the effects of these breeds were clearly seen in the hamlets. Males are kept in considerable numbers and sold for meat. Chicken eggs are sold at the local bazaars and tea shops. There, they are found in different color (red and white) and different size; this bespeaks the effects of introduction of the select breeds.

(7) Ducks

We saw a small number of ducks in the basin of Sindhuli. They probably can be multiplied in the riparian areas in the future. Hatching may be a problem but chickens may be used to hatch duck eggs.

(8) Others

According to JADP survey, beekeeping is in practise. However, we did not see it during our recent survey. Edible doves are kept by some. We encountered a passer-by carrying one as a souvenir.

2) Procurement of Feeds

(1) State of Feed Procurement, by Types of Livestock

1 Cattle

(i) Straw and stalks collected from farms are main deliberately produced fodders for cattle. Besides, grain wastes and the like are given before and after parturition.

(ii) Fodder trees planted in the forests and around the farms and dwelling houses are important as a fodder source for the dry season which continues for six to eight months. There is so much branch cutting that trees in accessible areas have nothing left but trunks and boughs.

These (i) and (ii) constitute the important part of feeds for cattle and, quite unlike in the Southeast Asian damp tropical areas in general, farmers make great efforts to secure feeds for their livestock.

(iii) Loose keeping around forests and farms and on river terraces: Cattle are released twice a day, once in the morning and once in the evening, whether in the rainy or dry season. The Hill Area contains few grasslands because of its topography. So, cattle are kept loose mainly around forests and farms and, where there are many river terraces, they are used for loose keeping but this is not general in the entire Hill Area.

Locally, however, river terraces in the upper reaches of the Kamla Nadi looked like irrigated pastures of gramineous grasses and were used during the dry season when we visited there. Vegetation around forests and farms now consists only of short turf after overgrazing and contains bushes of uneaten grass. This indicates that the animals prefer young grass though it is available only in limited quantities. It is urgently necessary to decide how to control pasturing in the future to maintain vegetation.

2 Water Buffaloes

The same approach may be taken about feeds for water buffaloes as feeds for cattle. Since, however, they produce milk, farmers seem to have the general conception of giving them feed for production; although they give a certain amount during the lactation period regardless of milk yield. (At the Kathmandu fair, straw and green grass cut into short pieces and sprinkled with concentrate feed similarly to the Japanese forage system were served.)

If the milk production of water buffaloes is to be increased in the future to improve productivity in hill agriculture, it will be important to prepare adequate feeds and disseminate the techniques of feeding and management.

3 Goats and Sheep

The same general principle applies to these as to cattle. However, goats are effective in the utilization of materials because they eat plants - or parts of plants - that cattle do not. But at the same time, this means damage to all the more trees and grasses. Goats and sheep are important as supplements to the local farming system due to the fact that they are small and do not require much by way of maintenance feeds. Yet, farmers do not pay as much attention to the care of these animals as to the care of cattle and water buffaloes. As the result, their losses due to malnutrition are heavy and their productivity is not being effectively utilized.

4 Pigs

The indigenous breed is kept as the scavenger eating not only food residues but also every edible thing found around the house. In this sense, it may be more suitable for pigs to be kept in the suburbs of cities but in this case the number to be kept will be limited.

The select breed already introduced into this area must be handled with the logic of money economy from the beginning.

5 Chickens

Chickens are kept loose in small numbers. They find and eat grass seeds, insects, etc. for themselves and are not fed by their keepers. The keepers give chicks such things as grain wastes, though.

6 Ducks

Ducks are kept at places with rivers or paddy fields, thereby making effective use of such resources as fish, aquatic insects and plants. They probably can be multiplied at suitable places but it will be advisable to keep them only at suitable places.

(2) Importance of Forests (and Grasslands) and Fodder Trees

As stated in the General Discussion, forests are important in the ecosystem of the Hill Area and one of the three major supports of the hill agriculture system with crops and livestock. They are equivalent to prairies in Europe and America as the source of supply of fodders for livestock. As described already, what may topographically be regarded as a prairie does not exist in this area. Natural grasslands exist only around forests and farms. So, in this discussion, they are included in the category of forests.

The Nepalese fodder trees characteristically differ from fodder trees in the advanced temperate countries which are completely independent of the natural ecological system and function as a crop. Collection from fodder trees in Nepal consists of collecting fodder from the very types of trees that form the forest ecosystem and the trees are suitable as a source of feed for livestock for the dry season.

K.K. Panday divides the utilization of fodder trees by altitudes into three: lowland (warm river ravines with tropical climate, 200 ~ 1,200 m), intermediate hill area (warm temperate to subtropical climate, 1,300 ~ 1,800 m) and high hill area (cold temperate climate, 1,900 ~ 2,000 m). Tree types that are used range for more than 30 families and amount to 90 species. As to the nutritive values of fodder trees, he estimates the dry matter weight at 30%, the digestible organic matter at 70%, the metabolic energy per kg of fresh matter at 0.7 Mcal and the crude protein at about 10% of dry matter.

We heard in Sindhuli district that there are 21 species at high and low altitudes. Farmers' standards in selecting fodder trees are said to be: 1 preference by livestock, 2 trees with as many leaves as possible and with twigs that livestock etc., 3 what appears to be nutritive, 4 what promotes lactation and 5 what improves the quality of ghee. The last three are rather subjective views. (See Appendix 10)

1. Devastation of Forests (and Natural Grasslands) by Collection from Fodder Trees and Overgrazing

In forests near villages - and even in relative recesses accessible to people collecting from fodder trees - excessive collection from fodder trees has left only old trees in place and the intermediate and bottom forest phases (young phase and germs) do not exist or are very scarce; thus the stabilized forest ecosystem, namely, the continuous growth system of elite tree species is destroyed. This can be observed from a helicopter for a considerable range. One may safely say that natural ecosystems remain only in topographically inaccessible areas.

Fodder trees about houses and farms are almost without branches. This is also the case with trees in natural forests near hamlets.

Devastation is furthered if livestock are kept loose where low forest trees have been weakened in this manner. There, the forest killer (banmara in Nepalese, *Eupatrium* spp., the like of the Japanese fujibakama or thoroughwort) multiplies. Its multiplication is now a big national problem. It exists everywhere in Sindhuli District and we found a great community of this weed in a forest located near the Ramechap heliport.

2. Loose Keeping of Livestock

In not only Nepal but also the Southeast Asian countries, there is the practice for farmers to jointly loose keeping livestock on farms after harvest, by the roadside, in miscellaneous lands and the natural grasslands around forests. The animals make a fairly large group as they are assembled from the different households. In this report, the term "loose keeping" (hanashigai in Japanese) is used distinctively from the term pasturing or grazing (hoboku in Japanese) because pasturing (or grazing) presupposes that the relations between livestock and the state of vegetation

in the pasture are properly regulated but, in loose keeping, there is considered to be unilateral usurpation of plant resources from the place of loose keeping. In spite of loose keeping, vegetation is maintained and yearly reproduction guaranteed at places where the terrain and the precipitation are favorable and there is harmony with the number of livestock. But in this country, Imperata spp. and finally the forest killer are now rampant as the short gramineous vegetation is disintegrated through gradual accumulation of the effect of overgrazing.

As stated in the General Discussion, loose keeping greatly contributes to the procurement of livestock feeds but farmers care little for the management of the place of loose keeping which they regard as their common property. Vegetation cannot be restored or maintained unless the village or the panchayat plans effective countermeasures with long-range consideration for the interests of individuals and the community.

3) Feeding and Management

The people of Nepal seem traditionally to know basically how to raise livestock. The form of livestock raising in the Hill Area is, in Japanese terminology, shagai (housing). In a lowland, log posts are put up three longitudinally and three or four laterally to be topped with a level ceiling frame with straw and stalks heaped on it to serve both as a roof and as a feed storage. In other words, it is a livestock barn with nothing but a roof. The animals are tied to the posts. In a highland, we saw an outhouse with stone and clay walls of which the first floor held animals and the second floor (or attic) contained feeds. Judging from the local climate, it is unlikely that these livestock barns or livestock tethering facilities seriously restrict the productivity of livestock in this area.

With limited feed resources, farmers feed their livestock in accord, to some extent, with the physiological needs of the animals. Specifically, they increase feeds for cows and water buffaloes before and after their deliveries and give tree leaves to young animals. However, the nutritive state of livestock throughout the year greatly changes between the rainy and dry seasons and one can easily imagine that, as a whole, their nutrition is basically insufficient. Indeed, this is clear from the difference between the state of nutrition of loose kept cattle in the Hill Area of Janakpur and that of loose kept cattle in the basin of Katmandu as we saw them during our survey. The two draft bullocks kept on the Sinduli farms of the JADP were so large and so well nourished because of their sufficient feeds that they looked as if they were specifically different from the loose kept cattle of local farmers.

The local authorities disclosed that there are heavy losses with the young of goats and sheep because farmers do not tend these livestock as carefully as they do cattle and water buffaloes.

For the present, it is important for many farmers to learn to use their limited feeds rationally and with priorities but the problem can not be basically solved unless the number of livestock is harmonized with the supply of feeds. The dissemination of stock raising techniques purporting to increase productivity must be attempted only after that.

4) Livestock Hygiene

(1) Cattle and Water Buffaloes

1 Rinderpest, R.P.

Cattle and water buffaloes (also, goats and sheep) contract this viral infections disease. If it starts in India, which is an immediate neighbor, it may well spread to Nepal. It is now generally under control in this country after a UN anti-rinderpest drive. Veterinary hospitals vaccinate local cattle and water buffaloes against the disease.

2 Haemorrhagic Septicaemia, H.S.

This, unlike R.P., is a disease caused by constantly present bacteria and sometimes occurs in many places. The bacteria are constantly present not only regionally but also constantly present in the bodies (air passages) of livestock and the disease occurs in many places all at once when there are all conditions necessary for its occurrence. At such time, it is infectious. It is, therefore, necessary to cope with this disease by not only preventive vaccination but also by precautions relative to feeding and management. Veterinary hospitals handle vaccination against H.S.

3 Liver Fluke

This disease is caused by the parasitism of *Fasciola* spp. in the liver. It is common in lowlands, swamps and paddy field areas because cercariae adhere to plants near the water surface in the life cycle of the parasite. The veterinary hospital of Sindhuli treats more cases of it than any other veterinary hospital. The administration of antiparasitics is effective but the Nepalese are experiencing difficulty importing them from India because the Indians themselves are in short supply. This disease does not bring immediate death but animals afflicted by it develop chronic malnutrition and become unproductive.

4 Foot and Mouth Disease, F.M.D.

This viral infectious disease afflicting all artiodactyls is not much of a problem in the Hill Area.

5 External Parasites

Tick: At Jiri Center, ticks recently occurred so much that it has become impossible to pasture Brown Swiss seed bulls and their feeding has been switched to drylot feeding with cut grass throughout all periods. This is probably because hybrids with European cattle are weak to *Babesia theileri*, a protozoan parasitized in red corpuscles and carried by ticks. (Of course, ticks are also harmful as bloodsuckers.) This has become a problem also in India. It requires caution in connection with the breed improvement through crossing with European cattle.

The above diseases of cattle and water buffaloes are arranged in the order of importance. According to experts, the national death rate of calves is about 10% and that of water buffalo calves is about 25%.

(2) Main Causes of Losses to Goats

- 1 Parasitic diseases: liver fluke, metastrongylosis, mange, ticks
- 2 Infectious diseases: sheepox, foot and mouth disease
- 3 Malnutrition, improper feeding and management
- 4 Damage by other animals

(3) Main Causes of Losses to Sheep

- 1 Infectious diseases: enterotoxemia, pneumonia by haemorrhagic septicaemia, foot and mouth disease, sheepox
- 2 Parasitic diseases: sheepox, metastrongylosis

3. Measures for Developing Hill Agriculture

There apparently are no immediately effective measures that can now be incorporated into the hill agriculture system where the factors of topography, geology, climate, crops, fodders from forests (and natural grasslands) and livestock are closely interwoven. Hill agriculture will begin steadily to develop only when the livestock production subsystem is stabilized on the basis of securing feed resources through the restoration of forests (and natural grasslands) and by increasing shipments of feeds through the improvement of field husbandry.

Measures that can be put into practice under these circumstances probably are restoring forests (and natural grasslands) and improving livestock as long-range projects. Of all livestock, water buffaloes must be first improved in view of their economic function. Below are the necessary measures arranged in the order of urgency.

1) Restoration and Preservation of Forests (and Natural Grasslands)

This is being mentioned as a matter of procedure apart from the question of whether this problem comes under the jurisdiction of the JADP or not.

(1) Restoration of Forests

In Nepal, the species of fodder trees agree with those of trees that properly form the forest ecosystem; thus the restoration of forests is synonymous with the multiplication of fodder trees. First, seedlings are planted in a forest and their preservation and the supply of fodder trees are harmonized by subsequent rational work. Fortunately, planting trees is in accordance with religious teachings in this country. Tree planting also serves to promote the proper functions of forests, such as preventing erosion, increasing the water holding capacity of soil and achieving shading effect. For this purpose, there must be facilities that can supply sufficient numbers of seedlings. There must also be the reformation of farmers' consciousness by training at the family level and the organized activities at the panchayat level.

(2) Planting Fodder Trees in Vacant Lots Around Farms and Houses

These lands will be planted with trees that can be used at small heights. (Imported fodder trees may be used for this purpose. See Appendix 10.) These trees will also have shading effect for farms and vicinities. Fodder trees are more easily established than pasture plants.

(3) Introduction of Pasture Plants into Forest Environs, River Terraces and Natural Grasslands

The stocking capacity will be increased by introducing tropical pasture plants into these areas. To this end, there must be an aptitude test on plant species to be used and the ensuring of supply of their seeds. (See Appendix 10)

2) Measures for Livestock

(1) Improvement of Feeding and Management

1 Dissemination of Method to Feed Livestock in Accord with Their Physiological Needs

As a whole, local farmers are traditionally rational about the apportioning of their limited feed resources but they must acquire detailed techniques purporting, primarily, to prevent losses to young animals by improved feeding and management and emphasizing also the feeding of adult animals before and after deliveries and the supply of production feed to lactating water buffaloes.

2 Prevention of Illness Losses through Improved Nutrition

The decline of productivity and the loss of individuals due to parasitic diseases and some infectious diseases will be prevented to a considerable extent by improving the nutritive state of young and adult animals.

But to make these measures effective, the efforts to increase feed supply and achieve the appropriate number of livestock in possession must be continued.

(2) Measures for Livestock Hygiene

1 Intensification of Vaccination

The present vaccination against R.S. and H.S. must be intensified by starting an itinerant formula and other measures.

2 Intensification of Countermeasures against Parasitic Diseases

The decline of the productivity of adult animals and the loss of young animals may be prevented by initiating the itinerant administration of antiparasitics rather than just induce visits to the veterinary hospital.

(3) Improvement of Livestock

[Phase I Measures]

The number of livestock will be maintained at the present level but their productivity will be improved.

1 Increase of Milk Yield of Water Buffaloes

The milk yield of water buffaloes believed to be economically most important in hill agriculture will be increased, thereby increasing food self-sufficiency and cash income.

Specifically, males of Murra and related breeds being multiplied by the government will issued. Or as the second best policy, males locally born from well-lactating mothers and having the physical characteristics of the breed will be selected and kept at the panchayat. In this case, the government will contract with the producer the lease of the male water buffaloes. The panchayat will create a breed improvement association, use them for three years until their offspring attain breeding age and then exchange them with males from elsewhere to avoid inbreeding. In this case, the panchayat will recommend mating with priority for farmers having females with particularly poor dairy character of females known for their low milk yields.

2 Improvement of Goats

The issuance of F₂ tested and produced by the UNDP or males obtained by back-crossing with the local breed. Mating will be controlled at the panchayat level. Goats easily multiply. So, unsatisfactory individuals will be sold for meat. If males are scarce, strongly built males born from large females at the panchayat will be temporarily utilized. Males will be exchanged to avoid inbreeding, as in the case of water buffaloes. Farmers must be exhaustively taught to avoid the inbreeding of their goats because many farmers keep he-goats.

3 Improvement of Sheep

This is applicable to the high-altitude part of the Hill Area. The basic policy is the same as in the case of goats.

4 Pigs

The present system of issuing pigs of the improved breed will be continued. Pigs are less important than herbivorous livestock.

5 Chickens

The present system of issuing chickens of the improved breed will be continued. Like pigs, chickens are less important than herbivorous livestock.

[Phase II Measures]

At this phase, the farming conditions of farmers will have already been improved and they are now at an advanced level of technology. They will try to reduce the number of livestock by eliminating unproductive individuals, taking advantage of the effects of the improvement of water buffaloes, cattle, goats and sheep, and at the same time maintain or increase the total amount of livestock production.

1 Improvement of Milk Yield of Cattle

Bulls of an improved temperate dairy breed based on the test results at Khumaltar and the improvement results by the Brown Swiss breed at Jiri will be issued. Artificial insemination will be feasible at places. At this stage, an organization to proceed with the improvement of both males and females will be established at every panchayat. Further, the active participation of individual farmers will be necessary.

Cattle of the temperate dairy breed may be somewhat unadaptable to the natural environments and feeding conditions in the Hill Area, which is the JADP's charge, but the improved technical level will make up for this. The size of the cattle will be intermediate between those of the Hill breed and the temperate breed. So, they will have increased draft power. But depending on the width of terraced farms, it may be necessary to use the smaller of these cattle for draft purpose.

2 Improvement of Milk Yield of Water Buffaloes

At this stage, the functions of the breed improvement association must be reinforced so as to be able to perform systematic crossing by selecting females according to their milk yields and also using males of the Murra breed that are issued and the superior males selected within the area.

3 Reduction of Number of Large Livestock and Choice between Cattle and Water Buffaloes

When this phase is well underway, farmers may begin choosing either cattle or water buffaloes as the stress in their management by comparing their overall productivity. Water buffaloes have the advantage of being able to be used as meat but are difficult to breed as a species and, in the long run, the improvement of their milk yield will hit the ceiling sooner. This means that genetically the milk yield of water buffaloes culminates in the Murra breed of India, which is the largest in the world, and it is impossible to exceed this yield. Cattle, in the meanwhile, are easy to breed and there are so many genetic resources concerning their milk production that, in Nepal, it is possible for their milk yield to catch up with the present milk yield of water buffaloes first and then outstrip it. However, the fact that bulls and bullocks cannot be used for meat for the reason of religious restrictions is a problem to the last.

At the stage that the above economic choice is made, the formula of draft utilization will change as a matter of course. This involves the improvement of tractive gear and plows besides the change of cattle themselves. Such improvement will be quickly accomplished if farmers switch to the modern principle of farming. A sufficiently nourished bullock may be able to work alone with the help of new tractive gear and a new plow. Also, the use of cows for draft purpose may be possible at this stage. In lowlands, such as the Sindhuli Basin, water buffaloes may also be used draft animals. Without these developments, reducing the number of large livestock animals will be impossible.

4 Improvement of Goats

A breed improvement association will be organized to continue breed improvement by selecting both males and females. Even if the farming conditions are improved, the economic character resulting from the traits of resource utilization will not change. However, it is necessary to make adjustments so as not to increase the number of goats too much.

5. Improvement of Sheep

This will be done by the same principle as the improvement of goats but it will be necessary to improve the quality of wool so that it may suit commercialization rather than home production.

6. Pigs and Chickens

At this stage, there will be commercial bases for these in different parts of the country and the development in the Hill Area may not go beyond this national level.

4. Measures to be Taken by Individual Farmers and Administrative Organizations to Achieve Steady Development of Hill Agriculture (with Respect, Particularly, to Livestock)

1) Individual Farmer

1 Restoration and preservation of forests (and natural grasslands): A farmer must understand the importance of this in maintaining hill agriculture and discharge his related responsibility. He must plant seedlings and protect them from the damage by livestock until they are established. He must also cooperate in preventing the overgrazing of natural grasslands and maintaining vegetation and sowing pasture plants.

2 Individual identification of livestock and the recording of their abilities: For some time, this will have to be done by literate people of the panchayat.

2) Panchayat

- (1) Organization of a livestock improvement association and control of breeding stock.
- (2) Organization of a forest utilization and control association and a nursery utilization association.
- (3) Organization of joint work relative to fodder trees and the sowing of pasture plants.

3) District

- (1) Planning of breeding stock utilization.
- (2) Tethering and control of superior seed bulls.
- (3) Performance of artificial insemination (Wherever possible).
- (4) Guidance and dissemination of feeding, management and livestock hygiene.
- (5) Dissemination and improvement of milk processing.

4) Zone and Government of Kingdom

- (1) Supply of superior breeding stock or seminal fluid through improvement of breeding stock farms.
- (2) Intensification of livestock hygiene measures.
 - 1 Establishment and expansion of veterinary hospitals and dispensaries.
 - 2 Intensification of countermeasures against livestock infectious diseases.
- (3) Construction of liaison routes.
- (4) Training instructors so as to be able to give thorough guidance about stock farming. Or training specialized stock farming instructors.
- (5) Establishment of milk processing plants and collecting centers in some area.
- (6) Furtherance of preparations to supply fodder tree seedlings and pasture plant seeds.

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