A Consistent Estimate of the Value of Animal Products in West Pakistan

by

CARL H. GOTSCH AND C. PETER TIMMER*

INTRODUCTION

According to the 1962/63 Revised National Accounts, livestock contributes 16.1 per cent of West Pakistan's gross domestic provincial product at constant (1959/60) factor cost. Given the size of the sector—it is larger than large and small-scale manufacturing combined—one would hope that estimates of gross production value, value-added, *etc.*, were based on fairly detailed and accurate studies. Unfortunately, such studies have never been done for West Pakistan, and only the crudest of indirect methods have been used to derive the figures used in official statistics. For example, milk production, which makes up roughly three-quarters of total livestock production (excluding power) is estimated by applying a poorly documented yield figure to an animal population that has never been accurately enumerated. Much the same procedure has been used for other products such as meat, eggs, hides and skins, *etc.*

To those with experience in working with livestock data from developing countries, the above comments may well be a familiar lament. It is our contention, however, that even with a relatively weak starting point, the estimates for West Pakistan can be improved *i*) by introducing relationships other than those of animal numbers and yield and, *ii*) by subjecting various parameters and assumptions to a type of sensitivity analysis. This approach is set out briefly in the following section. Subsequent sections deal with the actual revision of estimates of livestock production, the implications of these revisions for provincial gross domestic product (GDP) and the priorities for future research in the light of the present analysis.

II. METHODOLOGY: CONSISTENCY AND SENSITIVITY

A virtue of input-output analysis is that things must add up. This is as true for electricity, utilized and produced, as it is for animal feed grown and eaten. Neither electric motors nor livestock can consume more inputs than are

* The authors are associated with the Center for International Affairs, Harvard University. They are indebted to Walter Falcon and Will Bussink for comments. For any error or omission, only the authors are responsible.

available. It is this consistency of the input-output technique that is at the heart of our analysis.

Livestock is an intermediate sector. For an existing stock of animals the sector "buys" feed as inputs from the crop sector. The livestock transform these inputs into the various livestock products that are "sold" to the final demand sector. There are thus two directions from which our consistency analysis should work. Firts, we can survey final consumption of livestock products—the livestock sector must produce *at least* as much as is consumed. Second, we can determine how many inputs are *available* for transformation into outputs. Given certain well-established transformation coefficients (TDN requirements to support different types of animals, *etc.*), the availability of inputs determines how much *can* be produced. In a developing country such as Pakistan, we would expect little waste in this sector. If fodder is available, it is likely to be eaten by livestock. And if milk or meat is produced, it is almost certain to be consumed. Hence, the gap between potential production and consumption as measured by sample surveys should be small if the data are at all accurate.

The sensitivity analysis emerges quite naturally from the consistency approach. It is not known what proportion of coarse grains is fed to livestock—how sensitive is total estimated milk production to different assumed proportions? Grazing is variously thought to make either a substantial or a negligible contribution to livestock feeding requirements. What are the results of changing assumptions here? Attempts to test consistency obviously make of primary importance issues and data that were of secondary interest before.

III. MILK PRODUCTION

Three independent approaches are used to develop an internally consistent estimate of milk production. The *consumption* approach uses the national sample surveys to determine an average per capita consumption for West Pakistan, and with population, total consumption. The *TDN* approach takes as a starting point the biological requirements of the West Pakistan animal herd; feed availability in total digestible nutrients then places an upper bound on the number of animals that can be supported. With milk yields and census estimates of the ratio of milk animals to total animals, it is possible to estimate milk production. The *feed concentrates* approach relies on a more specific biological constraint than total digestible nutrients. Milk animals do not require concentrates to live and produce milk, but there is a positive response in milk yields to higher concentrates feeding. The relationship used in this note is that of Mellor and Ponteves who found a reasonably good quadratic relationship between concentrates fed per animal per day and milk yields in India [6].

On the basis of the 1961 National Sample Survey, consumption of milk, fluid equivalent, is estimated at 8.1 ounces per day per cepita[1]. This compares with the following nearby regions in India:

Punjab	13.3
Uttar Pradesh	7.4
Rajasthan	7.3
Himachal Pradesh	7.0
Weighted average	8.9 oz.

Rawalpindi government and commercial workers consumed an estimated 12.4 oz./capita/day in 1961. This is consistent with the 8.1 oz./capita/day for all West Pakistan if the average income elasticity of demand for such workers is of the order of 0.8, a figure that compares well with more detailed Indian studies of urban milk consumption. If the 8.1 oz./capita/day is accepted and maintained until 1962/63 when the population was 49 million, then total West Pakistan milk consumption in that year was 109 million maunds.

On the basis of TDN availabilities from crops plus an allowance for grazing, about 21.5 million animal units could be supported in 1962/63. Proportions of milk cows to total herd, based on the 1949, 1955 and preliminary 1960 agricultural censuses, indicate that about 4.8 million cows and buffaloes were in milk. And total milk production is estimated to be 108-110 million maunds if the Indus Basin Special Study (IACA) yields for cows and buffaloes are used, plus an allowance for goat milk.

The concentrates approach produces estimates of milk yields only slightly lower than those used by the Indus Basin Study[2]. The net result is that 109 million maunds is accepted as the best estimate of milk production and consumption in 1962/63. The price of milk in 1959/60 (the base year for the constant-price National Accounts) was 15.42 rupees per maund, giving a total value of 168.1 crore rupees.

IV. OTHER LIVESTOCK PRODUCTS

The estimation of other livestock products is not so amenable to the internal consistency checks to which milk production is subject. The fact that these products account for only about one-quarter of total livestock contribution to GDP is partly responsible—the impact of a relatively large change in, for instance, meat production on the total livestock herd and its TDN requirements is small. Our "double entry" checks are useless in this situation. It is possible,

[1] All calculations will be found in Appendix A.

[2] This is subject to a number of assumptions, which are spelled out and analyzed in Appendix A.

however, to check beef and mutton production against consumption (as for milk), and to see that certain technical requirements of animal slaughter are not violated by the amounts of various by-products. When this is done, the total value of meat, hides, poultry, *etc.* comes to 56.2 crore rupees. When added to the milk value the total is 224.3 crore rupees, which is increased by 5 per cent for dung to give a total West Pakistan livestock contribution to national income of 235.5 crore rupees.

V. IMPLICATIONS FOR SECTORAL AND REGIONAL ACCOUNTS

The revision in the contribution of the livestock sector is large enough to have an appreciable effect on the value added by agriculture and, indeed, on West Pakistan's gross domestic product. According to the estimate for 1962/63, value-added by livestock in constant 1959/60 prices was Rs. 2,996 million; according to our estimate it was approximately Rs. 2,355 million, or 21.4 per cent *lower* than the figure reported in the Provincial Accounts[3]. This reduction would mean a decline of 8.8 per cent for agriculture's contribution to GDP and a 3.4 per cent reduction in the overall value of the GDP for West Pakistan.

VI. GROWTH IN THE LIVESTOCK SECTOR DURING THE SECOND PLAN PERIOD

The preceding analysis has established a basis for a consistent estimate of livestock output for the year 1962/63. It is clear that this same procedure could be applied through time in order to obtain a consistent estimate for the *growth* in livestock products. In the following section, a brief description is given of the outcome of such an analysis. Because no attempt was made to construct detailed input-output relationships for the other periods, the estimates will be on a rather aggregate level.

The questionable nature of the growth rate for livestock products for the Second Plan period implied by the National Accounts (1.4 per cent) was first discussed in a paper by Falcon and Gotsch [2]. They pointed out that the low growth rate shown was due to several factors, the most important of which was the unusually low rate of increase in milk production (1.6 per cent annually). Also at fault was the practice of repeating the data for the past years when no new figures were available.

The argument regarding milk output in the Falcon-Gotsch paper relied entirely on an analysis of growth rates in herd size. Livestock census data for 1945, 1955 and 1960 were compared and it was estimated that the livestock

[3] According to the National Accounts of Pakistan, value-added by animal products is synonymous with the gross value of output. Inputs of fodder are neither subtracted from the products sector nor credited to the crop sector. This practice obviously results in a distortion of the relative importance of the two sectors. With regard to the total livestock sector as shown in the Accounts, however, the distortion is somewhat redressed by the failure to include the value-added by bullock power, *see* Explanatory Notes on Tables of National Products [4].

population in milk had been growing at the rate of about 2.7 per cent per annum. From this it was inferred that milk output had also been growing at this rate. No effort was made to see if this rate of increase was consistent with increases in fodder availability over the period or with the increases in consumption likely to have occurred as a result of population growth and higher per capita incomes.

Turning first to the question of TDN availability, Table I presents trend estimates of major fodder sources for the Second Plan period.

TABLE I

CROP PRODUCTION TRENDS, 1959/60—1964/65

	Annual growth rate* (per cent)	Percentage weights**	TDN contribution (growth)
Rice	7.8	.047	0.37
Wheat	3.7	.212	0.78
Bajra	6.9	.045	0.31
Maize	3.4	.053	0.18
Jowar	3.7	.028	0.10
Sugarcane	10.6	.181	1.92
Cottonseed	7.6	.010	0.08
Green Fodder	5.5	.423	2.33
			6.07

* Trends obtained from the least squares estimates of b in the equation: $\log Y = a + b \times \text{time}$.

** Weighted average annual increase in acreage, 1960/61—1964/65.

By weighting the growth rates of crops by their contribution to TDN (Table A-2), a trend in total TDN availability over the Second Plan period was obtained. This works out to be approximately 6 per cent per annum. Since it seems unlikely that the demand for fodder by work animals could have increased at this rate, acceptance of a 6 per cent increase in TDN availability for the production of milk, meat, *etc.*, is undoubtedly conservative.

At the same time that TDN availability was growing, the demand for livestock products was also increasing rapidly. Indeed, the following calculations suggest that it was growing at something like 4 to 5 per cent per annum.

The estimate has three components: *i*) population growth; *ii*) an income effect; and *iii*) a price effect. The Planning Commission figures for annual

population growth and increase in per cepita incomes in West Pakistan over the Second Plan period are 2.6 per cent and 1.6 per cent respectively. Assuming a weighted average income elasticity of approximately 1.2 for livestock products gives an increase in demand attributable to *i*) and *ii*) of 4.5 per cent per annum. (2.6+(1.6) (1.2) =4.5). The weighted price of livestock products shows an increase of about 2 per cent per year absolutely, but there is little or no trend away from the general price level. The range in rate of growth in demand for livestock products would thus appear to be on the order of 4 to 5 per cent per annum.

On the basis of the foregoing calculations it is apparent that the 2.7 per cent growth rate for livestock products suggested by the Falcon-Gotsch paper is probably too low. Indeed, the source of the difficulty with this figure is not far to seek. As indicated earlier, the source of the original estimate was an extrapolation of trends in the livestock population between 1945, 1955, and 1960. No account was taken of the general dynamism that appeared in the agricultural sector during the 1960—1965 period[4]. This holds for both the additional demand and the additional inputs of TDN.

The implications of the revised level and growth rate for livestock products for the provincial accounts of the Second Plan period are summarized in Table II. Keeping in mind the growth in TDN availability, the 4.5 per cent growth per year used in the calculation must be viewed as quite conservative.

TABLE II

AGRICULTURAL CONTRIBUTION TO GDP, WEST PAKISTAN

(Constant 1959/60 Factor Cost—Millions of Rupees)

Year	Official statistics			"Consistent" estimate		
	Livestock	Other	Total Agri.	Livestock	Other	Total Agri.
1959/60	2,837	4,874	7,711	2,093	4,874	6,967
1960/61	2,887	4,808	7,695	2,187	4,808	6,995
1961/62	2,940	5,231	8,171	2,285	5,231	7,516
1962/63	2,996	5,601	8,597	2,389	5,601	7,990
1963/64	3,048	5,708	8,756	2,496	5,708	8,204
1964/65	3,121	6,099	9,220	2,608	6,099	8,707
Average Annual % Increase, 1959/60—1964/65:						
	1.9	4.6	3.6	4.5	4.6	4.6

[4] For a more detailed discussion of agriculture during the Second Plan period, *see* Falcon and Gotsch [3].

The overall result of the exercise is to raise the growth rate for agriculture from 3.6 per cent to 4.6 per cent per year, an increase of 27 per cent.

VII. SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

It should be clear from the qualifications sprinkled throughout the text that the numbers put forth in this note are highly tentative. But one must begin somewhere on this unusually important and neglected subsector of agriculture in West Pakistan. Hopefully, the notions of consistency and sensitivity that we have stressed in our methodology will be carried over by other researchers as they improve upon our estimates.

Given the above caveats, our conclusions are two: *i*) that the contribution of the livestock sector to West Pakistan GNP is overstated, and *ii*) that it has been growing at a much faster rate than shown by the official statistics. The first result hinges largely on the finding that in the past, milk production and consumption have been overestimated; the second is based on the extremely rapid increase in TDN availability and demand.

With regard to further improvement in estimates of livestock production, the optimal programme would be an immediate, thorough and accurate livestock census. In the sub-optimal world we actually face, the preceding discussion suggests a number of areas where small-scale research can make substantial contributions. Some of these are:

i) What proportion of TDN requirements comes from grazing?

ii) What proportion of the cow and buffalo herd is in milk?

iii) What is the response of milk yields of cows and buffaloes to varying concentrated feeding rates?

iv) What is the average per capita consumption of milk and ghee separately?

REFERENCES

1. Ali, S. Mumtaz, "Planning Livestock Development in West Pakistan", *Community Development Information*, Vol. I, No. 11.

2. Falcon, Walter P. and Carl H. Gotsch, *Recent Growth of the Livestock Sector of West Pakistan and Provisional Benchmarks for the Third Five-Year Plan.* Mimeographed report. (Karachi: Harvard Advisory Group, 1965).

3. Falcon, Walter P. and Carl H. Gotsch, *Agricultural Development in Pakistan: Lessons from the Second Plan Period.* Reprint. (Cambridge: Harvard University Center for International Affairs, 1966).

4. Pakistan, *CSO Statistical Bulletin*, November 1967.

5. Hunting Technical Services, Ltd., *et al.*, *Programme for the Development of Irrigation and Agriculture in West Pakistan, Comprehensive Report.* Vol. 2-B, 1966.

6. Mellor, John W. and Bruno de Ponteves, "Estimates and Projections of Milk Production and Use of Concentrate Feeds, India, 1951—1976", *Cornell International Agricultural Development Bulletin*, No. 6, 1964.

7. Mellor, John W. and Bruno de Ponteves, "The Effect of Growth in Demand for Concentrate Feeds, India, 1951—1976", *Indian Journal of Agricultural Economics*, Vol. XIX, Nos. 3 and 4, 1964.

Appendix

The Consumption Approach

The third round of the National Sample Survey (1961) reports per capita monthly consumption of milk *and milk products* at the equivalent of 5.1 ounces/capita/day. The difficulty with this data is that no breakdown is available between whole milk consumed and the consumption of ghee and butter. The distinction is crucial—an ounce of ghee or butter requires 16 ounces of whole milk to produce. Mumtaz Ali estimated per capita daily availability of ghee and butter at 0.2 ounces, based on the 1955 livestock census [1, p.19]. Using this figure for the moment, the breakdown is 4.9 ounces/capita/day of whole milk and 0.2 ounces/capita/day of ghee and butter. The raw milk equivalent of the ghee and butter consumption, whole basis, is 4.9 + 3.2 = 8.1 ounces/capita/day in 1961. Population in 1961 in West Pakistan (revised figures) was 47.31 million, so the implied total milk consumption for that year is about 105 million maunds. On a 1962/63 basis, assuming the same per capita level of consumption, the total implied volume is 109 million maunds, based on 49 million population.

An alternative source, the consumption survey of government and commercial workers in Rawalpindi in 1961, found that the average monthly expenditure per household on milk and milk products was 35.18 rupees, as shown below:

	Monthly family expenditure (rupees)	*Daily per capita quantities (ounces)*
Fluid milk	17.59*	4.5**
Ghee and butter	17.59*	0.5 †
Total	35.18	12.4 ††

* Based on 1959 National Sample Survey expenditure pattern.

** Based on estimated retail price of 32 rupees per maund (rs/md). Wholesale price of 25.60 rs./md., raised 25 per cent, taken from *Markets and Prices, 1961.*

† Based on estimated weighted retail price of 290.88 rs./md., for ghee and butter. Wholesale price of ghee was 239.60 rs./md., for ghee and butter.
Butter was 220 rs./md. Ghee was assumed to be 3/4 of total and butter 1/4—wholesale price raised by 25 per cent for trade margin.

†† Fluid milk equivalent (12.4 = 4.5 + 16 (0.494)).

The total fluid milk consumption works out to 12.4 oz./ capita/day, over 50 per cent higher than the per capita estimate for West Pakistan as a whole. Are these two estimates consistent?

First, ghee and butter consumption in Rawalpindi was 0.5 oz./ capita/day vs. only 0.2 for West Pakistan as a whole. But this is perfectly plausible—the product with less water and higher value per maund should have a comparative advantage in the city, especially when transportation for fluid milk from the countryside is slow and costly, and when preservation of fluid milk is so much more difficult than of ghee and butter. We should expect substantially higher consumption of ghee and butter in the cities than for the country as a whole.

The essential question then is whether the higher *level* of milk and milk products consumption is reasonable *vis a vis* the estimate for West Pakistan as a whole. The 1961 National Sample Survey reported average monthly income for West Pakistani households at 173.90 rupees per month. The average income per household in the Rawalpindi survey was 292.5 rupees per month, or 68 per cent more than the average for West Pakistan as a whole. We have seen that milk consumption was about 53 per cent higher in the Rawalpindi household than for the country as a whole. This implies an average income elasticity of demand for milk by government and commercial workers in Rawalpindi of 0.8, a reasonable figure on the basis of more detailed Indian studies of urban milk consumption. If the income elasticity of 0.8 is accepted, per capita daily *milk* consumption of 8.1 ounces for all of West Pakistan and 12.4 ounces for the Rawalpindi workers seems at least to be consistent.

The TDN Approach

Crop production for 1962/63 serves as the base for estimates of TDN availability. Estimates of the important crops are shown in Table A-1:

TABLE A-1

Crop	Production (*000 long tons*)
Cotton (unginned)	519
Coarse grains	1,266
Fodder	59,878*
Oilseeds	288
Pulses	964
Rice	1,078
Sugarcane	18,148
Wheat	4,104

* Based on a *kharif* acreage of 1,501,100 acres with an assumed yield of 250 maund/acre plus a *rabi* acreage of 2,509,200 acres with an assumed yield (berseem) of 500 maund/acre.

The following factors developed by the Indus Basin Special Survey group (IACA) and TDN values for animal nutrition were used.

Conversion Factors

Wheat grain/straw	1:2
Barley grain/straw	1:2
Rice grain/straw	1:2
Coarse grains/straw	1:4
Pulses/straw	1:1:5
Oilseeds/straw	1:3
Cottonseed cake = 75% of cottonseed	
Cottonseed/lint = 2:1	
Oilseed cake = 60% of oilseed	
Sugarcane tops = 10% of sugarcane	
Rice bran = polishings = 5% of hulled rice	

No losses were assumed.

TDN Values

Berseem	11%
Kharif fodder	16%
Sugarcane	16%
Wheat straw	45%
Rice straw	38%
Pulses straw	40%
Oilseed cakes	75%
Cottonseed cake	70%
Rice bran/polishings	70%
Gram grains	80%
Coarse grains	75%

To avoid separate calculations for each type of animal raised in West Pakistan, all animals can be converted to animal units on the basis of their TDN requirements. The IACA conversion factors are shown below:

IACA Conversion Factors for Animal Units

Bullocks	1.00
Bovine cattle	0.77
Other work animals	0.95*
Sheep (total)	0.15**
Goats (total)	0.15**
TDN per animal unit	1.019 long tons per year†

* Average of 1.40 for work bull buffaloes and 0.50 for other work animals.

** Figure for "sheep, goats, lambs and kids".

† This works out to 6.25 lbs., of TDN per animal unit per day. In a detailed study by Hunting Technical Service, higher feeding rates are recorded. Based on their research, Zebu draft animals average 7.69 lbs., of TDN per day, Zebu milch 6.69, and Buffalo milch 8.79. None of the Hunting averages include any TDN from grazing.

A summary of the results of all the requisite calculations is shown in the table below:

TABLE A-2

Source of TDN	Amount (long tons × 10^6)	Animal unit supported (× 10^6)
Fodder	7.35	7.22
Wheat straw	3.69	3.63
Sugarcane	2.90	2.85
Coarse grains straw	2.03	1.99
Rice straw	0.82	0.80
Pulses straw	0.58	0.57
Coarse grains and pulses*	0.32	0.31
Sugarcane tops	0.24	0.23
Cottonseed cake	0.18	0.18
Oilseeds cake	0.13	0.12
Rice bran and polishings	0.04	0.04
	Total:	17.95

* Assuming that 20 per cent of total coarse grains and pulses are fed to livestock. This is not a sensitive assumption in terms of TDN availability—raising the proportion fed to 40 per cent increases the sustainable number of animal units from 17.95 million to 18.26 million, an increase of only 1.7 per cent.

The Agricultural Census showed the following results:

Type	*Number of animals (millions)*	*Number of animal units (millions)*	*per cent*
Bovine cattle	14.37	11.23	46.6
Buffaloes	7.95	7.95	33.0
Other work animals ...	2.47	2.35	9.8
Sheep	9.79	1.47	6.1
Goats	7.26	1.09	4.5
	Total:	24.09	100.0

The 24.09 million animal units reported in the 1960 livestock census are significantly higher than the 17.95 million animal units supported by the listed TDN availabilities. But goats and sheep receive their entire sustenance from grazing and presumably cows and buffaloes also receive some proportion of their nutritional requirements from free grazing. On this account, the supportable herd of 17.95 million animal units is increased by 20 per cent to allow for grazing support, for a total herd of 21.54 million animal units. The breakdown of these animals is as follows, using the same *proportions* as in the 1960 Agricultural Census.

Type	*Number of animal units*	*Number of animals*
Bovine cattle	10.04	13.04
Buffaloes	7.11	7.11
Other work animals	2.11	2.22
Sheep	1.31	8.73
Goats	0.97	6.47
Total:	21.54	

According to the 1960 preliminary Census of Agriculture (which seems most comparable with the previous two), 28.7 per cent of bovine cattle are milk animals and of these, 55.0 per cent are in milk. Of the buffaloes, 63.7 per cent are milk animals and 60 per cent are in milk. Thus, there were 2.06 million cows and 2.72 million buffaloes in milk in the 1962/63 supportable milk herd. Of the goats, it is assumed that 40 per cent are milk goats and 60 per cent of these are in milk. Thus, the number of goats in milk is 1.55 million. It is now possible to put together a total milk production estimate by using the milk yields assumed by the Indus Basin Special Study:

Type	*Kg./Yr.*	*Md./Yr.*
Buffaloes	1,000	26.80
Cows	600	16.10
Goats	200	5.36

The total milk production is as follows:

Milk production (million maunds)

Cows	$2.06 \times 16.10 = 33.17$
Buffaloes	$2.72 \times 26.80 = 72.90$
Goats	$1.55 \times 5.36 = 8.31$
	114.38

The assumed yields for goats are probably much too high—Ali suggests average yields of 1,400, 3,000 and 100 lbs. per year for cows, buffaloes and goats respectively. This compares with our assumptions of 1,320, 2,205 and 440 lbs. per year. Clearly, the yield for goats is quite out of line with Ali's assumptions while the cow yield is close and the buffalo yield is low but at least the same order of magnitude. A more likely estimate of total goat milk production in 1962/63 is 2 to 4 million maunds instead of the 8.31 million maunds projected on the basis of the Indus Basin study yields. Total West Pakistan milk production is thus set at 108 to 110 million maunds. This is consistent with the estimate of 109 million maunds for West Pakistan's milk consumption in 1962/63.

Concentrate Approach

Total digestible nutrients available give a gross estimate of sustainable livestock herds. It is possible, of course, that some more specific nutritional requirement, such as digestible protein, may not be fulfilled even though gross TDN availability is adequate. This estimate of concentrate availability is designed to investigate this possibility. The work by Mellor and Ponteves serves as a guide throughout this section.

Feed concentrates are made up of grain and pulses bran, cotton and oilseed cake and a proportion of coarse grains and pulses. Table A-3 shows the aggregate availability of such concentrates from the 1962/63 crop production:

TABLE A-3

AGGREGATE AVAILABILITY OF CONCENTRATE FEEDS, 1962/63

	Concentrates (*000 long tons*)	Concentrates (*million lbs*)
Wheat bran*	615.6	1,378.8
Rice bran*	53.9	120.7
Pulses bran*	48.2	108.0
Cottonseed cake	260.0	582.4
Oilseed cake**	173.0	251.9
Coarse grains, 20%†	253.2	567.2
Pulses, 20%††	192.8	431.9
Total:	1,596.7	3,440.9

* Wheat bran is taken as 15 per cent of wheat production, rice bran as 5 per cent of hulled rice production, and pulses bran (chuni) as 5 per cent of pulses production.

** Oilseed cake is assumed to be 65 per cent feed and 35 per cent manure.

† Here the percentage of coarse grains fed is sensitive. Raising the rate from 20 per cent to 40 per cent raises the level of concentrates available from 3,440.9 million lbs., to 4,008.1 million lbs., an increase of 16.5 per cent. Mellor and Ponteves use 3.6 per cent of *total foodgrains* as livestock feed, basing the estimate on market surveys in India. If 3.6 per cent of West Pakistan's foodgrains were fed, but only in the form of coarse grains, 18 per cent of the coarse grains would be fed to livestock.

†† The rate of pulses feeding is slightly less critical than that of coarse grains. The rate assumed here is based on the 20 per cent of gram only fed to livestock assumed in the Hunting Technical Services Comprehensive Report, Volume 2-B, p. 8.

The relationship between concentrates fed and milk yields that Mellor and Ponteves found for India, 1954-60, is shown in tabular form below:

Pounds of concentrate fed per animal per day	0	0.5	1.0	2.0	3.0	4.0	5.0
Production per animal milk yield, maund/year	11.5	14.7	17.7	23.2	27.9	31.8	34.9

With 20 per cent of coarse grains utilized as livestock feed, the total available concentrates work out to 3.44 billion lbs., or 9.427 million lbs. per day. If we assume that a fixed portion of this total is fed to cows and buffaloes in milk, we arrive at different average daily feeding rates for each assumed level of milk animal numbers. From the concentrate-yield relationship above each per animal feeding level is associated with an average milk production per animal and hence a total production. Table A-4 below shows this series of calculations assuming 20 per cent of coarse grains and pulses are fed as concentrates.

TABLE A-4

Number of animals in milk (*millions*)	Average concentrates fed per animal in milk* (*lbs.*)	Average yield (*maund/yr*)	Total cow and buffalo milk production (*million mds.*)
3.6	2.29	24.7	88.9
3.8	2.17	24.2	92.0
4.0	2.06	23.6	94.4
4.2	1.96	23.1	97.0
4.4	1.87	22.5	99.0
4.6	1.79	22.2	102.1
4.8	1.72	21.7	104.2
5.0	1.65	21.4	107.0
5.2	1.59	21.0	109.2
5.4	1.53	20.7	111.8

* Assuming 7/8 of total concentrates available are fed to cows and buffaloes *in milk*. The other 1/8 are presumed fed to work bullocks, *etc.* This proportion of concentrates fed to milk animals may be high. A well-documented figure would be welcome.

The TDN approach showed that given the proportions of the 1960 preliminary census, the sustainable milk herd was 2.06 million cows and 2.72 million buffaloes, for a total of 4.78 million. This implies an average concentrate feeding rate of 1.72 lbs./animal/day, and thus an average milk yield of 21.76 maunds per year. Total production from cows and buffaloes is thus about 104.0 million

maunds, which compares with the estimate of 106.0 million maunds using IACA estimates for cows and buffaloes in the TDN approach. Any reasonable assumption about goat milk production brings total 1962/63 West Pakistan milk production from 106 to 108 million maunds.

At this stage it is possible to pull the TDN and concentrate approaches together and to examine the effects of changing some of the assumptions, in particular those assumptions about extent of grazing and percentage of coarse grains fed to livestock. Most other assumptions, while possibly as sensitive as these, have clear-cut implications. Several of these will be discussed after the analysis of changing grazing and coarse grains assumptions is completed.

Figure A-1 plots total cow and buffalo milk production on one axis and animals *in milk* on the other. The grid represents various levels of coarse grains fed to livestock and percentage increases in basic TDN availability to account for grazing. The impact of coarse grains fed is through the concentrate-yield relationship. An assumed constant yield for all animal numbers would naturally give much more steeply rising lines than actually are shown. The grazing lines slope to the right because, while each line holds grazing constant, per cent coarse grains fed rises as the line rises vertically, and hence a larger animal herd can be supported. A similar grid would result if per cent pulses fed replaced coarse grains.

The results seem to be much more sensitive to changes in grazing assumptions than to changes in coarse grains consumed—partly because the reasonable range for coarse grains consumed is narrower. In view of the Mellor-Ponteves assumption, based on better data than is available for West Pakistan, that 3.6 per cent of total grains are fed to livestock (implying that 18 per cent of West Pakistan's coarse grains are fed), a value between 15 per cent and 25 per cent seems likely. On the other hand, estimates as high as 30 per cent of total TDN requirements supplied by grazing (about the same as a 40 per cent increase of basic TDN availability) have been seriously proposed (Indus Basin Special Study), but there are also studies and comments to the effect that grazing is insignificant for cows and buffaloes, at least in the Punjab and any canal-irrigated areas. Here is an obvious area where a small amount of well-designed research could pay high dividends. Other assumptions, not covered by the sensitivity grid but critical nonetheless, are *i*) the percentage of those total animals that are bovine and buffaloes, *ii*) the percentage of those that are milk animals, and *iii*) the percentage of those that are actually in milk[1]. Raising the ratio of cows

[1] The Indus Basin Special Survey uses the proportions of the final 1960 Census of 50 per cent cows in milk and 48 per cent buffaloes in milk. These proportions would clearly give *lower* total milk production than the proportions of 55 per cent and 60 per cent respectively used here.

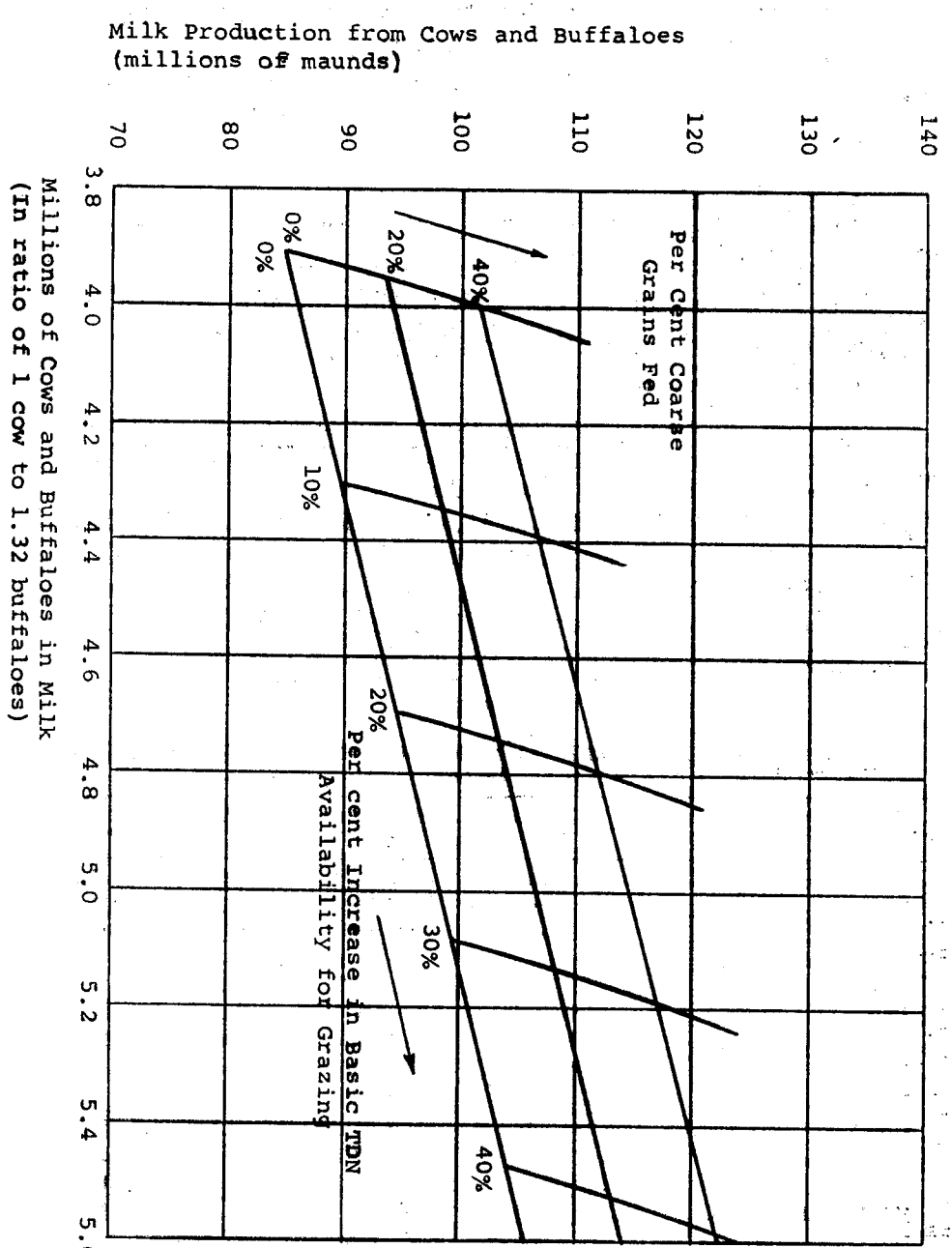
Milk Production from Cows and Buffaloes
(millions of maunds)
70
80
90
100
110
120
130
140
3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
Millions of Cows and Buffaloes in Milk
(In ratio of 1 cow to 1.32 buffaloes)
Per Cent Coarse Grains Fed
0%
0%
20%
40%
10%
20%
30%
40%
Per cent Increase in Basic TDN Availability for Grazing

Figure A-1

and buffaloes in milk to the total herd clearly means more milk-yielding cows are supported from given TDN availabilities, and the result is to slide up the relevant "coarse grains fed" isoline in the grid. The proportions of the 1960 preliminary census were used here, as they were closest to the 1948 and 1955 proportions. But here too more accurate numbers could make a sizeable impact on the results.

Lastly, the Mellor-Ponteves relationship has been accepted uncritically despite their misgivings about interpreting it as a production function, and without any corrections for possible differences in proportions of milk cows to milk buffaloes in the two countries. A suitable function for West Pakistan is not available, and until it is, there is nothing better than the Indian study.

Other Livestock Products

Since the input-output technique does not give good results for other livestock products, the levels of production suggested by Falcon and Gotsch are used. These levels are based on a reasonably consistent set of estimates for livestock contribution by S. Mumtaz Ali, who based his work on the 1955 livestock census plus some slaughter and trade statistics. These estimates were compared with revised national accounts estimates by Falcon and Gotsch and adjustments made in the light of data from secondary sources. The estimates for 1962/63, with 1959/60 constant prices, are shown in Table A-5.

TABLE A-5

NON-MILK INCOME ORIGINATING FROM LIVESTOCK, WEST PAKISTAN 1962/63

Commodity	Unit	Production (*000*)	Price	Total value (*000 Rs.*)
Mutton	md.	2,715	70.00	190,050
Beef	md.	3,590	33.84	121,486
Eggs	no.	150,200	10.80 (per 100)	16,222
Wool	md.	379*	132.40	50,180
Hair	md.	67	91.20	6,110
Hides	no.	1,800	12.33	22,564
Skins	no.	7,000	6.00	42,000
Bones	md.	1,600	10.14	16,224
Guts	no.	8,100	1.69	13,689
Poultry	no.	9,000	2.18	19,620
Animal fat	md.	300	63.00	18,900
Edible offal	md.	380	95.50	36,290
Heads and trotters	md.	670	12.70	8,509
Total:				561,844

* National Accounts, revised.

Per capita consumption of beef and mutton was *0.471* lbs. and *0.315* lbs. per month respectively in 1961. Assuming constant per capita consumption until 1962/63, this works out to 3.368 million maunds of beef and 2.246 million maunds of mutton consumed. Thus, mutton consumption is 83 per cent of estimated production and beef consumption is 94 per cent of estimated beef production. Between 6 per cent and 17 per cent loss from production to consumption does not seem too unreasonable. A more likely explanation is an increase in per capita meat consumption between 1961 and 1962/63[2].

About the only way to check the reasonableness of the estimates of livestock by-products is to assume a meat/live animal ratio and see if everything adds up. The by-products should weigh the same as the meat if the dressing ratio is 50 per cent. Table A-6 adds up the score:

TABLE A-6

MEAT AND MEAT PRODUCTS

	(in 000 mds)
Mutton	2,715
Beef	3,590
	6,305
—Bones	1,600
	4,705
—Animal fat	300
	4,405
—Edible offal	380
	4,025
—Heads and trotters	670
	3,355
—Hides[1]	915
	2,440
—Skins[2]	350
	2,090
—Guts[3]	2,025
Discrepancy	65

[1] 1,830 hides × 1/2 md. per hide = 915. Based on FAO statistics.

[2] 7,000 skins × 1/20 md. per skin = 350. Based on FAO statistics.

[3] 8,100 guts × 1/4 md. per gut = 2,025. Based on a detailed guess as to what an average gut should weigh.

If all the assumptions are approximately correct, then the meat and by-products estimates do not seem too unreasonable.

[2] Section VI discusses this possibility in more detail.