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Strategy for Farming Systems Research in Nepal

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CROPPING SYSTEMS PROGRAM

NEPAL

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INTRODUCTION

The National Cropping Systems Program (CSP) was initiated in Nepal in 1977 within the Division of Agronomy of the Department of Agriculture as a part of the HMG/USAID-supported Integrated Cereals Project. Within the first year of establishing the CSP, five Cropping Systems sites (Kundi Bhumdi in Kaski District, Khandbari in Sankhuwasabha District, Lele in Lalitpur District and Chauri Jahari in Rukum District in the mid-hills and two sub-locations in Parsa District in the Terai, one rainfed and one irrigated) were in operation. In 1980, an additional site was initiated at Ratna Nagar in Chitwan District in the Inner Terai. All Cropping Systems sites are currently in operation. During the intervening years, numerous reports have been published that document the research activities that have occurred including both socio-economic and agronomic aspects.

From the outset, the CSP has been a member of the Asian Farming Systems Network (previously called the Asian Cropping Systems Network) supported by IRRI. This has allowed scientists working in the CSP in Nepal to actively participate in the evolution of Cropping Systems Research and Extension Methodologies through frequent contact and visit with scientists working in similar programs in other Asian countries. In addition, scientists in Nepal have been able to take advantage of training opportunities in Cropping Systems Methodologies at IRRI and to benefit from the advice of IRRI scientists designated to support the Network countries through frequent in-country visits. This interaction has led to a similar approach that is being followed by the Network countries in their Cropping Systems Program which was summarized in an IRRI publication entitled, A Methodology for On-Farm Cropping Systems Research, by H.G. Zandstra et al (1981) available from IRRI.

1/ - IADS/ICP Senior Cropping Systems Agronomist, IADS/ICP Cropping Systems Agronomist and HMG/Division of Agronomy Cropping Systems Assistant Agronomist, respectively.

Best Available Document

The CSP has provided an almost unique situation in Nepal for interactive research in farmers' fields that has involved biological scientists (primarily agronomists), socio-economists and farmers working together as a team. It has been unique for Nepal in that socio-economists have been involved in the pre-implementation and implementation phases and not, as has usually been the case, as only post-implementation evaluators. The presence of socio-economists has helped to reinforce the role of the farmers and their families as part of the team.

The objectives of the CSP have been:

1. To develop a better understanding of the Farming Systems that exist in the selected Cropping Systems sites.

2. To conduct, with this basis of understanding, research in farmers' fields with active farmer participation to identify relevant technologies for improving crop production that are compatible with: a) household goals, resources and other components of the Farming Systems and b) existing or potentially feasible infrastructure support agencies (AIC, Sajha Cooperatives, ADB/N) and the extension system.

3. To provide a link between crop research institutions (Discipline Divisions and National Crop Commodity Programs) and farmers through testing new technology recommendations in farmers' fields. This allows feed-back of farmer-tested strengths and weaknesses in the recommendations to the concerned institutions. It also allows the possibility for modification and refinement of the recommendations with farmer participation to facilitate adoption.

4. To develop suitable extension methodologies to extend useful crop production technologies verified in the Cropping Systems sites to other similar areas for similar verification there and eventual extension into defined area production programs.

The CSP has tried to achieve these objectives through the gradual evolution of useful research and extension methodologies at the six Cropping Systems sites. Although the emphasis has been on improving the crop production activities of the Farming Systems at the various sites, efforts have been made to understand other components of these Farming Systems and their relationship to crop

production. (See S.B. Mathema and M.G. Van Der Veen, 1978 and 1981, S.B. Mathema, 1980 and M.G. Van Der Veen, 1980). Adoption of some crop production technologies that have appeared to be highly desirable from the strictly agronomic point of view, has not occurred in some situations because of unfavorable conflicts with other components of the Farming Systems.

Identification and extension of improved crop production technologies, however, has occurred in the Cropping Systems sites and in other similar areas through cooperation with interested District Agricultural Offices and/or Defined Area Agricultural Development Projects. This has been particularly successful in irrigated areas of the Terai and has led to the Department of Agriculture 35,000 ha. Cropping Systems-Based Production Program currently ongoing in 17 districts of the Terai. Excellent improved crop production technologies have been identified at the rainfed Cropping Systems site at Sukchaina in Parsa district with extensive adoption of the technologies by farmers in the site. But there has been little interest or support to extend the proven technologies into other similar areas.

In the four mid-hill Cropping Systems sites, the effectiveness of the CSP in development and extension of improved crop production technologies has been comparatively limited. This may be explained by several factors:

1. There has been minimal available, improved technologies to test for many important crops grown by farmers in the mid-hills. This obviously is the case for such crops as grain legumes, oilseeds and finger millet for which there is a very minor research support base in Nepal. However, the availability of relevant, improved technology for even major crops like rice and wheat for the mid-hills, especially in rainfed situations, has also been meager as compared to the Terai. This has improved in the last three years with the release of useful hill rice varieties such as Khumaltar 3 (K-39), Himali and Kanchan. Where there have been examples of useful new technologies (especially new varieties) that fit farmers requirements, rapid adoption in the mid-hill Cropping Systems sites has occurred. This certainly argues for more research relevant to these situations.

2. Adoption of improved crop production technologies that rely on external

supply of inputs (particularly fertilizer but also seed) has been hampered in the more remote mid-hill sites because of a lack of effective infrastructure (AIC, Sajha Cooperatives, ADB/N) to provide inputs and credit on time or at all. This, hopefully, will improve but it provides support for the argument to emphasize the development of better technologies designed to maximize the use of existing resources.

3. Although the CSP has been active in its efforts to understand the relationships between crop production activities as practiced by farmers in the Cropping Systems sites with other components of their Farming Systems to assure that new crop technologies are relevant, there is evidence that more attention must be given. Studies that have been conducted by the socio-economic unit of the CSP and observations of researchers working with farmers at the sites consistently have shown that many decisions that farmers must make which involve changes in some aspect of their crop production activities to improve crop production are largely conditioned by how these changes interact with other farm activities. The interactions that appear to exist between crop production and livestock production activities in the mid-hill sites are so numerous that it can be argued that minimal improvements can be made it one without corresponding attempts to improve relevant aspects of the other. This is particularly apparent as it relates to:

a) Increasing cropping intensity though growing additional crops in land normally left fallow during parts of the year because of potential shortages of both farm yard manure from livestock to apply to the additional crops, thereby maintaining soil fertility and bullock power for land preparation for additional crops.

b) Increasing labor requirements involved with new crop production technologies and/or more intense land use that may compete with existing labor requirements for caring and providing feed for livestock.

c) The importance of land currently being left fallow during part of the year and used as a source of livestock feed through grazing as opposed to cropping the land and keeping livestock out of the fields. (Many times this involves a community level decision

because of general unrestricted grazing.)

d) The adoption of new crop varieties that may have higher food grain yields but lower total straw yields or poorer quality straw which is an important part of the livestock feed ration.

e) The trade-off in the use of scarce capital resources for adopting improved crop production technologies which may be more costly than traditional technologies versus their use for livestock production activities.

f) The general shortage of high quality green fodder, especially during the pre-monsoon dry months (from January to June), which results in reduced livestock production and performance and high labor requirements to collect what green fodder is available. This may be alleviated by production of fodder crops within cultivated crop land areas and by improving fodder crops/trees in non-cultivated areas thereby reducing current labor requirements for fodder collection.

All of the above factors and, probably several more, have contributed to the relatively modest and uneven success that the CSP has achieved in the mid-hill sites. It is further postulated that if new sites are developed in the high hill regions (above 1500 m.a.s.l.), these factors will take on added significance. This will especially be evident concerning the interactions between the crop and livestock components of Farming Systems in the high-hills where it is commonly assumed that livestock play a more major role. Therefore, the CSP has decided to initiate research that will address the development of appropriate methodologies to conduct Farming Systems Research with interventions involving both crop and livestock production activities.

This will involve some modification in the research methodologies currently being used with participating farmers for Cropping Systems Research at the sites. Initially, the primary research activities involving livestock will concentrate on improving fodder and feed availability within the context of improving whole farm crop and livestock production. Close farm monitoring of farmers participating in the research program will be emphasized to better understand the linkages between crop and livestock production activities and to determine where improvements can be made to increase fodder production at critical times during the year

which are complimentary with maintaining or increasing food crop production. The CSP looks forward to active collaboration with the Department of Livestock in this work.

The Pumdi Bhumdi Cropping Systems site has been selected as the first site where crop-livestock activities will be initiated. Focus on only one site at the beginning will allow an opportunity for the testing and development of appropriate methodologies for crop-livestock research with a Farming Systems Perspective and when appropriate, these methodologies can be extended to other sites. Pumdi Bhumdi will be part of a small number of sites in different countries that will be monitored as a part of the Asian Farming Systems Network as other countries strive to develop methods to integrate crop and livestock research at the farm level.

CHARACTERISTICS OF PUMDI BHUMDI 1/

General Background

Pumdi Bhumdi Panchayat is located in Kaski District of the Western Development Region about eight kilometers west of Pokhara on both sides of the Pokhara-Bhairahwa road. The estimated population of the Panchayat is 6000 inhabitants. Of the nine wards of this Panchayat, the CSP has concentrated most of its research activities in wards 2, 3, 4, 5 and 6. Agronomic research was initiated during the monsoon season, 1977 following several visits for site selection. A formal key-informant survey of the site was conducted in 1978 to describe the Farming Systems at Pumdi Bhumdi (Mathema and Van Der Veen, 1978). Subsequently, several focused surveys, some published (Mathema, 1980, Mathema and Van Der Veen, 1981 and Van Der Veen, 1980) and some unpublished have furthered the process of understanding the Farming Systems with particular emphasis on the crop and livestock components.

Pumdi Bhumdi Panchayat lies on the north and south sides of a hill which varies in elevation from 750 to 1270 m.a.s.l. The five wards where research has been conducted are on the south-facing slope. Average rainfall is approximately 4000 mm with over 90% occurring between mid-April and mid-October. There are usually six months with over 200 mm of rain and five months with markedly less than 100 mm. Daily mean temperatures range from a low of 13 °C in December-Janu-

1/ - This section present a brief summary of published reports, unpublished and intuitive observations concerning the Pumdi Bhumdi C.S. Site following over six years of experience there by the CSP.

ary to a high of 25 °C from June through August but this varies with elevation. Temperatures below 0 °C rarely occur and are restricted to the higher elevations in the Panchayat.

Hail is a serious problem for farmers and can chronically occur in the pre-monsoon period (March to June) and post-monsoon period (September to November). The pre-monsoon hails can damage the ripening wheat and newly planted maize and the post-monsoon hails can drastically damage the ripening rice crop.

Soils in Pumdi Bhumdi are silty loams belonging to the Inceptisol major soil order. Soil pH is generally low, ranging from 5.0 to 6.0, and total N, P, K and organic matter range from low to high depending on the previous history of compost/farm yard manure application, land type and cropping pattern followed.

Farm Structure

The farms in Pumdi Bhumdi differ according to amount of cultivated land. Although the size of farm is generally very small, considerable variation in farm size does exist. According to survey results from 1978, the average cultivated area for the 83 randomly sampled households was 0.87 ha with 41% of the households cultivating less than 0.61 ha and 33% cultivating more than one hectare. However, 39% of the farms did not produce their household grain requirements in 1977-78. These farms were usually less than 0.61 ha cultivated land but a few larger farms with particularly large households were also deficit producers (Van Der Veen, 1980).

The farms in Pumdi Bhumdi are characterized by a mix of land types. Cultivated land in the site is broadly divided into two major land types; upland (bari) with maize-based cropping patterns and lowland (Khet) with transplanted rice-based cropping patterns. It is estimated that 32% of the cultivated area is upland and 68% is lowland in the five wards were research has been conducted. Each of these major land types are further divided into sub-categories based on the production potential as related to existing cropping patterns, distance from the house, history of compost/farm yard manure application etc.

Approximately 63% of the farms are "mixed land type" having more than 20% of both upland and lowland fields. Most other farms are "mainly lowland" having less than 20% cultivated area of the upland type and tend to be larger farms. Very few farms are "mainly upland" and are of extreme small size. Mixed land

type farms are slightly more predominant among smaller farm size categories (Van Der Veen, 1980).

The average household size in Pumdi Bhumdi is 5.8 persons and is not strongly correlated with farm size. As a result of this, the average number of family members per cultivated hectare is inversely correlated with farm size as indicated in Table 1. This table presents the results of a recent unpublished survey of crop-livestock activities conducted in 1983 at Pumdi Bhumdi involving 21 farms. The farms were selected to include representatives within four defined farm size categories. Table 1 also indicates that most farms including small farms have access to some uncultivated land and the relative amount appears to increase with farm size. Table 2 presents results from the same survey indicating the mix of land types for each farm size category and the prevalent fragmentation of cultivated land into many separate parcels. This mix of land types, divided into numerous parcels explains the complexity of the Cropping Systems encountered at Pumdi Bhumdi.

Cropping Activities

The uplands tend to be more intensively cultivated. In the key-informant survey conducted in 1978, over 50% of the upland fields were triple cropped with Maize/Finger Millet-Wheat as the predominant cropping pattern. Over 40% was double cropped with Maize/Finger Millet-Fallow predominating while less than 2% of the area was mono-cropped with Maize-Fallow-Fallow. Highest priority was given to applying available compost/farm yard manure to the upland fields principally at the time of maize planting. Any excess was applied to the lowlands as explained below. Most farmers tend to inter-crop varying amounts of cowpeas, beans, soybeans, and cucurbits with the maize crop. Other minor crops encountered in the uplands in the winter season in place of wheat are mustard, potato and barley (Mathema and Van Der Veen, 1978). Current observations would indicate that more land is now being triple-cropped in the uplands using the Maize/Finger Millet-Wheat cropping pattern.

The key-informant survey of 1978 indicated that the lowlands were markedly less intensively farmed. A mono-crop of Rice-Fallow-Fallow was followed on about 55% of the lowland and 18% was occupied by double-crop patterns, predominately Rice-Wheat-Fallow and Rice-Fallow-Maize. Twenty-four percent of the lowlands

were planted to the Rice-Wheat-Maize cropping pattern (Mathema and Van Der Veen, 1978). Current observations indicate that there is probably less land being mono-cropped to Rice-Fallow-Fallow with more land being planted to the pattern Rice-Fallow-Maize. However, Rice-Fallow-Fallow mono-crop is still the predominant pattern in the lowlands.

The CSP has tried to identify better technologies to improve the existing cropping patterns at Pumdi Bhumdi and to try to increase cropping intensity. In the uplands, which are already intensively cropped, there has not been much scope for further intensification but some research has been directed at replacing existing winter crops with other possible crops. Little progress has been made, however, in developing new alternative cropping patterns for the uplands.

The much less intensively cropped lowlands have offered more scope. Research has been directed at : i) determining if existing but improved double crop patterns could be extended into the mono-cropped areas and, similarly, if existing but improved triple crop patterns could be extended into areas being double cropped and ii) if other crops, not being grown or very minor in importance, could be planted in the fallow seasons in mono-cropped and double-cropped lowland areas. Some success has been achieved but constraints particularly for the first option above have been identified.

Farmers cite several reasons for not planting more crops in mono-cropped and double-cropped areas. Among these, the problems most commonly given are lack of plant nutrients, water shortage or shade, problem of unrestricted grazing, field is distant from the house, problem of wild animal damage and lack of labor and/or bullocks in descending order of importance.

It is noteworthy that lack of plant nutrients is given as the most important reason. As the CSP has developed its research approach in Pumdi Bhumdi, there has been an attempt to classify the major land types into sub categories. This classification is based on the farmers' own perception of differences in the production potentials of their fields. Therefore, fields are classified in the case of the lowlands into high, medium and low production potentials which largely correspond to the intensity of cropping. Triple crop patterns are usually being followed in lowland, high production potential fields whereas at the other extreme a mono-crop of rice is usually grown in lowland, low production potential fields.

Although there is some relationships between production potential and distance from the house, perception of available residual moisture after rice etc, it appears that the availability and amount of compost applied each year is of most importance. For example, in lowland fields that are triple-cropped (high production potential), an average of 9.5 t/ha per year of compost/farm yard manure was applied in 94% of the fields. For the double-cropped lowland (medium production potential), 4.7 t/ha was applied in 87% of the fields and 1.8 t/ha was applied in 58% of the mono-cropped (low production potential) lowland fields (Van Der Veen, 1980). This shows the clear relationship of cropping intensity and compost/farm yard manure use.

Cropping pattern trials to test planting Rice-Wheat-Fallow in land where only a mono-crop of rice was traditionally grown (lowland low production potential) have shown that wheat production is generally low even with a modest application of chemical fertilizer if no compost is applied on the wheat or the previous rice crop. Applying compost along with chemical fertilizer usually increases yields. This calls into question the wisdom of trying to intensify cropping in the fallow periods in lowlands by using existing high nutrient-demanding cereals like wheat and maize with the apparent shortage of available compost. Recent research has concentrated on testing other potential crops such as mustard and oats (for fodder) but particularly emphasis is being given to legumes such as broadbeans, mung beans, cowpeas, lentils, vetches (for fodder) and peas which may enhance soil fertility especially if directly plowed down for green manure or the residues plowed down. They can potentially provide better quality fodder for livestock and thereby indirectly affect soil fertility through the returned farm yard manure.

The CSP has been able to improve components of the existing cropping patterns at Pumdi Bhumdi especially the varietal component. Khumal Yellow maize has proven more productive than local maize especially in the high production potential uplands. Over 70% of farmers are growing this variety on part of their upland. Arun maize, an early maturing variety, fits well in the Rice-Wheat-Maize and Rice-Fallow-Maize patterns and is more productive than local but its adoption has been hampered because of chronic supply of poor quality seed from AIC. RR 21 wheat is now widely grown in Pumdi Bhumdi especially in the lowlands but unfortunately, no newer wheat varieties that have been tested appear to be better. But perhaps, the major success has been the adoption of Khumaltar 3 (K-39) rice.

This early maturing rice variety is being rapidly adopted by farmers because of its superior yield performance. Perhaps, more important, however, is its early maturity which reduces hail risk and allows farmers more time for land preparation to plant winter crops. Kumaltar 3 has particularly reduced the tight turn-around times between crops with the Rice-Wheat-Maize pattern.

Early rice varieties like K-39 offer more latitude for farmers to consider crop intensification. This, coupled with the interest that farmers have shown in growing crop like oats or vetch in winter for direct use as fodder or Leucaena (Ipil-Ipil) fodder trees to feed livestock, has been one of the prime reasons that Pumdi Bhumdi was selected as the site to initiate crop-livestock research by the CSP.

Livestock Activities

Livestock production is an integral part of the Farming Systems in Pumdi Bhumdi. According to the key-informant survey conducted in 1978, the average household with five to six members (three involved full time in farming) and cultivating 0.87 ha owned seven head of livestock. These included an average of 1.7 buffaloes, 1.45 bullocks, 1.0 cow, 1.15 calves, 2.36 goats, 4.90 poultry and 0.36 pigs (Mathema, 1980). Results concerning livestock ownership from the 1983 survey referred to above are presented in Table 3. It shows the general expected, trend for more livestock per farm as farm size increases. However, this survey concentrated on those wards in Pumdi Bhumdi Panchayat with mainly ethnic groups who do not consume poultry and pork resulting in their absence. This seems to be compensated by the relatively high numbers of female milking buffaloes which is somewhat consistent across farm size categories. Table 3 also indicates the high livestock pressure on each hectare of land for the smaller farm categories which diminishes as farm size increases.

Milk sale is an important income generating activity among many farmers at Pumdi Bhumdi. The 1978 survey indicated that sale of fresh milk and milk product accounted for an average of 67% of the benefits to owning livestock at Pumdi Bhumdi (Mathema, 1980). Table 4 presents the results of the 1983 survey pertaining to the current estimated milk production, use and value to the surveyed farmers. Milking buffalo are important in all four size categories and percent of milk or milk products sold is higher for the smaller farms (Categories I & II)

peaking for those farms in Category II which range from 1.0-1.5 ha total land area. The larger farms consume more of the milk produced which probably reflects that the relative value of revenue from selling milk may not be as important for cash generation as it is for the smaller farms which tend to be deficit producers of food grain and other food crops.

The survey conducted in 1983 also investigated the livestock feed situation of the surveyed farmers at Rumdi Bhumdi. Although estimates of available livestock feed through interviewing farmers is subject to considerable error, Table 5 presents the results derived from the survey. As expected, the survey confirmed the increasing availability of crop residue associated with increasing farm size. It is of interest to note, however, the corresponding large increase in availability of green fodder from fodder trees as farm size increases. The relationship of grain fed to livestock does not differ greatly between Farm Categories and probably reflects the priority for feeding grain to lactating buffaloes which are similar in numbers across the four categories although working bullocks are also fed grain during peak work periods.

Table 6 attempts to estimate the total livestock feed energy available and that required to maintain the average number of Livestock Units (See Table 3 for a definition) for the farms surveyed in 1983. This exercise is more to illustrate gross differences related to farm size and not to relate precise value estimates. The results indicate the probable feed energy deficits prevalent for the small farms in Categories I and II as indicated by the negative energy balances. To meet these deficits, these farmers must rely on collecting grasses and weeds on and off-farm and purchasing additional feed. The deficits are certainly under estimated because no allowances have been made for alternate uses of crop residues such as thatching, livestock bedding etc or non-use of some residues. In many cases, livestock of farms in Categories I and II probably are not being fed much above maintenance levels leading to poor production and performance. The larger farms in Categories III and IV appear to have sizable feed energy surpluses especially from crop residues. This is supported by observations that larger farmers sell crop residues, especially rice straw, for which a ready market exists. Also they tend to use more crop residues for livestock bedding purposes resulting in comparatively higher amounts of compost.

The 1983 survey also attempted to document the livestock feeding practices of the surveyed farms and to contrast these practices according to the different farm size categories. It was evident, as expected, that the availability of the common crop residues used as livestock feed (rice, finger millet and wheat straw and maize green and dry stover) was more prevalent for the two larger size Farm Categories III and IV and was fed for longer periods of time during the year as compared to the two smaller sized Farm Categories I and II. It was also apparent that the length of time during the year that green grasses and weeds were collected for livestock feed was substantially greater for the smaller farms. This entailed a much higher proportion of labor use for this purpose for the smaller farms as compared to the larger farms.

The length of time that green fodder from fodder trees was fed during the year was somewhat similar across all farm size categories (from mid October to mid May). However, a review of the data in Table 6 would indicate that the amounts available on a daily basis would be quite low for the smaller farms.

Grazing of livestock appeared to be more prevalent for the larger size farms. There was a tendency for year-round grazing for the larger farms whereas the smaller farms generally grazed their livestock from mid-October until June and restricted grazing during the monsoon period. This probably results from two main factors. First, the period from mid-October to June coincides with the time that much of the lowland is fallow. Therefore both smaller and larger farms take advantages of these fallow fields for grazing. Second, many of the larger farms have sizable areas of land not under cultivation (see Table 3). Some of these lands are used for grazing, probably throughout most of the year, but are particularly useful from June to October when no fallow fields are available to graze. Most smaller farmers do not have access to such land or to only very small areas.

The overall picture that resulted from the 1983 crop-livestock survey at Pumdi Bhumdi concerning livestock feeding was that the smaller farms in Farm Categories I and II had much less, readily available livestock feed throughout the year including both energy roughages (straw etc) and high quality green fodders. The period from January to June was especially critical for both types of feed. Larger farms in Farm Categories III and IV were considerably better off, especially for energy roughages, but the availability of high quality green fodder to combine with the roughage was also limiting during the dry season from

January to June especially for farms in Farm Category III. Recalling the particular importance of milking buffalo at Pumdi Bhumdi and the corresponding importance of milk sales, especially for the smaller farms, it appears that the most evident first step in integrating crop and livestock production research should focus on increasing the availability of feed sources, with particular emphasis on high quality green fodders for use during the dry pre-monsoon period, to increase buffalo milk production and improve the quality of available fodder throughout the year.

STRATEGY FOR CROP-LIVESTOCK RESEARCH AT PUMDI BHUMDI

The Cropping Systems Research Methodologies that have been followed at Pumdi Bhumdi and the five other Cropping Systems sites have basically involved four activities as follows:

1) Cropping pattern trials are implemented to test both improved versions of existing cropping patterns and new, alternate cropping patterns in the predominant land types. The nature of these trials is based on the information base continuously broadened as insight and experience are developed over time. Trials are modified as need d based on this experience. Usually five farmers fields are selected for each cropping pattern trial in the appropriate land type and 500-1000 m^2 of land are used with each farmer. The farmers manage the trials under the supervision of the site research staff.

2) Component technology trials are simultaneously conducted to test a wider spectrum of possible varieties, fertilizer rates, seed rates or other factors to identify better alternatives of these components than currently being used in the cropping pattern trials. Their design is similar to trials carried out in experiment stations usually with replication and smaller plot sizes. They are conducted with active farmer participation but are more fully "researcher managed trials".

3) Local crop cuttings for yield are taken from non-participant farmer's fields for crops in the existing, predominant cropping patterns in each land type, the farmers are interviewed about how they have managed the crops and what inputs were used. The results of these local crop cuttings

provide a basis for comparing the performance of the improved cropping patterns in the trials with what farmers are doing following their traditional practices. When satisfactory, improvements are observed, this provides credibility for extension of the improved cropping pattern technologies.

4) Monitoring is conducted to ascertain the general farmer reaction to the improved cropping pattern technologies being tested. This has mainly been accomplished through focused surveys by the socio-economic unit to determine farmer perceptions (of a new variety, for example). This, coupled with the normal socio-economic descriptive research and the day-to-day interaction between the site research staff and farmers, has allowed a continuous appraisal of the research results in each site.

These four activities will continue to form the basis of the research strategy in Pumdi Bhumdi as steps are taken to conduct research involving both crop and livestock production activities. Research will continue to emphasize the identification of relevant, compatible crop production technologies. There will, however, be an integration of research directed towards increasing the general supply of livestock feed, especially sources of high quality green fodder for use during the dry months before onset of the monsoon. This will include identification of better fodder sources for use both within and outside the cultivated land. The primary means to evaluate the research involving fodder production will be to monitor milk production and changes in livestock feeding practices.

More emphasis will be given to developing technologies to improve soil fertility to increase crop and fodder production and enhance crop intensification but which rely more upon resources within the farm. Emphasis will be given to introduce more legumes into the Cropping Systems, particularly in the lowlands for multiple-purpose use. For example, early maturing cowpeas could be plant before rice which would allow harvest of green pods and/or grain with the plant residues being fed to livestock or plowed down for green manure. Efforts to improve compost use and management will also be intensified. It must be recognized, however, that adequate yield increases may not be achieved if chemical fertilizer is completely excluded. Therefore, the judicial use of fertilizer will continue to be investigated but with more emphasis to its complimentation

with available plant nutrient sources on the farm.

The principal change in current research methodologies at Pumdi Bhumdi will involve the selection of farms to participate in the research and the relationship between these selected farm households and researchers. There are not sufficient available resources to "add-on" the crop-livestock research activities and still continue the existing cropping systems research. Modifications will have to be made to encompass the crop-livestock research within the existing program. In the past, more emphasis has been given to selecting interested farmers with appropriate land types to conduct both cropping pattern and component technology trials. A selected farmer usually had only one or two trials in only one land type. This involved a larger number of farms which was useful because it allowed testing technologies across a broad back-ground of conditions. However, it tended to inhibit an assessment of the interactions in resource allocation between land types. For example; it was difficult to determine if there was a resource constraint to intensifying cropping in lowland, low production potential fields caused by an existing need for available resources in the farm's upland high production potential fields. Also, the difficulties in supervising many farmers in the mid-hill sites because of trekking time to visit all farms prevented an intimate understanding of these whole farm activities.

Therefore, as crop-livestock research is implemented at Pumdi Bhumdi, farms will be selected to allow an assessment, through close monitoring and trials, of whole farm production activities. Two groups of five farms each will be selected. Most of these farms will be among those which have participated with past research activities. The farms in each group will exhibit several common characteristics as follows:

1) A cultivated land area between 0.5 to 2.0 ha
2) Mixed land type with at least 20% each of upland and lowland.
3) Between 5 to 8 household members with three - four members involved full time in agricultural activities.
4) Livestock owned by the farms will be "representative" for the area but each farm will own two or more female milking buffalo to ensure that milk production plays a major role.

One group of five farms will be considered as a "control group". Involvement with these farms will be limited to regular monitoring of their agricultural activities. Profiles of their available cultivated land, uncultivated land and livestock will be developed. Production of both grain and fodder will be monitored for crops being grown in the various land types. Livestock feeding practices will be monitored including feed sources from crop residues, grain fed as supplement, green fodder collected from within and outside the farm, purchased feed and grazing activities. Records will be kept of livestock turn over and milk production from each lactating buffalo throughout the year. Attempts will be made to assess human labor and bullock allocation within the farms and to determine hiring and exchange of labor and bullocks. The extent of this monitoring will evolve as experience is gained in the field. The objective will be to identify only those factors which must be routinely monitored to provide the necessary information to design and then evaluate research interventions with active farmer participation.

The other group of five farms will be similarly monitored but research interventions or trials will also be implemented with these farms. Initially, the actual cropping pattern trials conducted on these farms will be determined though discussions with the farmers. The objective will be to include ongoing cropping pattern trials involving different land types with this group of farms to allow an assessment through monitoring of the interactions in resource allocations between land types and livestock feeding implications. Component technology trials specifically involving potential fodder crops for use in the lowlands in winter (vetch, oat etc) and spring (cowpea) will also be implemented with this group of farmers, as will attempts to introduce fodder sources such as improved grasses and Leucaena in the non-cultivated areas, on terrace faces and on bunds. As soon as these component technologies are verified, new cropping pattern trials involving these fodder crops will be implemented with these farms.

All research, trials, however, will not only be concentrated with this group of farms. Some cropping pattern trials and component technology studies will be conducted with other farmers as needed to assure that adequate replication will be obtained. The objective with the five "intervention group" of farms will be to expose these farms to improved technologies in a manner which

allows on assessment of the "fit" of these technologies within the whole farm context. The close interaction, through close monitoring and experience with the conduct of the trials, between the farm households and the researchers will insure that actual farm situations dictate the nature of the trials and that the farm households are intimately involved in the trial designs. These farms will be encouraged to begin to make whole farm level decisions concerning technology adoption as rapidly as possible. As this occurs the regular monitoring involving the "control group of farms" and the "intervention group of farms" should begin to detect relative differences in such factors as crop yields, feed availability, livestock feeding practices, milk production and labor use especially for green fodder procurement during the pre-monsoon dry period. In addition, the monitoring should pinpoint new technologies tested with the "intervention farms" that are observed and adopted by the "control farms".

It must be recognized that there has been adoption of new production technologies (especially new varieties) by most farmers in Pumdi Bhumdi during the past years that the CSP has been working there. This process is continuing and will be encouraged and supported. As new technologies are developed with a crop-livestock focus, the extension of these appropriate technologies to other farmers will be included. This, in fact, is the ultimate objective of the program. Useful methodologies have been developed by the CSP to test, verify and extend crop production technologies that are relevant to farm conditions. The challenge now is to further develop these methodologies to combine livestock production considerations with crop production. This, in itself, is only a further step towards the development of suitable methodologies which can guide on-farm research to address those components of a given Farming Systems that are both important to the farm households and offer potential for improvement.

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November 25, 1984

Table 1: Characteristics of Population Pressure on Land of Surveyed Farms at Pumdi Bhumdi, 1983[1/]

Farm Category	Farm Size Range (ha)[2/]	% of Total Farm Surveyed	Average Farm Size (ha)[2/]	Average Cultivated Land (ha)	Average Uncultivated land(ha)[3/]	Average Households members Per ha cultivated land	Ha. Cultivated Land per adult Engaged in Farming
I	0-1.0	25	0.70	0.56	0.14 (20)	8.4	0.22
II	1.0-1.5	36	1.20	0.90	0.30 (25)	7.1	0.41
III	1.5-2.0	20	1.82	1.30	0.52 (29)	5.2	0.33
IV	2.0 and above	14	3.98	2.76	1.22 (31)	2.1	0.68

1/ - Summarized data provided by Mr. B.K. Singh and B.R. Gurung, Agronomist and Socio-Economist, respectively, with the CSP.
2/ - Total land including cultivated and non-cultivated land.
3/ - Figures in parentheses are percent of uncultivated land as it relates to total average farm size.

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Table 2: Characteristics of Land Holdings of Surveyed Farms at Pumdi Bhumdi, Kaski, 1983[1/]

Farm Category[2/]	Average Cultivated Area (ha)[3/] In Different Land Types		Average Number of Parcels In Different Land Types		Average Area (ha) Per Parcel In Different Land Types	
	Lowland	Upland	Lowland	Upland	Lowland	Upland
I	0.37 (67)	0.18 (33)	2.1	2.0	0.17	0.09
II	0.67 (75)	0.22 (25)	3.5	2.0	0.19	0.11
III	0.93 (75)	0.32 (25)	6.0	3.0	0.16	0.10
IV	1.97 (72)	0.78 (28)	10.0	4.8	0.19	0.16

1/ - Summarized data provided by Mr. B.K. Singh and Mr. B.R. Gurung, Agronomist and Socio-Economist, respectively, with the CSP.

2/ - Please refer to Table 1 for an indication of the farm size ranges for each Farm Category.

3/ - Figures in parentheses are percentages of total cultivated land.

Table 3: Livestock Ownership and Livestock Pressure on Total Land of Surveyed Farms at Pumdi Bhumdi, '83 1/

Farm Category 2/	Average Farm Size (ha) 3/	Average Cultivated Land (ha)	Average Non-Cultivated Land (ha) 4/	Number of Livestock: Female Buffalo 5/	Bullock	Cow	Goats	Average No. Livestock Units 6/	Ave. No. of Livestock Units Per ha of Land
I	0.70	0.56	0.14	2.4 (1.6)	0	0	0.2	3.2	4.0
II	1.20	0.90	0.30	2.8 (1.5)	0.5	0	1.8	4.0	3.3
III	1.82	1.30	0.52	3.8 (1.8)	1.0	0.8	0.5	5.2	2.8
IV	3.98	2.76	1.22	3.3 (1.5)	1.0	0.3	2.0	4.7	2.1

1/ - Summarized data provided by Mr. B.K. Singh and Mr. B.R. Gurung, Agronomist and Socio-Economist, respectively, with the CSP.

2/ - Please refer to Table 1 for an indication of the farm size range in each Farm Category.

3/ - Total land including cultivated and non-cultivated land

4/ - Pasture or waste land.

5/ - Figures in parentheses are number of lactating buffaloes at time of interview.

6/ - Livestock Units (LU) have been calculated as follows:
Milking Buffalo = 1.8 L.U., Young Buffalo = 0.8 L.U., Bullock = 1.1 L.U., Cow = 0.8 L.U.,
Female Calf = 0.4 L.U., Bullock Calf = 0.5 L.U., Adult Sheep and Goats = 0.25 L.U.

Table 4: Numbers of Milking Buffalo and Milk Production and Use of Survey Farms at Pumdi Bhumdi, '83 1/

Farm Category 2/	Average No. of Female Milking Buffalo 3/	Milk Production and Use		
		Average Total Annual Milk Production (l.)	Percent Sold	Value of Milk Sold (Rs) 4/
I	2.4 (1.6)	736	36	1,072
II	2.8 (1.5)	937	62	2,323
III	3.8 (1.8)	950	28	1,064
IV	3.3 (1.5)	762	24	724

1/ - Summarized data provided by Mr. B.K. Singh and Mr. B.R. Gurung, Agronomist and Socio-Economist, respectively, with the CSP.
2/ - Please refer to Table 1 for an indication of the farm size range in each Farm Category.
3/ - Numbers in parentheses are number of lactating buffaloes at time of interview.
4/ - 1 U.S. $ (Dollar) = 17.3 Nepali Rupees.

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Table 5: Estimated Available Livestock feed of surveyed farmers at Pumdi Bhumdi, Kaski District, 1983 1/

Farm Category 2/	Average Amount of Crop Residue Per Farm (kg) 3/	Average Amount of Green Fodder from Fodder Trees Per Farm (kg)	Average Amount of Grain Fed to Livestock (kg)	Average Available Total Feed Dry Matter Per Farm 4/ (kg)
I	4,165	1,914	352	4,324
II	5,636	5,275	458	6,001
III	10,145	8,200	310	11,335
IV	21,207	13,225	460	22,122

1/ - Summarized data provided by Mr. B.K. Singh and Mr. B.R. Gurung, Agronomist and Socio-Economist, respectively, with the CSP.
2/ - Please refer to Table 1 for an indication of the farm size ranges for each Farm Category.
3/ - Stover of maize, straw of rice, wheat, finger millet and other crops. Does not consider other uses of these products such as thatching, bedding for livestock etc.
4/ - Estimation of total Dry Matter follows methodologies presented at the Asian Farming Systems Network Crop-Livestock Workshop Held at IRRI on April 25 - 28, 1983.

Table 6: Total Estimated Feed Energy Available, Required and the Balance for Livestock of Surveyed Farm at Pumdi Bhumdi, Kaski District, 1983 1/

Farm Category 2/	Estimated Available Feed Energy (M.J.) 3/			Total Energy Available (M.J.)	Total Energy Required (M.J.) 4/	Energy Balance (M.J.)
	Crop Residues	Fodder Trees	Grain			
I	22,074	4,785	5,104	31,963	40,880	- 8,916
II	29,865	13,187	6,641	49,693	51,100	- 1,406
III	53,768	20,500	4,495	78,763	66,430	12,333
IV	112,397	33,062	6,670	152,129	60,042	92,087

1/ - Summarized data provided by Mr. B.K. Singh and Mr. B.R. Gurung, Agronomist and Socio-Economist, respectively, with the CSP.

2/ - Please refer to Table 1 for an indication of farm size range for each Farm Category.

3/ - Calculation of Available Feed Energy in Mega Joules (M.J.) were made following the report by Nigel Hopkins entitled "The Fodder Situation in the Hills of Eastern Nepal, APROSC, April, 1983.

4/ - Total Energy Required based on average number of Livestock Units for each Farm Category given in Table 3. Energy for maintenance of one livestock unit per day is equivalent to 35 M.J.

IADS/KDS: ds
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