Grains and Roughage Production and Its Utilization in Asian-Australasian Region*
- Review -

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ABSTRACT : Asian-Australasian region comprises of 82 countries spread over varying agro economic zones, habitats and ecosystems varying from dry hot to humid tropics and cold deserts. The literacy standards vary from very low to almost 100 percent. On the basis of economic development there are 4 countries Japan, Australia, New Zealand and Korea which are developed countries, rest are in varying states of development and growing economically very rapidly. Based on Agro ecosystems and farming practices, we have chosen four countries for indepth study in this paper namely China, Thailand, Indonesia and India. They represent 70% of the bovine and poultry population of the region. This paper makes a comparative study of the grain and roughage production and utilization at present and in 2000 A.D. by examining information on feed rates demand patterns and feed requirements in these four countries keeping in view the size and growth of bovine and poultry population and dietary pattern of the people. It has been observed, there has so far been no country level detailed study on the livestock feed requirements. Apart from conceptual discrepancies, most of the estimates given in various reports brought out by the national governments and international agencies do not have any scientific basis. Hence an inter-country comparison is virtually impossible on the basis of the available information. We have however, attempted to analyse the dietary pattern in the different countries, feedgrains requirements, availability of feed based on the information available from the various published and unpublished reports. We have given an inter-country comparison of feed rate and feed requirements which, however, needs to be tested by carrying out a micro level study in each selected country. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 3 : 481-492*)

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INTRODUCTION

Asian-Australasian region comprises of 82 countries spread over varying agro economic zones, habitats and ecosystems varying from dry hot to humid tropics and cold deserts. The literacy standards vary from very low to almost 100 percent. On the basis of economic development there are 4 developed countries Japan, Australia, New Zealand and Korea. Rest are in varying states of development and growing economically very rapidly. Japan and Korea is a net importer of feed grains, Japan also imports roughages. While Australia, New Zealand and Thailand are net exporters of grains, others are marginally self sufficient or net importers of grains. Based on Agro ecosystems and farming practices, we have chosen four countries for an indepth study in this paper namely China, Thailand, Indonesia and India. They represent 70% of the bovine and poultry population of the region (table 1).

With increasing demand for livestock products on the one hand and uninterrupted increasing human population, and shrinking land area on the other, future hopes of feeding the millions and safeguarding their food security will depend on intensification of agriculture and new breakthrough in food/feed biotechnology. In this context, it becomes incumbent on us to evolve (i) scientific

Table 1. Agricultural and livestock production in selected countries (Thousand tonnes)

Crop	India 1995	China 1995	Indonesia 1995	Thailand 1995
Rice	79,307	124,868	32,300	14,227
Wheat	65,767	102,212		
Coarse Cereals	29,321	129,052	8,225	4,434
including Maize	9,667	108,000		3,800
Total	174,395	356,132	40,525	18661
Total Milk	64,500	8,777	719	301
Cow	32,000	5,810	449	265
Buffalo	30,565	2,100	-	6
Sheep	-	680	78	-
Goat	1,935	187	192	30
Total Meat	5,430	56,877	2,115	1,718
Goat & Sheep	646	1,742	94	1
Beef	1,292	3,474	280	248
Buffalo	2,493	3,803	301	311
Pigmeat	421	38,651	681	301
Poultry Meat	578	9,207	759	857
Total Eggs	1,540	15,387	579	648
Hen	1,540	12,340	453	538
Others	-	3,047	126	110

Source: FAO Production Year Book and Food Outlook.

Table 2. A comparative study of productivity levels of various livestock products 1995

Item	China			India			Indonesia			Thailand		
	No.	Prod.	Yield	No.	Prod.	Yield	No.	Prod.	Yield	No.	Prod.	Yield
Cow milk	3,619	5,810	1,606	32,000	32,000	1,000	379	449	1,185	120	265	2,208
Meat												
Beef & Veal	17,373	3,474	200	12,543	1,292	103	1,800	280	156	1,239	248	200
Buffalo	3,006	301	100	8,725	1,204	138	310	54	173	250	0.63	253
Goat	66,522	832	13	47,415	474	10	6,070	61	10	23	0.35	15
Pigs	494,360	37,686	76	12,000	420	35	12,200	671	55	6,092	301	50

No.: 000 heads, Prod.: 000 MT, Yield: kg per No.   (Source : Production Year Book, FAO, 1995)

systems to project the demand for foodgrains production and utilization, (ii) for livestock feed and fodder, over short/long periods, this would help in evolving appropriate development policies and a technology agenda for their production/availability. While there is a reasonably strong data base available about production and human consumption of foodgrains in a major part of the developing world, there is hardly any empirical study available which can help to provide any empirical basis for the present consumption pattern of livestock (feedgrains, concentrates and roughages) or project the demand for the same in the major part of the region.

CHANGES IN DIETARY PATTERNS

The four countries studied have diverse dietary habits. Indonesia has a significantly large percentage of Muslim population for whom eating pork is a toboo. In India, predominant Hinduism regards cattle as sacred and the majority of Indians are vegetarian who obtain their major share of protein from pulses and dairy products. While eating of beef is prohibited for Hindus and pig for Muslims, the consumption of poultry (egg and chicken) is fast increasing in these countries. Chinese food is characterized by a relatively large consumption of pork and fried vegetables. For Asian countries, we can regard rice as the common staple food. However, many depend on other starchy food, such as roots and tubers, in their daily diet. Moreover, in North China and some states of India, rice is not a staple food. Despite these diverse eating habits and customs, certain common changes have taken place in dietary patterns of all these four countries. Most important of these changes is shift

from mainly cereals to larger consumption of livestock product.

Regarding the share of food in the total monthly per capita expenditure, the data available for the four countries are for different years (table 3) but by and large the food expenditure shares in the four countries confirm Engels law that as income or expenditure increases, the food expenditure share decreases. Among these four countries, the highest share of expenditure on food is in rural India (63.2%), while that of Indonesia is the lowest at 36.2%. Socio economic profiles of these countries reflect the changes in social structure which determines the feeding patterns.

There is a clear contrast in the long-run trend of direct consumption of certain livestock and dairy products. A decreasing trend of cereal consumption is observed in all the countries except for rural areas in China. This may be due to the overall early stage of rural socio-economic development there where cereal consumption has not yet reached its satiation point. The most remarkable decrease in cereal consumption is in urban areas of China where per capita cereal consumption decreased from 145.4 kg/capita/year in 1978 to 97.8 kg/capita/year in 1993. As for Thailand and India ,there is a relatively large decline in cereal consumption which fell by more than 10% during the early or middle 1970s to the latter half of 1980s. Indonesia, however, is the only country among this group where per capita consumption of cereals has increased.

An analysis of the Thai dietary pattern shows that meat is becoming more important in the daily diet. Therefore, it is expected that demand for meat will

Table 3. Food expenditure share (in US dollars)

Year	China, 1988		India, 1993-94		Indonessia, 1993	Thailand, 1988
	rural	urban	rural	urban		
Monthly expenditure/capita	10.67	24.73	10.8	17.6	32.26	44.35
Food expenditure share (%)	53.41	51.36	63.2	54.7	36.2	39.80
Cereal	36.55	13.34	24.2	14.0	24.3	27.3
Meat	16.83	30.03	3.3	3.4	5.2	28.4
Dairy product	N.A	N.A	9.5	9.8	5.0	6.4
Vegetable	11.59	12.47	6.0	5.5	8.8	6.9
Fruit	n.a	n.a	1.7	2.7	4.7	19.0*

Source: NSSO, 50th Round for India; Itharattana 1996 for Thailand; Guoqiang 1997 for China; Gunawan 1997 indonesia.
Note: In India meat includes meat, eggs and fish. In Thailand monthly expenditure per capita and food expenditure share are those of production workers. The share are percentages in the food expenditure.

Table 4. World cereal utilisation (million tonnes)

	Cereals total		Wheat		Coarse grain		Rice	
	84-85	95-96	84-85	95-96	84-85	95-96	84-85	95-96
Food	768	912	332	400	163	190	273	332
Feed	622	620	99	93	516	518	7	9
Other uses*	203	250	63	72	112	146	28	32
Total	1,593	1,792	494	564	790	855	308	373
Feed as % of total	39.0	34.6	20.0	16.5	65.3	60.6	2.27	2.4

* Other uses include seed, industrial uses and waste. Source: Food Outlook, FAO April, 1987 and April 1997.

increase. Using the CAPPA data base (from a study undertaken in Thailand by FAO) for function types and parameters, the demand for meat, eggs, and milk in 2001 was projected (table 4). The projection was done under the assumption that the population grows at a rate of 1.04% annually and per capita income expenditure growth rate is 7.18%. The projected quantities of these commodities were converted to demand for feed through the number of livestock.

As income increases, the Thai population increases its consumption of meat, eggs and milk. It is expected that demand for pork, chicken meat, eggs and milk will increase from 382.8, 736,686.8 and 1,226 thousand tons in 1996 to 433, 832, 769 and 1,713 thousand tons in 2001, respectively. The quantities of meat demand in 2001 were converted to live animals by 5.28, 700.25, 41.02, and 0.68 million heads of swine, chicken, hens and dairy cows, respectively. As a result, feed requirement for the whole livestock industry totals 5.4 million tons in 2001 whereas it is going to be 4.565 million tons in 1996.

Consumption of other foods, especially meat and milk is low compared to other Asian countries in Indonesia. Besides their relatively high price, this is probably due to the eating habits of most Indonesians who prefer vegetable protein to animal protein. Cereals are the largest source of calories and protein for most of the population, more so than in other countries with similar economic conditions.

Surveys on food consumption trends from the 1970s to the 1990s in each of the countries show a shift away from cereal consumption towards meat and dairy products. People in these countries are likely to consume more meat and dairy products as their income improves.

The above discussion would highlight the fact that livestock feeding practices and norms will primarily be effected by changes in dietry pattern of human population and the production systems. While poultry meat is produced under the intensive system every where, systems for producing other types of meat-beef, buffalo, sheep, goat and pig etc.- vary from country to country. China produces nearly 57 million tonnes of meat, of which more than 84 percent is from piggery and poultry (major part in the semi organised extensive sector). Total meat production in India, on the other hand, is estimated at 5.4 million tonnes, of which hardly 10 percent of poultry meat is the contribution of organised sector. The position in Indonesia and Thailand is also similar to China where meat production, although

in small quantities, is produced in the organised sector.

WORLD ESTIMATES FOR FEEDGRAINS

According to FAO estimates, as much as 39 per cent of cereals were used as feed during 1984-85 for the whole world. This came down to 34.6 percent during 1995-96. The physical quantity of foodgrains is less by 2.0 million tonnes (table 4). Estimated consumption of wheat, coarse grains and rice for feed during 1994-95 was 647.0 million tonnes as estimated by FAO when the world production of meat, milk and eggs was less than 1995-96. The Story is however different according to USDA sources (table 5).

Table 5. Consumptions of foodgrains for feed (million MT)

	Total production	Feed consumption	Feed as % of total
Wheat, 1995-96	534.7	94.3	17.6
Coarse Grains, 1995-96	787.4	547.6	69.5
Total* 1995-96	1322.1	641.9	48.6

(Source: Grain, World Market & Trade, May 1996, USDA)
*According to USDA no rice is fed to animals as feed.

Data from the two sources do not tally which is possible because the methodology in each case may be different. But what is important in the two sources is that while according to FAO the total quantity of coarse grains, wheat and rice fed to animals came down from 622 to 620 million tonnes during the 11 years period, corresponding figures for USDA are 608.7 and 641.9 million tonnes. A long time data series of USDA shows that the consumption of wheat for feed increased from 60.6 to 97.2 million tonnes (62.3%) and coarse cereals from 336.4 to 568.4 million tonnes (59.2%) during 1968-69 to 1995-96. There is a steady increase upto 1987-88 when estimated feed (wheat and coarse grain) peaked at 661.5 million tonnes. Eight years later (1995-96), the estimate is only 641.9 million tonnes-nearly 20 million tonnes less than the base 1987-88.

According to USDA rice is not being fed to animals anywhere in the world, but FAO shows that this has increased from 7.0 to 9.0 million tonnes during the same period. Our studies show that small quantities of

rice are being consumed by livestock in India. While in China during 1993 as much as 20.0 million tonnes of rice was consumed by the animals. A study by IFPRI shows that the estimated consumption of paddy for feed use was 32.0 million tonnes representing 8.0 per cent of production during 1980. Total consumption of cereals according to the IFPRI Study during that year as feed was 681.0 million tonnes representing 43.5 per cent of total production.

A comparison of these three sources of data FAO, USDA and IFPRI depicts a rather confusing picture. IFPRI does not give any annual data series. But for 1980 its estimate is 681.4 million tonnes as against 559.6 million tonnes by USDA. Again for 1984, FAO estimate is 622 million tonnes against USDA 582.2 million tonnes. Besides such varied estimates, one striking feature is that while cereal feed consumption according to FAO and USDA has come down during the last 10-11 years, world production of eggs, meat and milk increased many fold during the same period. With this type of data before us from the three highly respected sources, one would wonder what sanctity can be attached to all these estimates. The only conclusion which one can derive from all this is that none of these organisations which, of course, depends on country information, has any empirical basis for estimating the demand for feedgrains either at the national or international levels. Every one of the players in the game is depending on guess work. IFRPI appreciates that the use of cereals for livestock feed is growing rapidly in developing countries and is reaching significant proportions and that this fact has profound implications for food security of low-income people, employment, and the size of markets available to exporters of cereals and did undertake a few studies, but no one has tried to find the real ground situation which has its own peculiarities.

Taking the case of China, the largest consumer of feedgrains, we find that besides the national sources, estimates are available from FAO, USDA and IFPRI. None of these however make any sense in the context of livestock products produced by the country. We provide here a comparison of various estimates (table 6).

Table 6. Consumption of feedgrains in China (000 tonnes)

	Rice	Wheat	Maize	Other Cereals	Total
FAO (1992-94)	2,340	3,000	53,667	3,826	62,833
USDA (1993/94)	-	2,700	7,170[1]	-	74,400
National Sources (1993)[2]	2,000	-	80,000	12,410	124,100
IFPRI (1990-92)	11,000	4,000	56,000	6,000	77,000
(2020)	-	-	-	-	232,000
World Bank (2020)	46,300	21,600	-	138,200	206,100

[1] Represents total coarse grains, [2] Separate for wheat is not available. This possibly includes all other cereals.

COUNTRY PROFILE

Indonesia

In the case of Indonesia where per capita consumption of meat is just 0.5 kg. per annum and eggs only 0.3 Kg., FAO. Food Balance sheet shows a consumption level of 739 thousand tonnes of rice and 3050 thousand tonnes of maize during 1992-94 as used for feed. USDA estimate of total feedgrains used during 1992-93 is 2930 and for 1993-94,3190 thousand tonnes. FAO Food Balance sheet shows a consumption level of 204.8 kg. per annum per capita during 1993-94 and the corresponding figure according to national sources is only 123.2 kg. There is no mention of wheat in the human consumption pattern, although imports have touched nearly 4 million tonnes in recent years- all for human consumption. Calculated on the FAO basis, human consumption of cereals works out to 38.1 million tonnes, leaving a few thousand tonnes for feed, and wastages. At the same time, the country is a net exporter of 0.5 million tonnes of rice and coarse cereals.

All these data have no relation with the National sources. Reliable data on utilization of each commodity for different purposes such as feed, food industries, and human consumption are not available in Indonesia. The time series Food Balance Sheet (FBS) data provide information on the average availability of each crop per capita per year and the use for feed and food industries as well as for human consumption. These data are published by Ministry of Agriculture (MOA) and Central Bureau of Statistics (CBS). Production, export and import on the supply side are regarded as accurate, but the data on feed and food industries which are usually estimated as percentages of total supply are generally very poor. In FBS data, the portion of commodity for seed is estimated as 5%, waste around 20%, and feed 2%. Hence, it is difficult to estimate the trend in demand for industry for a particular commodity using FBS data.

Indonesia produces about 40 million tonnes of cereals, of which around 32.0 million tonnes is rice. According to national sources, 2 per cent of cereals is used for feed. On the basis of total production, it will calculate to 0.8 million tonnes and if restricted to coarse cereals alone, it would mean 0.16 million tonnes. The FAO Food Balance Sheet as against this shows 3.8 million tonnes as feed consumption. Human consumption of maize in Indonesia is around 6 kg per capita per annum. For a total population of 190 million, this will calcuate to only 1.14 million tonnes during 1994. Indonesia produced a total of 6.9 million tonnes of maize and imported another 0.5 million tonnes. If the total human, livestock and industrial consumption was hardly 1.3 million tonnes, what happened to the remaining quantity. In nutshell, we will not, therefore, be wrong to assume that, there is a major problem with the collection and inter pretation of data about the consumption patterns, not only of feed, but also of human cosumption.

Thailand

Thailand produced 3.4 million tonnes of maize during 1993, of which 3.2 million tonnes was used for industry and seed. Industry means primarily feedgrains. National sources give norms for calculating feed requirements which are in terms of concentrates. Total quantity of such concentrates required for 1996 has been calculated as 4.5 million tonnes. FAO Food Balance sheet as against this shows the quantity of foodgrains used for feed during 1992-94 as 4.1 million tonnes, of which 3.5 million tonnes is maize and the balance is rice, although according to national sources no rice is fed to livestock. National sources also calculate the demand for maize for the feed industry as 3.68 million tonnes during 1994. What is the basis of norms fixed as given above is not clear. Even otherwise, although different estimates vary between 3-4 million tonnes, the difference is quite significant in a country where total human consumption is only 12.0 million tonnes.

India

India, is perhaps the only country where feedgrains estimates are lumped together with seed and wastages. A fixed rate of 12.5 per cent has been adopted by the Govt. of India for a period of nearly 50 years for feed, seed and wastages without any empirical basis.. This is neither scientific nor does it make any sense. A survey conducted by TERI during 1986-87 showed that the total consumption of feedgrains was 10.32 per cent for the region with a wide variation (8.22 to 12.01). Some of the scholars in India have estimated feed requirements for the year 2000. Praduman Kumar by counting total livestock production in LOU (Livestock Output Units) concluded that total feed available during TE 1992 was 14.5 million tonnes, of which share of foodgrains was only 2.7 million tonnes.

There are 3 international sources, FAO, World Bank and IFPRI whos estimates are available. FAO Food Balance Sheet gives 1730 thousand tonnes of foodgrains used as feed during 1992-94. As against this, World Bank shows that, during 1995, of the total supply of 33.7 million tonnes of concentrates, against a demand of 31.6 million tonnes, 22.0 million tonnes was from brans of foodgrains and the balance of 11.0 million tonnes from oil cakes. IFPRI estimates, on the other hand calculate the requirements of feedgrains as 52 million tonnes for the year 2000. We tried to approach this problem for the year 1993-94 according to the residual method and found that a total of 10.2 million tonnes of foodgrains were consumed by livestock in that year. (table 7).

In the absence of any empirical evidence available to calculate the actual quantity of foodgrains consumed as feed, we have adopted a residual approach based on the following assumptions:

1. Total population as on March 1994 calculates to 914.1 million. This is based on the 1991 revised figure of 861.4 million and 2% annual growth.
2. With the base population of 896.17 million on March 1993, estimated population fed during 1993-94 is taken as 900 million, of which 225 million at 25% is calculated as urban.
3. According to the 50th Round (1993-94) NSSO Survey, per capita consumption of cereals was around 168 kg per annum for rural and 132 kg. per annum for urban areas. Adding to this the total production of pulses (13.3 million tonnes), total human consumption comes to 154.34 million tonnes constituting 86 per cent of toal production.
4. Based on our study, 1.2 million tonnes of foodgrains are required to produce one million tonnes of chicken/eggs.
5. Seed requirements have been calculated for 122.75 million hect. area under foodgrains.
6. Since a part of the wasted grain is consumed by livestock, a total of 1.5 per cent of total production and net imports is taken as the grain which is actually wasted. Over 66 percent of wasted grain was used for livestock feeding.
7. Total availability of grain in circulation during 1993-94 is taken as total production (179.48) minus changes in public sector stocks (9.6) plus net imports (2.4 million tonnes).
8. Balance left, 8.35 million tonnes, was fed to animals to produce 3.1 million tonnes meat, 60.6 million tonnes of milk produced during 1993-94, and rest used for work animals and for other livestock etc.
9. India has a special place for Draught Animal Power (DAP) and this aspect of the feed requirement has actully been ignored by practically every body (national/international researchers). This is peculiar to India and its neighbours where animals form a major part of the economy. DAP produces energy equivalent to 6 million tonnes of petroleum, has to have proper energy sources. Assuming that animals have to be fed concentrates say for 100 days in a year and an average 30 kgs of foodgrains are given per animal per year, requirements of foodgrains for a total of 82.0 million work animals would calculate to 2.5 million tonnes.
10. There are over 12.0 million (including half a million cross bred) non castrated male cattle and about a million male buffaloes kept for breeding. This 13 million or odd breeding bovines, the recommended norm is 0.3 kg per day per animal. Requirement of this group of animals should then be around 0.8 million tonnes.
11. The feed requirements for meat other than chicken has been worked out as 1.5 million tonnes. All the meat from female cattle is a by product. Nearly half (about 7.0 million) buffalo males, around 1.5 million crossbred sheep out of a total of about 50.0 million,some of the 100 million goats, about 1.0 million crossbred pigs (out of a total of over 10.0 million) are getting some concentrates. In the absence of any information available, we assume 1.5 million tonnes of foodgrains for all the 3.1 million tonnes of meat produced other than chicken.

12. Out of a total of 8.5 million tonnes left with us for livestock feeding other than poultry, we are now left with 3.56 million tonnes for milk. This when calculated for 60.6 million tonnes of estimated milk production during 1993-94, gives us a conversion factor of 17.0 kg of milk for one kg of foodgrains. This appears to be reasonable as compared with our Regional Survey estimate of 14.0 kg milk for one kg. foodgrains for North India where animals are welfed. It must be appreciated that of the 25 million or so of cattle in milk less than 7% are cross bred. Most of the non descript animals who produce less than 22.5 kg of milk no concentrates are fed to them. Proportion of animals producing less than 22.5 kg. of milk is quite high. (table 7).

Table 7. Consumption pattern of foodgrains in India during 1993-94

	Million tonnes
Human Consumption (Million Nos.)	
Rural(675 @ 168 kg.per annm.)	111.34
Urban(225 @ 132 - do -)	29.70
Total(900 @ 159 - do -)	141.04
Pulses(Total production)	13.30
Poultry (Million Tonnes)	1.85
(1.54@ 1.2 tonnes per tonne)	
Seed of foodgrains	5.00
Wastage (@ 1.5% for total production	2.73
+net imports (181.9 million tonnes)	
Total	163.92
Total availability 179.48-9.6 (public	172.28
sector stocks) 169.88 + 2.4 imports	
Balance for milk & other meat	8.36
and Work force	
Work force	2.5
Breeding Bullocks	0.8
Other meats	1.5
Total	4.8
Balance for milk	3.56
Total production of milk during 1993-94 =	60.60
Milk produced per kg. foodgrains consumed.	17.0 (kg)

On the basis of above examination of the published data, from national and international sources, on estimates for livestock feeding (Grains and roughages) and projections for 2000 AD. There is neither any basis for these estimates, nor any type of agreement between the calculated numbers by different agencies. The variation between them is so wide that no reconciliation is possible. Since the importance of livestock products is increasing in human consumption patterns we recommend that a reasonable empirical basis is established to determine the requirements of feedgrains and projections for future.

China

In China, feed is conventionally divided into three types: feed grains, oilcakes and bran. Feed grains include maize which is the major grain, rice, tubers and roots. Tubers and roots in China refer to field crops including potato and sweet potato, but taro, cassava and other tubers and roots used as vegetables and grown in suburbs are excluded.

Presently, there are no formal statistical data of feed in China. Feed data in China are generally calculated in two ways: one way is to take food, seed, the part for industry, stocking, the difference between import and export and the losses from the total grain production, and consider the remainder as feed grain; the other way uses the yearly livestock and fishery output to calculate feed by a certain feeding ratio. Both methods are based on estimated data or data from sampling surveys. The estimated food consumption in the first method tends to be a little higher because food is always over-supplied in both urban and rural areas and rural consumers usually use the remainder as feed. On the other hand, with the second method, it is not easy to determine the feeding ratio. Two feeding patterns for livestock and fisheries exist now in China, namely, household raising and large scale raising. Household raising accounts for the majority production and its feed type, nutrition and husbandry vary greatly. Consequently, it is very difficult to calculate a set of feeding ratios for household raising.

The first method of calculation is based on grain and it gives the available amount of feed, while the second is based on the production of livestock and fish and it gives the consumption of the feed. The gap between the two methods is considerable, but it is generally believed that the first is more realistic. (table 8).

Because of the difficulty in accessing statistical data directly, the total level of feed grain availability is generally based on its share in the output of grain. In 1990, feed grains accounted for about 25% of grain production compared to about 15-20% before the reforms and opening up to the outside world, which amounts to 100 million tons more feed grain. In 1994, this proportion reached more than 30%.

According to the nutrition requirements of livestock and poultry, the protein content in the feed should be up to 14.5% while in China now, it is only about 10%. Although the output of oilcake has increased to a certain extent in recent years, it only constitutes 3.8% of the total feed production (Team for Chinese Medium and Long-term Food Development, 1993). The shortage of protein feed supplements causes an imbalance between energy and protein feeding and thus influences the feeding ratio. Protein mainly comes from the high protein oilcakes only 30% of oilcake output was used as feed in China in 1980. In 1993, the output of oilcake was 21 million tons, of which 15 million tons was used as feed, accounting for about 71% (Institute of Feed 1995).

Statistical analysis indicates that total bran production accounts for 21% of food consumption of raw grains, of

which 62% can be used as feed. In 1993, the output of bran feed in China was 36 million tons (Institute of Feed, 1995).

From the limited statistical data, we cannot get details of the share of feed grains. Calculations based on related available data indicate the following: feed grains make up the largest share, about 70%, oilcakes 8% and bran 20%. Maize, rice and tubers and roots account for the major proportion of feed grain output. Some recent research demonstrated that about 58 million tons of maize output and the 13.32 million tons of rice were used for feed, but these estimates may be somewhat on the low side.

The output of industrial feeds rose at a rate of 10% each year, the demand still cannot be satisfied. It is important to note that the additives used in concentrates and premix feed have to be imported (National Feed Industry Office, 1995). Based on the demand projection for livestock products, the requirement for feed is projected for the year 2000 (table 8).

Table 8. Domestic demand for feed in China

Item	Feeding ratio	1990-1992	2000 Trend projection	2000 Demand system
Domestic demand for livestock products				
Pork	3.50	24.56	36.13	35.64
Beef	3.20	1.53	2.09	1.98
Mutton	3.20	1.17	1.70	1.51
Poultry	2.10	3.91	7.23	6.86
Egg	3.00	9.12	24.90	13.79
Milk	1.84	5.21	14.37	6.43
Domestic demand for feed				
Feed demand for				
pork		85.96	126.46	124.74
beef		5.36	7.32	6.93
mutton		4.10	5.95	5.29
poultry		13.69	25.31	24.01
egg		31.92	87.15	48.27
milk		18.24	50.30	22.51
Total domestic demand for feed		159.25	302.47	231.74
Annual growth rate (%)			7.39	4.26

There is a big variation in the feed requirement by the year 2000 obtained by the trend projection and

demand system methods. The trend line method projected the demand for feed at about 302.47 million tons in the year 2000 with an annual compound growth of 7.39%. On the other hand, the consumer demand system projected the feed demand at 231.74 million tons in the year 2000 with a growth of 4.26% per annum. Looking at the actual growth rate in availability of feed during 1980 to 1992 (6.1%), the projections derived from the demand system approach appear to be more realistic. Thus, China should plan for meeting the annual domestic demand for feed of about 231.74 million tons in the year 2000.

The projected annual growth in domestic demand for feed is 3.22% for maize, 5.65% for soybean meal, 0.88% for rice and 0.13% for grain equivalent for sweet potato and potato during the period 1991 to 2000. The demand as animal feed in the year 2000 will be about 73.98 million tons of maize, 3.08 million tons for soybean meal, 21.94 million tons for rice, 15.46 million tons of grain equivalent for sweet potato and potato.

In the year of 2000, the demand as animal feed will be about 103.82 million tons of maize, 6.03 million tons for soybean meal, 25.95 million tons for rice, 19.47 million tons for grain equivalent of sweet potato and potato. Looking at the actual feed composition in availability of feed in the early 1990s and comparing the results of demand projections, the demand projections as animal feed for maize, soybean meal, rice, sweet potato and potato (table 8) appear to be more realistic. Thus, these products together would meet about 67% of the projected total feed demand (231.74 million tons) for the year 2000. The other share of future feed demand has to be met from other sources.

ROUGHAGES

Roughages include grass and grazing, crop residues, Industrial by-products, (sugarcane, fruits, vegetables distallaries) cultivated fodders, weeds and fodders from trees. One would have very much liked to have complete information on each and every one of these sources of livestock feeds as available and being utilised by the animals. Since quantity and productivity levels of animals certainly depends on the quality of fodder, available for feeding and importantly absorptive capacity of the animal. It is necessary that these two parameters

Table 9. Meat demand, livestock numbers and feed requirement in Thailand

Year	Meat demand (1,000 tons) Pork	Broiler	Egg	Milk	Livestock numbers (million head) Swine	Broiler	Layer	Dairy cattle	Feed requirement (million tons) Swine	Broiler	Layer	Dairy cattle	Total
1996	382.8	736.1	686.8	1226.0	4.668	619.613	36.629	0.490	1.284	2.231	0.134	0.916	4.565
1997	395.4	756.0	704.0	1322.0	4.822	636.364	37.547	0.529	1.326	2.291	0.137	0.989	4.743
1998	407.7	775.6	720.8	1419.0	4.972	652.862	38.443	0.568	1.367	2.350	0.140	1.062	4.910
1999	419.8	794.8	737.2	1516.7	5.120	669.024	39.317	0.607	1.408	2.408	0.144	1.135	5.095
2000	431.7	813.5	753.3	1614.9	5.265	684.764	40.176	0.646	1.448	2.465	0.147	1.208	5.268
2001	433.2	831.9	769.1	1713.1	5.283	700.252	41.019	0.685	1.453	2.521	0.150	1.281	5.405

(Source: Office of Agricultural Economic, Thailand)

be ensured in the feed, as most livestock with small holders are raised on straws and supplemental grazing. The level of feeding will thus be in direct relationship with the output. Some idea in this respect about the countries studied can be made from the unit productivity levels (table 10, 11) which cannot be quantified, it, however, highlights the manifold systems of mixed crop/livestock farming in the different countries (table 12).

Use of the crop residues as livestock feed is a common practice. There is infact, an enormous potential for a better utilisation of crop residues as livestock feed. Here again, some standard conversion factors have been applied to come to these numbers, but very little information is available about the qualitative aspect. The relative importance of crop residues has inter and intera country as well as regional variations depending upon agro-ecological conditions and various other allied aspects. Some idea about the relative importance of crop residues in the total diet composition of livestock can be formed from the scattered information available (table 13).

Crop residues are generally of low nutritive value. One way of improving the quality of the diet is to supplement them with other feed resources which are richer in energy and protein and/or superior in digestibility or intake.

An attempt has been made to tabulate this information for the four countries (table 11) cereal straws have, no doubt, been the main focus of attention as the main source of livestock feeding. But unfortunately hardly any progress has been made by the farmers to adopt available technologies like urea ammonia treated straw enriched with molasses. Some of the key factor associated with this are :

Too much emphasis on the characterization and pretreatment of cereal straws. Inadequate project design, lacking in a systems approach, ensuring effective priority setting in accordance with farmer's needs, farmer participation in technology design, on farm evaluation with farmers, and appropriate mechanisms for technology transfer. No clear demonstration of the economic benefits of this technology to farmers. Without such benefits, farmer acceptance and adoption are likely to remain insignificant.

An attempt has been made here to provide information about the potential available in the 4 countries from grazing as well as stall feeding. A study of Land Use Patterns (table 10) in different countries can give a comparative picture of the available grazing facilities. China is the only country in the region which has the maximum (43%) area under permanent pastures, while Indonesia is on the top with regard to forests and woodlands. How much of these areas are available for livestock grazing and what is their capacity of feeding is, however, not known. Some idea can, however, be made by an understanding of the major agricultural systems (table 12).

If we look at availability of roughages (table 13) it will be observed that the current dificiency of dry fodder varies from (531%) 5% for China to 31% for India. Similarly for Green fodder from 2% for China to 23% in India. The availability of CPR (Common Property Resources) have shrunk by 30% in the last 4 decades. This gap is likely to widen by 2000/20 AD if the present technologies remain and no new breakthroughs are available. It will be observed from the data presented in this paper that regardless of the constraints with the data and its contradictions, the fact which emerges rather clearly is that most countries are short of both concentrates and roughages to support even the present levels of production what to speak of meeting the near term food requirements (2000 AD) or long term food needs of 2020 and beyond using conventional research inputs so far available. In our estimation this is not likely to be of great value except

Table 10. Land use patterns in 1993 and changes in relative proportions of each land use type since 1974/76

Country/ region	Area	AL	PC	PP (1,000 ha)	F/W	Other	A+PC	PP (% of total area)	F/W	A+PC	PP 1974/76(%)	F/W
China	932,640	92,708	3,267	400,000	130,496	306,169	10	43	14	-1	12	2
India	297,319	166,100	3,550	11,400	68,500	47,769	57	4	23	1	0	1
Indonesia	181,157	18,900	12,087	11,800	111,774	26,596	17	7	62	6	0	-6
Thailand	51,089	1,760	3,200	800	13,500	15,989	41	2	26	8	1	-10

(Source : FAO, 1984, 1994)

[1] AL-arable land, PC-permanent crops, PP-permanent pasture, F/W-forest and woodland, A+PC-arable land and permanent crops.

Table 11. Estimated crop residue availability (000 t fresh weight) in 1993[1]

Country/ region	Wheat	Rice	Barley	Maize	Rye	Oats	Commodity Millet	Roots & tubers	Sorghum (total)	Pulses (total)	Soyabean	Groundnut (in shell)	Sigar-cane
China	138,314	233,968	4,550	309,138	1,400	910	15,844	22,448	28,990	23,828	61,292	33,984	33,984
India	73,791	152,168	1,958	28,959	0	0	34,576	47,212	4,449	52,580	18,488	30,504	56,963
Indonesia	0	62,635	0	19,380	0	0	0	0	3,971	2,016	6,836	4,272	8,250
Thailand	1	25,892	3	9,984	0	0	0	832	4,084	1,760	2,052	0	9,456

[1] Based on conversion factors in Kossila, 1988.   (Source : FAO, 1994)

Table 12. Main agricultural systems in different countries

Country/region	Classification of Zone (mm annual rainfall m altitude)	Main crops	Livestock[z]	Main livestock products	Predominant
China	Pasturing area (northern China)	NA	C,S,G, camel	Meat,Milk,wool, transport, fuel	Grazing
	Cropping-pasturing area	NA	C,S,G	Transport, draught	NA
					Manure, fuel, meat
	Cropping area (southern China)	Rice, wheat, maise soyabean, rapeseed groundnut,sugarcane sugarbeet, linseed	C,S,G B	Meat, milk, draught mean	milk, wool NA
India	Arid (Rajasthan and surroundings)	Millet, pulses, cotton Oilseed,wheat	DC, S, G camel	Milk, wool, hair meat,draught	Grazing Feeding millet leave
	Semiarid (south and central)	Rice, wheat, surgarcane pulses,oilseed, sorghum cotton	DC,B,S, G, camel	Milk, wool, hair, meat, draught	Grazing Stall feeding of straws Feeding stover grasses
	Humid/suhumid Tracks	Rice,wheat,sugarcane, pulses, oilseeds, sorghum cotton	DC,B,S, G	Milk,wool,hair, draught	Grazing Stall feeding of straws chopped green stover, grasses
	Subtropical/temperature	Rice,wheat(forest)	S, G, DC	Wool, meat, milk	Mainly grazing Stall feeding of stover and straws
	(Humalayan foothills) Highlands (alpine/subalpine tracts)	Rice,buckwheat,small millets,vegetable (forest)	S, G	Wool, meat, milk	Grazing Party stall feeding of chopped fodders
	Coastal region	Rice,coconut,cassava small millet (forest)		Wool,meat, milk	Grazing Party stall feeding with soopped straws and other fodders
Indonesia	Lowland (<100m)	Rice,maize,cassava vegetable,sugarcane oilparm,coconut rubber	B, C, S claves	Draught, meat residues,tree,folder	Grazing and cut-and carry Tree-livestock system
	Upland (>500m)	Maize,rice,potato sweet potato	C,G	Draught, meat	Cut-and-carry,limited grazing of crop residues Crop-livestock system
Pasture	(100-5-m)	rainfed rice, Maize	C, B, G	Tramping meat	mainly grazing natural, crop residues Crop-livestock system
Thailand	Subhumid lowlands	Rice, maize	BC, DC	Meat, milk	Grazing and cut-and carry Rice, straw concentrate, crop residues
	Humid lowlands	Fruit tree plants	BC, S, G	Meat	Grazing and cut-and carry Tree fodder

for two countries Australia and New Zealand. Rest of the countries will perforce have to give up animal production and become net importers of animal foods (milk, meat, eggs). There is however, a silver lining which could change the future of animal production in this region. This calls for total re-examination of available technology options in respect of major raw material ingredients available for livestock feeding (i) Crop residues and industrial by-products; (ii) Oil-cake, oil meals from cultivated oil seed crops, oil meals from forest produce and (iii) By-product of petroleum industry.

These are ingredients which have been used for feeding of livestock.. The present research on animal nutrition and physiology has reached a stage that traditional feeding system will not deliver the higher productivity levels as these two basic raw materials have a low digestibility of (hardly 2-3%) and are short on available/usable energy and protein. It has however, a major reserve of energy in the untapped plant cell wall in terms of ligno-cellulose complex and will yield enough energy to feed all the one billion livestock if released.

This will however, require large investments in

Table 13. Feeding system in the selected countries

	India	China	Thailand	Indonesia
Milk	Mainly dry and green fodder and waste foodgrains. Concentrate only to hybrid milch cattle primarly in the organised dairy sector	Total production hardly 12-13% that of India and major part in the organised sector. A by-product of beef	Practically no milk production A by-product of beef	practically no milk production A by-product of beef
Beef	Mainly dry and green folder and waste foodgrains besides grazing. A by-product of dairy	Major part in the organised sector depending on adequate concentrate feeding.	Stall feeding with concentrate	Stall feeding with concentrate
Pork	Scavanging waste food-grains.Concentrates only to crossbred pigs numbe-ring about 1 million which are stall fed.	Pork meat production is 97 times that of India and productivity three times. This calls for appropriate stall feeding with concentrate.	Stall feeding	Pork production double than that of Thailandand 25% higher than that of India. Mostly stall fed.
poultry product	Concentrate to the organised poultry farms. Rest on kitchen waste and scavanging around.	Chiken production based on concentrates only. But total production 20 times of India. Major part of egg production in the extensive sector from improved local breeds with concentrate feeding.	Organised sector with concentrate	Organised sector with concentrate

research on feed bio-technology, of manipulating and constructing microbes through genetic engneering which can digest the lignin ring and release the sugars for animal feeding. The current nutrition and biotechnology research has to focus research goals on only this area.

The source of protein in oil meals and cakes etc. produced from oil seed crops and forest produce, unfortunately is bound by various chemical moieties like tannin and other antigrowth factors and this protein is not readily available to animals, a method has to be found that these chemicals are removed from these oil meals so that the abundant protein in these meals is available to livestock.

If we are able to address these two problems within the next 25 years we should be able to solve the problem of livestock feed to meet the targets of 2020 to feed the human population.

CONCLUSION

1. A comprehensive study of the production and consumption patterns of the four major countries of the Asian region shows that while the production estimates of foodgrains (cereals in particular) by different national as well as international sources are more or less in agreement with each other, estimates of quantities used as feedgrains for livestock are nothing more that guestimates in all these countries.
2. Picture is not very clear even with regard to human consumption. National sources estimates in this respect are based primarily on consumer surveys, but international data (particularly FAO Food Balance Sheets) provide diagrametrically opposite trends. In the case of India while N.S.S.O. data shows a consistent decline in per capita consumption of foodgrains. FAO Feed Balance Sheet gives an increasing trend.
3. At the World level, there is no consistancy in the estimates given by the different agencies on the one hand and on the other even for the same agency, there is no relationship between feedgrains consumed and livestock products produced from year to year.
4. At the national level, there is confusion between concentrates and feedgrains. It has to be clearly understood that other than roughages, animal nutritionists have laid down specified quantities of DCP (Digested Crude Proteins) and TDN (Total Digestible Nutrients) in formulating concentrates. But these are also of indicative nature. The farmer rarely goes by these recommendations. He is invariably guided by his instinct, traditions and above all availability and economics of the various feed components. It is, therefore, extremely necessary that we should have the composition of various feeds and concentrates that are fed and utilized by the farmers to have a clearer picture.

Our comments for different countries are as follows:-

(a) Feed data in China are generally calculated in two ways: one way is to take food, seed, the part for industry, stocking, the difference between import and export and the losses from the total grain production, and consider the remainder as feed grain; the other way uses the yearly livestock and fishery output to calculate feed by feeding ratio technique. Both ways are based on estimated data/data from sampling surveys. The estimated food consumption in the first method tends to be a little higher because food is always over-supplied and rural consumers usually use the remainder as feed. With the second method, it is not easy to determine the feeding ratio. Two feeding patterns for livestock and fisheries exist, namely, household raising and large scale raising. Household raising accounts for the majority of output and its feed type, nutrition and husbandry vary greatly. Consequently, it is very difficult to calculate a set of feeding ratios for household raising. This is the theoretical approach. But the real position is different. Estimates of feedgrains used for livestock in China during 1992-94 vary from 62.8 to 112.4 million tonnes.

(b) In India, official estimates assume 12.5 per cent of gross production as feed, seed and wastages as well as industrial uses. It has no empirical basis, most importantly, none of the component has any relation with the production of foodgrains and it is quite incorrect to use a constant denominator over a period of 50 years, while all relationships have changed. All future projections made by various researchers make their own assumptions - the result is confusion worse confounded.

(c) In Thailand, some conversion rates are given for feed (concentrates). According to these norms, total concentrate required is 5.4 million tons in 2001. This estimate for 1994 for maize was 4.68 million tons. FAO Food Balance Sheet (FBS) for 1992-94 shows a feedgrain consumption of 364 thousand tons of rice and 3498 thousand tons of maize. National source balance sheet for paddy does not allocate anything for industrial uses. Soya meal national sources shows 1.16 million tons and FAO (FBS) nil.

(d) Reliable data on utilization of each commodity for different purposes such as feed, food industries, and human consumption are not available in Indonesia. The time series Food Balance Sheet (FBS) data provides information on the average availability of each crop per capita per year and the use for feed and food industries as well as for human consumption. These data are published by Ministry of Agriculture (MOA) and Central Bureau of Statistics (CBS). Production, export and import on the supply side are regarded as accurate, but the data on feed and food industries are generally very poor. Data on seed, feed and food industries are usually estimated as percentages of total supply. In FBS data, the portion of commodity for seed is estimated as 5%, waste around 20%, and feed 2%

(see CBS; Statistic Indonesia 1993). Hence, it is difficult to estimate the trend in demand for industry for a particular commodity using FBS data.

REFERENCES

Anonymous. 1994. Statistical Abstract of United States Situation, United States Department of Commerce Washington D.C.

Anonymous. 1995. Livestock and Poultry; World Markets and Trade, U.S.D.A. Beltsevilla Maryland, USA.

Anonymous. 1996. Indian Livestock Sector Review : World Bank Report No. 14522-IN. Washington, D.C.

Anonymous. 1996. Cereal, Feed Use in the Third World: Past Trends and Projecion to 2000, Research Report 57. IFPRI Washington. D.C.

Anonymous. 1997. Livestock Products in the Third World: Report 49. Past Trends and Projections to 1990 and 2000, IFPRI, Washington. D.C.

Bansil, P. C. 1959. Future Feed, Seed and Wastage Rates, Indian Journal of Agricultural Economics, Vol 21(2) : 2733.

Bansil, P. C. 1987. Feed, Seed and Wastage Rates in India, A Regional Study Techno Economic Research Institute, New Delhi, Memograph notes pp 29.

Bansil, P. C. 1997. Indias Demand for Foodgrains in 2000 AD - Simple Incremental Demand Model. Indian Farming, 46 (2) : 2332.

Bansil, P. C. 1997. Feed grains for livestock. Indian Farming 47(7) : 3843.

Bhalla, G. S. 1994. Economic Liberalization and Indian Agriculture. Institute for Studies in Industrial Development, New Delhi.

Bhat, P. N. 1994. Livestock Policy in India, Draft Paper Department of Animal Husbandry and Dairying, Ministry of Agriculture, Krishi Bhavan, New Delhi.

Bhat, P. N. 1995. Bovines in India Working paper No. 28, Department of Animal Husbandry and Dairying, Ministry of Agriculture, Krishi Bhavan, New Delhi.

Bhat, P. N. and P. C. Bansil. 1996. Poultry Development in India, Perspectives and Approaches, Indian Journal of Animal Production, 28 (S) : 1240.

Bhat, P. N. 1997. Science and Technology in Agricultural Development-A Key to the Future 2nd Indian Agricultural Science Congress, NAAS, New Delhi 3140.

Cheng, Guoqian. 1997. Market Prospects for Upland Crops in China, Working Papers Series, The CGPRT Centre, Jakarta, Indonesia

Devendra, C. 1992. Non-conventional Feed Resources in Asia and the Pacific : Strategies for Expanding Utilization at the Small Farm Level. Fourth revised edition. Regional Office for Asia and the Pacific (RAPA), Food and Agriculture Organization of the United Nations (FAO), Bangkok, Thailand.

FAO. 1994. FAO Production Yearbook, vol. 48. Food and Agriculture Organization of the United Nations, Rome, Italy.

Government of India. 1976. Report of the National Commission on Agriculture part III : Demand and Supply, Ministry of Agriculture and Irrigation, New Delhi.

IFPRI. 1984. Assessment of Food Demand-Supply Prospects and Related Strategies for Developing Member Countries of the Asian Development Bank. International Food Policy Research Institute, Washington, D.C., Mimeo.

Kossila, V. 1988. The availability of crop residues in

developing countries in relation to livestock populations. In: Reed, J. D., B. S. Capper and P. J. H. Neate (eds), Plant Breeding and the Nutritive Value of Crop Residues. Procceedings of a Workshop, 710 December 1987, International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia, pp. 2939.

Kumar, P., W. R. Mark and E. B. Howarth. 1996. Demand for Foodgrains and Other Food in India, Indian Agricultural Research Institute, New Delhi and International Food Policy Research Institute, Washington, D.C., Mimeo.

Kumar, P. 1997. Market prospects for upland crops in Thailand, Working Paper Series, The CGPRT Centre.

Machal, J. H. H. 1997. A synthesis of country reports presented at the workshop on Crop Residues in sustainable Mixed Crop/Livestock Farming Systems (Ed) Renard C. ICRISAT. Hydrabad, India.

Mamed, G. 1997. Market Prospects for Upland Crops in Indonesia, Working Paper 25, The CGPRT Centre, Jakarta, Indonesia

Mishra, S. N. and R. K. Sharma. 1990. Livestock Development in India - An Appraisal, Vikas Publishers, New Delhi.

Patel, R. K. (1994) Draught Animal Power, Journal of Rural Energy, 2 (24) : 2933.

Radhakrishna, R. and C. Ravi. 1991. Food Demand Projections for India, Centre for Economic and Social Studies.

Hyderabad.

Radhakrishna, R. and C. Ravi. 1992. Effects of Growth, Relative Price and Preferences on Food and Nutritions, Indian Economic Review, Vol. 27 : pp. 303.

Radhakrishna, R and C. Ravi. 1994. Food Demand in India : Emergence trends and perspectives, Paper presented at the International Conference on Economic Liberalisation in South Asia, Australia South Regional Centre, Australia National University, 30 November 2 December, 1994.

Ranjhan, S. K. 1994. Feed and Fodder Requirement, Consultancy Report, Dept. of Animal Husbandry and Dairying, Ministry of Agriculture, New Delhi.

TAC. 1992. Review of CGIAR Priorities and Strategies, Part 1. Technical Advisory Committee of the Consultative Group on International Agricultural Research (CGIAR), Rome, Italy.

Van Soest, P. J. 1988. Effect of environment and quality of fibre on the nutritive value of crop residues. In : Reed, J.D., Capper, B.S. and Neate, P.J.H. (eds), Plant Breeding and the Nutritive Value of Crop Residues. Proceedings of a Workshop, 7-10 December 1987, International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia, pp. 7196.

Verma, J. M. 1994. Food Exports and Food Requirement, Economic and Political Weekly, 29(35) : 2261