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A CONSISTENT ESTIMATE OF THE ANIMAL PRODUCT CONTRIBUTION TO GDP IN WEST PAKISTAN

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A Consistent Estimate of the Animal Product Contribution to GDP in West Pakistan[1/]

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I. Introduction

According to the 1962/63 Revised National Accounts, livestock contributes 16.1% 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

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1/ This note originated in an on-going attempt to construct an agriculturally-oriented input-output table for West Pakistan for 1962/63. The starting point was a 70 sector table prepared by the Perspective Planning Section of the Planning Commission for 1962/63. While 70 sectors would be a fairly decent description of the economy if sectors were approximately the same size, in fact the table had only three agricultural sectors -- jute, of which West Pakistan grows practically none; cotton, an important export crop; and "other agriculture," a sector that turns out to be considerably larger than the sum of large and small scale manufacturing. The attempt to break down this sector resulted, early in the work, in detailed estimates of crop and livestock production in West Pakistan for 1962/63 (the year of the original table). As those who have worked with Pakistan agricultural data will appreciate, the greatest difficulty encountered was in specifying the livestock sector. It is for this reason that the preliminary results contained in this note are being circulated prior to the completion of the table. Comments on the work would be highly appreciated. It should be emphasized that at this point we are still concerned with estimating the gross production value and not value-added by livestock.

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 (1) by introducing relationships other than those of animal numbers and yield and, (2) 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 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. First, we can survey final consumption of livestock products -- the livestock sector must product 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 should 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. The gap between potential production as measured by sample surveys should be small if the data are at all accurate. This is the hope and design of this analysis.

The nature of the livestock sector is such that the two-pronged attach is suitable only for milk production. But this is three-quarters of the sector. Production of the other products can be checked only from the consumption end, if at all.

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? Clearly, the consistency approach makes of primary importance issues and data that were of secondary interest before. The emphasis on simply counting heads of cows and buffaloes, and the debate on whether the

numbers are high or low, now seems to be somewhat misdirected. A more important issue is the proportion of animals in milk out of the total herd. This seems to be an easier question to answer accurately on the basis of well-designed small surveys than that of actual total herd size. Similarly, average milk yields for the whole province would be very desirable figures to have, but a cheaper substitute yielding almost as good results would be a well-designed sampling of cow and buffalo milk yields in response to concentrate feeding rates.

Consistency and sensitivity analyses are powerful tools for pinpointing weak assumptions. On the other hand, consistency alone is no virtue and does not guarantee that our results are right. We may simply be consistently wrong. But the methodology should be robust in this respect, and it is the methodology that we hope is important.

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 utilizes the biological requirements of the West Pakistan animal herd -- feed availability in total digestible nutrients 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 the TDN approach. 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 (1964a,b) who found a reasonably good quadratic relationship between concentrates fed per animal per day and milk yields in India. Naturally, both the TDN and concentrates approaches draw on the crop production estimates, including forage and by-products, generated by the work on the input-output table.

On the basis of the 1961 National Sample Survey consumption of milk, fluid equivalent is estimated[1/] at 8.1 ounces per day per capita. 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 on 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,

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1/ All calculations will be found in an appendix.

based on the 1948, 1955 and preliminary 1960 agricultural censuses, indicate thatabout 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 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.[1/] 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, 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

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1/ This is subject to a number of sensitive assumptions, which are spelled out and analyzed in the appendix.

total is 224.3 crore rupees, which is increased by 5% 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. 2996 million; according to our estimate it was approximately 2355 million, or 21.4% lower than the figure reported in the Provincial accounts. This reduction would mean a decline of 8.8% for agriculture's contribution to GDP and a 3.4% 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 is being made to construct an input-output table for the other periods, the analysis 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%) was first discussed in a paper by Falcon and Gotsch (1965). 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% 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 population in milk had been growing at the rate of about 2.7% 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 1 presents trend estimates of major fodder sources for the Second-Plan Period.

Table 1: Crop Production Trends

1959/60-1964/65

	Annual Growth Rate* (per cent)	(Conversion Factor)	TDN Contribution (Growth)
Rice	7.8	.047	0.37
Wheat	3.7	.212	0.78
Bajra	6.9	.045	0.31
Jawar	3.7	.028	0.10
Maize	3.4	.053	0.18
Sugarcane	10.6	.181	1.92
Cottonseed	7.6	.010	0.08
Green Fodder	6.4**	.423	2.71
			6.45

* 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, 1962/63-1964/65.

Using the contribution of various crops to TDN that appears in Table A2, the trend in total TDN availability over the Second-Plan Period is on the order of 6% increase per annum.

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 4-5% per annum.

The estimate has three components: (1) population growth, (2) an income effect, and (3) a price effect. The Planning Commission figures for annual population growth and increase in per capital incomes in West Pakistan over the Second-Plan Period are 2.6% and 1.6% respectively. Assuming a weighted average income elasticity of approximately 1.2 for livestock products gives an increase in demand attributable to (1) and (2) of 4.5% per annum. (2.6 + (1.6)(1.2) = 4.5). A weighted price of livestock products shows an increase of about 2% per year absolutely, but relative to the general price level there is little or no trend. Even with a price elasticity of demand as large as -1.5 the change in demand per year could not be more than plus or minus 0.5%. Thus the range in rate of growth in demand for livestock products is 4% to 5% per year.

On the basis of the foregoing calculations it is apparent that the 2.7% 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.[1/] 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 2. The more conservative 4.0% per year growth in livestock is shown.

Table 2

Agricultural Contribution to GDP, West Pakistan

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

	Official Statistics			"Consistent" Estimate		
Year	Livestock	Other	Total Agri.	Livestock	Other	Total Agri.
1959/60	2837	4874	7711	2093	4874	6967
60/61	2887	4808	7695	2177	4808	6985
61/62	2940	5231	8171	2264	5231	7495
62/63	2996	5601	8597	2355	5601	7956
63/64	3048	5708	8756	2449	5708	8157
64/65	3121	6099	9220	2547	6099	8646
Average Annual % Increase, 1959/60-1964/65:						
	1.9%	4.6%	3.6%	4.0%	4.6%	4.4%

The overall result of the exercise is to raise the growth rate for agriculture from 3.6% to 4.4% per year, an increase of 22%.

VII. Summary, Conclusions, and Suggestions for 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 sub-sector of agriculture in West Pakistan.

1/ For a more detailed discussion of agriculture during the Second-Plan Period, see Falcon and Gotsch, (1966).

Hopefully, the notions of consistency and sensitivity that we have stressed in our methodology will be carried over by other researchers as they improve on our estimates.

Given the above caveats, our conclusions are two: (1) that the contribution of the livestock sector to West Pakistan GNP is overstated and (2) that it has been growing at a much faster rate than shown by the official statistics. The first finding hinges largely on the feeling 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 program 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:

1. What proportion of TDN requirements come from grazing?
2. What proportion of the cow and buffalo herd is in milk?
3. What is the response of milk yields of cows and buffaloes to varying concentrated feeding rates?
4. What is the average per capita consumption of milk and ghee separately?

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/day/capita. 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, in "Planning Livestock Development in West Pakistan" (p. 19) estimated per capita daily availability of ghee and butter at 0.2 ounces, based on the 1955 livestock census. 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 rs./md. Wholesale price of 25.60 rs./md., raised 25%, 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% 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% 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 à vis the estimate for West Pakistan as a whole. The 1961 NSS 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% more than the average for West Pakistan as a whole. We have seen that milk consumption was about 53% 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 detailedIndian 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 seem 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 A1:

Table A1

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 maunds/acre.

The following IACA factors and TDN values for animal nutrition were used.

Conversion Factors

Wheat grain/straw	1:2	Cottonseed cake = 75% of cottonseed	
Barley grain/straw	1:2	Cottonseed/lint = 2:1	
Rice grain/straw	1:2	Oilseed cake = 60% of oilseed	
Coarse grains/straw	1:4	Sugarcane tops = 10% of sugarcane	
Pulses/straw	1:1.5	Rice bran = polishings = 5% of hulled rice	
Oilseeds/straw	1:3		

No losses were assumed.

TDN Values

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

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 averaged 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 next table:

Table A2

Source of TDN	Amount (long tons x 10^6)	Animal Units Supported (x 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% 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% increases the sustainable number of animal units from 17.95 million to 18.26 million, an increase of only 1.7%.

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	22.0
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% 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
	21.54	

According to the 1960 preliminary Census of Agriculture (which seems most comparable with the previous two) 28.7% of bovine cattle are milk animals and of these, 55.0% are in milk. Of the buffaloes, 63.7% are milk animals and 60% are in milk (p. 4 of Falcon and Gotsch paper). 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% are milk goats and 60% 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 x 16.10 = 33.17
Buffaloes:	2.72 x 26.80 = 72.90
Goats:	1.55 x 5.36 = 8.31
	114.38 million maunds

The assumed yields for goats is 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 2-4 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 108-110 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 oil seed cake and a proportion of coarse grains and

pulses. Table A3 shows the aggregate availability of such concentrates from the 1962/63 crop production:

Table A3

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
	1,596.7	3,440.9

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

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

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

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

With 20% of coarse grains utilized as livestock feed, the total available concentrates works 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 A4 below shows this series of calculations assuming 20% of coarse grains and pulses are fed as concentrates.

Table A4

Number of animals in milk (millions)	Average concentrates fed per animal in milk* (lbs.)	Average yield (Maunds/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.

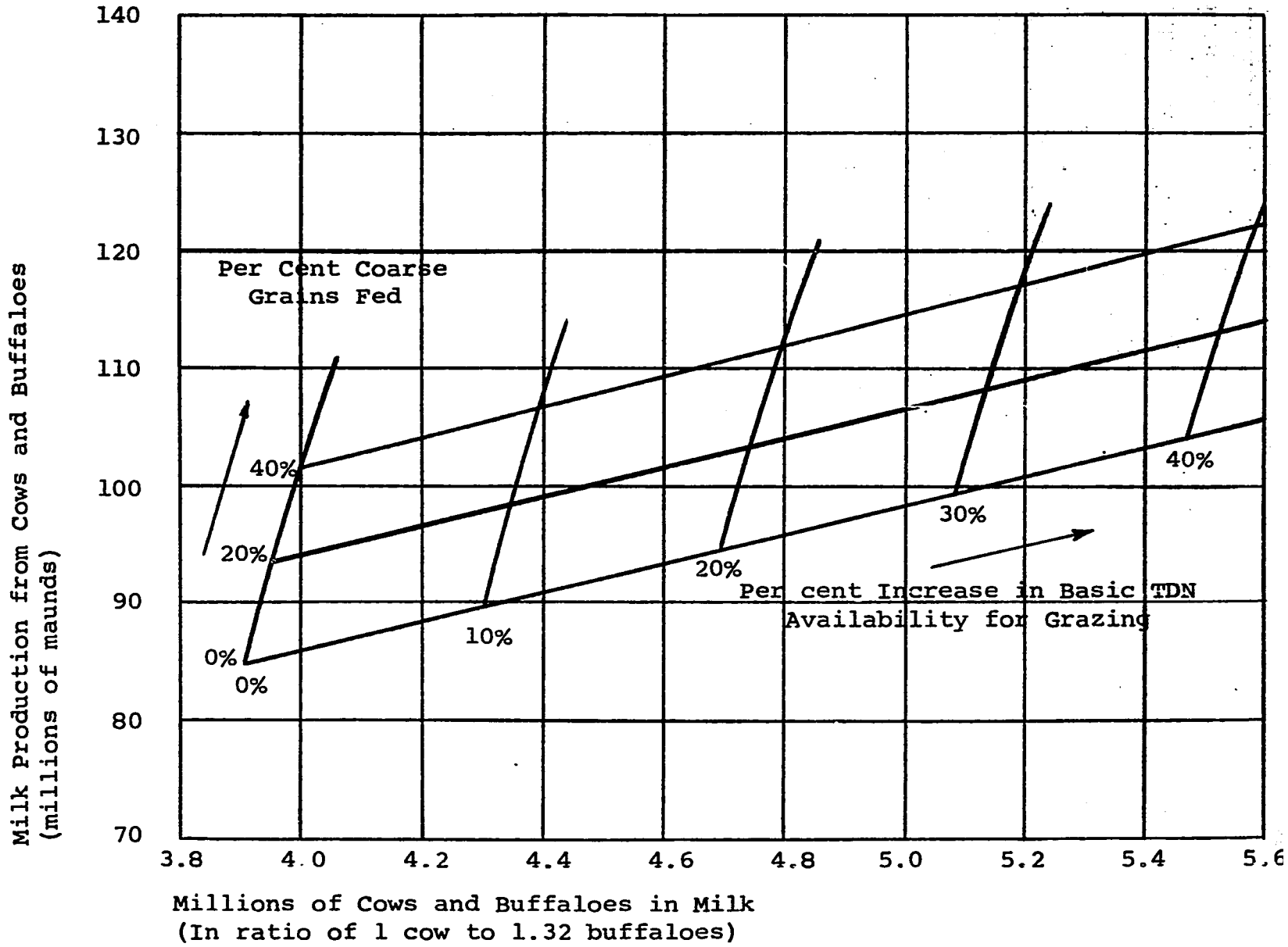
The TDN approach showed that given the proportions of the 1960 preliminary census, the sustainable milk herd was 2.06 million cows and 2.72 million buffaloes, for a total of 4.78 million. This implies an average concentrates feeding rate of 1.72 lbs./animal/day, and thus an average milk yield of 21.76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

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 to 106-110 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.

The figure below plots total cow and buffalo milk production on one axis and animals <u>in milk</u> 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%


140
130
120
110
100
90
80
70
Milk Production from Cows and Buffaloes
(millions of maunds)
Per Cent Coarse
Grains Fed
40%
20%
0%
0%
10%
20%
30%
40%
Per cent Increase in Basic TDN
Availability for Grazing
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)

of total grains are fed to livestock (implying that 18% of West Pakistan's coarse grains are fed), a value between 15% and 25% seems likely. On the other hand, estimates as high as 30% of total TDN requirements supplied by grazing (about the same as a 40% 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 (1) the percentage of total animals that are bovine and buffaloes, (2) the percentage of these that are milk animals, and (3) the percentage of those that are actually in milk.* Raising the ratio of cows 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.

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

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 1962/1963, with 1959/1960 constant prices, are shown in Table A5.

Table A5

Non-milk Income Originating from Livestock, West Pakistan

1962/1963

Commodity	Unit	Production (000)	Price	Total Value (000Rs)
Mutton	md.	2715	70.00	190,050
Beef	md.	3590	33.84	121,486
Eggs	no.	150200	10.80 (per 100)	16,222
Wool	md.	379*	132.40	50,180
Hair	md.	67	91.20	6,110
Hides	no.	1800	12.33	22,564
Skins	no.	7000	6.00	42,000
Bones	md.	1600	10.14	16,224
Guts	no.	8100	1.69	13,689
Poultry	no.	9000	2.18	19,620
Animal fat	md.	300	63.00	18,900
Edible offal	md.	380	95.50	36,290
Heads & trotters	md.	670	12.70	8,509
Total				561,844

* National account, 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% of estimated production and beef consumption is 94% of estimated beef production. Between 6% and 17% 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.[1/]

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%. Table A6 adds up the score:

Table A6

Meat and Meat Products, 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 & Trotters	670
	3,355
-Hides[2/]	915
	2,440

(Table continued on next page)

1/ Section VI discusses this possibility in more detail.

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

(Table A6 continued)

(Carried over)	2,440
-Skins[3/]	350
	2,090
-Guts[4/]	2,025
Discrepancy	65

3/ 7,000 skins x 1/20 md. per skin = 350. Based on FAO statistics.

4/ 8,100 guts x 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.

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