Livestock and feed trends in West Asia and North Africa : past, present and future

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Livestock and Feed Trends in West Asia and North Africa: Past, Present and Future

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Abstract. This paper describes trends in populations of four major classes of livestock[1] and in quantities of feeds in three classes[2] for fifteen countries of West Asia and North Africa (WANA)[3] over a recent twenty-year period (1967-71 to 1987-91). This addresses a gap in understanding the places and roles of the various livestock and feed classes and of the growing importance of concentrate feeds for poultry, dairy and feedlot production in particular. Using population projections to the years 2000 and 2025, and assumed expansions in production of crop residues, we project strong declines in the per capita numbers of livestock units supported by domestic sources of feedstuffs and grazing. Very large national deficits in livestock and/or feeds are projected and implications for research planning by ICARDA and national agricultural research systems (NARS) of WANA are explored.

Key words. Livestock – Feed – NARS – West Asia – North Africa – ICARDA

Titre. Evolution du bétail et des aliments du bétail en Asie de l'Ouest et en Afrique du Nord : passé, présent et futur.

Résumé. *Cet article décrit les tendances pour quatre principales classes de populations de bétail[1], et pour des quantités d'aliments classés en trois catégories[2], dans 15 pays de l'Asie de l'Ouest et de l'Afrique du Nord (WANA)[3] au cours d'une période récente de 20 ans (de 1967–71 à 1987–91). Il permet de faire un saut dans la compréhension des places et rôles des différentes classes de bétail et d'aliments et de l'importance croissante des aliments concentrés, en particulier pour les volailles, la production laitière et les fermes d'embouche. Les projections de population pour les années 2000 et 2025 et l'expansion prévue de la production des résidus de culture font envisager une forte baisse du nombre d'animaux approvisionné par des ressources locales ou des pâturages. De très importants déficits nationaux pour le bétail et/ou les aliments du bétail sont prévus et cette communication explore les possibilités de programmes de recherche de l'ICARDA et des systèmes nationaux de recherche agricole (NARS) du WANA.*

Mots clés. Cheptel – Alimentation du bétail – SNRA – Asie de l'Ouest – Afrique du Nord – ICARDA

Introduction

There has been dramatic growth in poultry production and use of feed grains and other concentrates in WANA *(Figures 1 and 2)*. Thirteen of the fifteen countries had aggregate numbers of ruminant livestock units (LU) in close balance with aggregate feed quantities in 1987-91: feed consumption was in the range of 1.5 to 3.0% of liveweight per day *(Figure 3)*. Saudi Arabia was outside this range on the well-fed side, Ethiopia on the hungry side. Twenty-year shifts in the composition of ruminant diets were generally toward greater use of concentrates and reduced dependence on natural pastures *(Figure 4)*. Reduced proportions of pasture in diets, however, are often due to larger numbers of ruminant animals on fixed pasture areas receiving greater levels of supplementary concentrates and crop residues than in earlier years.

Projections of domestic feed availabilities were made assuming a 25% increase in crop residue and feed grain production over 1987-91 levels, and no change in pasture offtake levels, by the year 2025. Based on these projections, and assuming feed consumption at 3% of liveweight per day (e.g., 5.475 metric tons dry matter per year for a 500 kg LU), total LU's supportable by domestic feeds alone were calculated for the years 1989, 2000 and 2025. These estimates were divided by national human populations in 1989 and World Bank projections for the years 2000 and 2025 (except Afghanistan as population projections were not available) to find LU levels per capita *(Figure 5)*.

The median 1989 level was 0.2 LU per capita and, for all fourteen countries, dramatic declines in per capita levels of LU's supportable by domestic feed were projected. This is due to the high rates of growth in human populations. The LU numbers represent maintenance and production for the entire animal population, including draft, breeding and dairy animals as well as egg laying poultry, not simply feed for meat production. In any case, per capita annual meat consumption in the WANA countries is typically quite modest compared to that in western Europe or north America: less than 20 kg in Egypt or Turkey, compared to over 90 kg in France, Australia, Hungary and the USA. In the poorer states, it is likely to become much more modest.

Assuming constant levels of 0.2 LU per capita are to be maintained for the growing populations, deficits of domestic feed or LU were calculated for the years 2000 and 2025 *(Figures 6 and 7)*. Only Sudan, Turkey and Ethiopia are projected to be able to support 0.2 or more LU per capita by the year 2025. The other eleven countries are expected to face considerable deficits in domestic feeds, requiring large feed imports to maintain 0.2 LU per capita. Egypt, Algeria and Saudi Arabia are the WANA countries currently importing the greatest quantities of feed and livestock products. The projected deficits are plotted along with projected human populations to emphasize the relationships and magnitudes involved. Iran, for example, whose population may reach 158 million by the year 2025, would face an LU deficit roughly equivalent to all the sheep in Australia today.

It is most unlikely that some of the poorer countries will be able to satisfy their projected feed and livestock deficits with imports or domestic production. Rather, grain legumes are likely to take a greater role in human diets as they provide a cheap substitute for livestock products. A given quantity of grain legume imports for human consumption will substitute for a considerably larger quantity of feed grain imports, perhaps at a ratio of 1:3 or more. Countries with low but rising real per capita incomes, however, are likely to favor growth in imported feeds and livestock products in addition to food legumes.

To the extent that feed deficits are satisfied with feed imports, these will be comprised of feed grains and other concentrates due to their good economic value per unit of weight and volume. It is further likely that these concentrates will go chiefly to dairy, poultry and feedlot production as their most efficient uses. Ruminant breeding and growing operations, on the other hand, will likely continue to make valuable use of native pastures and of crop residues in particular. Both of these sources will come under heavily increased pressure, with the former accounting for ever smaller proportions of total feed supplies and the latter for greater total quantities.

Research and development programs to arrest or reverse the widespread degradation of rangelands and to improve the associated sustainability of dryland cropping systems through better integration of legume, cereal and small ruminant production, are the focus of ICARDA's Pasture, Forage and Livestock Program in partnership with NARS. In addition to the sustainability benefits expected from this work, greater and more efficient production of feed and young stock will have economic benefits in the form of import substitution. NARS of WANA have the additional challenge of enabling their domestic dairy, poultry and feedlot producers to operate most efficiently.

I. – Trends in Livestock and Poultry in WANA

National aggregate estimates on livestock numbers published by the FAO (1991a) provide us with a starting point for a study of trends in fifteen WANA countries (Afghanistan, Algeria, Egypt, Ethiopia, Iran, Iraq, Jordan, Libya, Morocco, Pakistan, Saudi Arabia, Sudan, Syria, Tunisia and Turkey). We chose to summarize the FAO livestock population data in four main classes:

1. small ruminants (sheep and goats),
2. bovines (cattle, buffalo),
3. draft animals (camels and equines: horses, mules, asses), and
4. poultry (chickens and turkeys).

Year-to-year changes in national livestock numbers reflect fluctuations in weather, feed supplies and prices. Therefore, we calculated five-year averages in each of these four livestock classes for the periods 1967–71 and 1987–91 to show trends over a twenty-year span in *Figure 1*. Trend lines connecting the two five-year periods are plotted with livestock numbers in log scales. The diversity and trends in livestock populations among the countries are illustrated.

The explosive growth in poultry production is the most prominent feature of *Figure 1*. Nowhere was this growth greater than in Libya or Saudi Arabia. The economic forces behind the expansion of poultry production are the same as those which should fuel an expansion in feedlot production: growing demand for livestock products, full use of existing crop residue and natural grazing resources, and the relative efficiencies of concentrate feeding.

There is no consistent trend among the fifteen countries in changes in ruminant livestock numbers over the past twenty years. Pakistan, Ethiopia and Sudan are among the states with the largest ruminant populations in the WANA region and have reported steady or increased numbers in all classes (see *Figure 1*). Tunisia has shown similar trends, though it is among the states with lowest ruminant populations.

Turkey and Morocco have reported reduced populations of ruminants in all classes over the past twenty years.

Afghanistan and Iraq have reported strong reductions in small ruminant populations; likewise with

Figure 1. Livestock numbers in WANA countries by classes, 5-years averages, 1976–71 and 1987–91
(million head)

Afghanistan's bovine population, while Iraq's was reduced slightly; both countries reported nearly constant numbers of draft animals.

Jordan and Libya reported strong increases in small ruminant populations, accompanied by little change in bovines and reductions in draft animal populations.

Syria and Algeria have reported strong increases in small ruminant and bovine populations and declines in draft animals.

In 1987-91, Iran had the greatest population of small ruminants among WANA countries, having surpassed Turkey and Ethiopia over the past two decades. Increases reported in Iran's bovine numbers came with a small decline in the draft animal class.

The remaining states (Egypt and Saudi Arabia) reported increases in populations of all ruminant classes. These states met great increases in demand for livestock products, pushed by different forces (population versus income growth), with large increases in imports of feed grains financed by very different means (foreign aid versus oil wealth).

These trends in livestock populations are presented later in terms of aggregate livestock units in conjunction with aggregate feed availabilities. It is useful first to discuss the major trends in feedstuff and pasture use in disaggregated terms.

II. – Feed Use Trends in WANA

Feeds in the WANA region present a challenge to anyone wishing to describe them briefly. Crop residues of all sorts are used as well as grazing of native pastures and forest areas. Feed grains and other concentrates are also widely used. In general, livestock populations in WANA are closely matched to local amounts of free or very cheap feed which has little or no other use. This point is made clearer in the subsequent section on “mega-trends”. We first examine the feed story, class-by-class.

Crop residues (straws, stalks, leaves, roots and wastes) are not generally reported in statistical series of any country in the region, nor in FAO statistics, even though these materials are often the major feed resources supporting ruminant livestock. Quantitative estimates for these can be derived, with more or less confidence, by taking the reported statistics for the relevant crops harvested and multiplying by a factor specific to each.

Under the heading of crop residues and forage crops we include estimates for the following: wheat and barley straws and stubbles, rice straws, maize stalks and leaves, sorghum and millet stalks and leaves, sugar cane and beet crop residues (including bagasse and pulp), lentil and faba bean straws, cotton leaves, vetch, berseem *(Trifolium alexandrinum)* in Egypt and Pakistan, and teff *(Eragrostis Abyssinica)* straw in Ethiopia. Details on the above estimates run to several pages of tables and are given in Nordblom and Shomo (1993b). Using the same reporting years as for livestock numbers, the five-year averages for aggregate estimates of these feeds are plotted in *Figure 2*.

The twenty-year trend lines for most countries show an increase in crop residues and forage crops, reflecting general increases in crop production across the region. Notable exceptions are provided by Afghanistan and Jordan, with declines in this feed category; Iraq and Algeria held nearly constant over the twenty years *(Figure 2)*.

Native pasture (rangeland) and forest grazing areas are the most important feed sources for a number of countries in the region. Data sources for areas were the FAO Production Yearbooks of 1972, 1987 and 1991b. Quantities of grazing offtakes from these lands are, however, not reported in any regular statistical series. We have estimated grazing offtake by multiplying the reported native pasture and forest areas by country-specific kg-per hectare assumptions.

For ten countries, our assumptions were based on ACSAD/AOAD (1985) values: Algeria, 300; Egypt, 90; Jordan, 79; Libya, 100; Iraq, 110; Morocco, 500; Saudi Arabia, 20; Sudan, 500; Syria, 200; and Tunisia, 600 kg/ha. For Pakistan, we have taken Noor's (1987) estimate of native pasture offtake, 660 kg/ha. For the remaining countries (Afghanistan, Ethiopia, Iran and Turkey) we have assumed pasture offtake is 500 kg/ha.

Where the bases of statistical reporting remain unchanged, one would expect to see pasture and forest areas change little over time. This is the case for most countries in *Figure 2*. Afghanistan, however, reported a major decline in pasture areas and a slight decrease in forest; likewise for Turkey except for a slight increase in forest areas too small to offset the decrease in pasture area. Morocco, Iran, Saudi Arabia and Syria have indications of increases in pasture and/or forest areas. These inconsistencies may contribute errors of greater or lesser significance to our aggregate feed estimates, depending on the relative importance of this feed category, country by country.

Figure 2. Trends in quantities of three major feed classes in WANA, 1976–71 and 1987–91
(dry matter, metric tons x 1000, log scale)

Feed grains and other concentrates including barley grain, maize grain, cottonseed (wholemeal and cake), both domestic and imported, comprise the smallest feed category for most countries in WANA. Exceptions are provided by Saudi Arabia, Jordan and Libya *(Figure 2)* where spectacular increases in feed imports have been reported over the past twenty years. There is little doubt that much of the increase in this feed category has been absorbed by various feeding businesses: poultry, dairy and meat production. We recognize that quantities have also gone to "mobile" small ruminant dairy and fattening operations in a number of countries in which transhumant and sedentary flocks of small ruminants are hand fed: see Nabulsi et al. (1992) for examples in Jordan, and Wachholtz et al. (1993) for examples in Syria. Sources of feed grain and concentrate data included FAO (1991a) and USDA/ERS/PS&D (1991), the latter being particularly useful in defining feed imports.

III. – Mega-Trends in Feed and Ruminant Livestock: The Big Picture

The overall trends and balances of feed and ruminant livestock can be shown by subtracting the calculated quantities of feed grains and concentrates for poultry for each country and plotting the remainder, added to the other feed categories (crop residues and forage crops, and pasture and forest grazing), against an aggregate sum of ruminant Livestock Units.

The latter are derived by taking the numbers of each kind of ruminant times a factor for conversion to a standard Livestock Unit (LU), in this case, a 500 kg bovine at maintenance. We follow Kosilla (1988) in conversion factors: sheep, 0.09; goats, 0.08; cattle, 0.7; buffalo, 1.0; camels, 1.1; horses and mules, 0.8; donkeys, 0.6. The resulting aggregate Livestock Units are plotted against total feed for ruminants (in *Figure 3*) as twenty-year trend arrows, with tails at the 1967-71 levels and heads at the 1987-91 levels.

Our "mega-trend" chart *(Figure 3)* summarizes a large amount of data in a simple form, illustrating a fairly close match between aggregate Livestock Units and total feed availabilities across small and large populations of livestock in the WANA region. Such a close match should not surprise us. Demand for livestock products by the burgeoning human populations of the region suggests that very little "cheap feed" in the form of crop residues or native grazing, will go unused. On the other hand, livestock numbers could not be sustained for long beyond the annual carrying capacity of available feed resources.

Indeed, in *Figure 3*, the envelope of annual dry matter consumption covering the range of 1.5 to 3.0 percent of liveweight per day, for our 500 kg Livestock Unit, includes all but three of the fifteen countries in the 1987-91 period. Ruminant populations in Pakistan and, particularly, Ethiopia appear outside this envelope on the "hungry side" while those in Saudi Arabia appear outside on the "well-fed" side. Remarkably, those of most of the remaining twelve countries appear not only within the envelope, but with their twenty-year trend arrows converging from all directions toward its center *(Figure 3)*.

Any significant departure from the envelope on the "hungry side," such as the cases of Ethiopia and Pakistan, may indicate that we have neglected to include some major feed sources, underestimated the contributions of some, or over-estimated animal liveweights. In the case of Pakistan, for example, we have not included the contribution of elephant grass because we could find no data on this source. In the case of Ethiopia, we have probably overstated the weight of cattle in our Livestock Unit calculations. This points out the need to enlist local experts, familiar with livestock and feeds in their own countries, in order to arrive at a complete picture.

IV. – Shifting Compositions of Ruminant Diets in WANA

Our mega-trends chart *(Figure 3)* shows that Turkey and Sudan have very similar and large total feed resources and numbers of ruminant Livestock Units. Likewise, Afghanistan, Egypt and Morocco appear in a tight cluster. Finally, large and equally balanced increases in ruminant Livestock Units and in total feed use appear to have been made in Saudi Arabia over the past twenty years; small ones have been made in Jordan. We can now show how very different the countries within these "clusters" are, and in which ways the compositions of ruminant diets have shifted during the apparently "balanced expansions" in Jordan and Saudi Arabia.

Having removed poultry and poultry's share of feed grains and concentrates from the national feed availabilities (which include imports), we can express the gross compositions of the remaining ruminant diets in percentage terms. The three categories: (i)

Figure 3. Ruminant livestock and feed in selected countries of WANA, 1967–71 and 1987–91 (log-log scale)

Figure 4. Diet compositions of ruminant animals, by feed category: 20-year trends (1967–71 to 1987–91) for selected countries of the West Asia-North Africa Region

crop residues and forage crops, (ii) natural pasture and forest grazing, and (iii) feed grains and other concentrates, nominally add up to 100% of ruminant feed use for any country at a given time. Thus, we are able to plot twenty-year trend lines for each of the countries in a three-dimensional composition chart *(Figure 4)* which works on the same principle as a soil chart showing the fractions of sand, silt and clay.

Contrasts in the feed resource endowments of Turkey and Sudan are readily apparent in *Figure 4*. Sudan's ruminant population, by our reckoning, subsists on a diet comprised mostly (86%) of pasture and forest grazing, and partly (13%) of crop residues, with very little (1%) of feed grains or other concentrates. In sharp contrast, ruminant diets in Turkey have shifted out of pasture and forest grazing and into crop residues and forage crops, with a modest increase in grains and concentrate feeds *(Figure 4)*.

Even greater contrasts are shown among Afghanistan, Egypt and Morocco. Each occupies a different sector of *Figure 4*. Ruminants in Afghanistan appear to have diets more closely related to those in Sudan, comprised mainly of natural grazing resources. Ruminants in Morocco appear to take about half their feed from natural grazing, over 30% from crop residues and forage crops and over 10% from grains and concentrates. Egypt differs in the extreme, with very little natural grazing, over 70% of the ruminant diet from crop residues and forage crops and over 20% from grains and concentrates. Thus, similar numbers of ruminant Livestock Units are kept under very different feed conditions *(Figure 4)*. This reflects differences in natural resource endowments, and how these are managed in the three countries.

Comparisons between Saudi Arabia and Jordan, in terms of shifts in ruminant diet compositions in the past twenty years, are useful. Saudi Arabia exhibited the greatest proportional expansions of feed and livestock among the WANA countries. It also has made the most remarkable shift in diet compositions, with grains and other concentrates increasing from near zero to over 40%, with an equivalent reduction in the role of natural grazing, and with the contributions of crop residues and forage crops holding steady at over 40%. In Jordan, grains and other concentrate feeds increased to over a third of the ruminant diet, with both other feed/grazing categories losing shares.

In recent years, ruminant diet compositions in Libya have shifted to levels similar to those in Jordan, with about a third coming from feed grains and other concentrates *(Figure 4)*. Four other countries have exhibited ruminant diet shifts towards greater proportions of grains and concentrates and crop residues, at the expense of natural grazing: Algeria, Tunisia, Turkey and Syria. Iran and Iraq have made shifts towards grains and concentrates while reducing shares held by crop residues and forage crops *(Figure 4)*.

Pakistan, Ethiopia and Afghanistan appear to have shifted to somewhat greater dependencies upon crop residues and forage crops at the expense of natural grazing. Ruminants in these states, and those in Iran, receive the lowest levels of feed grains and other concentrates in their diets; only Sudan used less. Only Morocco and Iran, among the fifteen WANA countries, increased the share of ruminant diets supported by natural grazing over the past twenty years, but did so by less than 4%.

There is in WANA, generally, little room to sustainably increase production by cultivating larger areas of arable land; yield increases and increased cropping intensity are the only avenues still open (Alexandratos, 1988). Pushed by growing economic demand for livestock products, rising ruminant populations are using most of the natural grazing resources and crop residues in the WANA region. Enhancement and sustained productivity of these most important feed resources, through efficient use and management, have from ICARDA's early days been major goals of our Pasture, Forage and Livestock Program.

The general trend toward greater use of feed grains and concentrates can confidently be expected to continue through the foreseeable future. Much of this will be pure substitution of these feeds to supplement diets based primarily on limited quantities of crop residues and natural grazing. Rising amounts, however, will inevitably be used in expanded feeding operations for dairy, meat and poultry production in most countries. Some reasons for this are set out in the following section.

V. – Livestock Units per capita Supportable by Domestic Feed Production

Domestic feed production in most WANA countries is likely to expand with advances and developments in crop and sown pasture production. Quantities of both domestic crop residues and feed grains will increase, as will better management of crop rotations with the inclusion of forage crops. For pur-

poses of illustration, we assume that domestic feed production from crop lands will reach 125% of current levels by the year 2025 in all WANA countries. We also assume the path of this increase is linear, so that a proportional increase can be assumed for the year 2000. We further assume that offtake from grazing of native pastures and forests will continue at current levels, though there are indications of declines in these resources due to widespread overgrazing and other unsustainable practices.

Large increases in human populations are predicted throughout the WANA region over the coming decades. We take the World Bank (1991) estimates and projections for national populations in the years 1989, 2000 and 2025. With these, and the domestic feed supplies projected for the same years (assuming continued current levels of efficiency), we derive estimates of per capita Livestock Units (LU) supportable in the future without imports *(Figure 5)*. Recall that we assume one LU is the equivalent of a 500 kg bovine at maintenance (Kosilla, 1988). Afghanistan is missing from this chart because population projections were not available.

The large projected growths in human populations will cause a dramatic decrease in the number of domestically supported LU's per capita, even though we assume the absolute quantity of domestic feeds from crop lands will increase 25% by the year 2025. Human populations are simply growing much faster. This is a useful way to illustrate some of the practical implications of population growth in the future of this region. For the poorer states, it will mean lower quality diets (in the sense of animal protein) for the masses. For the middle income and rich states, it will mean increasing dependence upon feed grain and/or livestock product imports to fill the demand gap to a lesser or greater degree. With rising incomes will come rising demands for livestock products, spurring domestic production but also increasing the gaps to be filled by imports.

What is remarkable in our per capita LU chart *(Figure 5)* is the general similarity across countries. Most countries show per capita numbers of domestically supported Livestock Units in the range of 0.1 and 0.2 in 1989, considerably below levels that western Europeans or North Americans enjoy. For example, per capita meat consumption in Egypt and Turkey was less than 20 kg in 1990 but over 90 kg in France, Australia, Hungary and the USA among others (Durning and Brough, 1991). The high per capita LU's in Ethiopia and Sudan point out a need for caution in interpretation of this chart. These are "cattle countries" but their cattle live under harsh conditions and may have considerably lower productivity than suggested by their numbers.

Based on domestic feed production, or on purchasing power, the excesses and health hazards of over-consumption of livestock products in the developed countries seem almost totally out of reach for the masses in most WANA countries. But the environmental degradations of overgrazing, deforestation and soil loss that come with mismanaged livestock are evident already in most of the countries. The health and environmental problems associated with high consumption of livestock products have been well documented by Barkin et al. (1990), Durning and Brough (1991) and Rifkin (1992), among others, who point out the damages being caused also to developing countries in the course of meeting demands for livestock exports. Most WANA countries, however, are net importers of livestock products and/or feeds.

VI. – Projected human populations and deficits in domestic feeds

What will human population growth mean in terms of national surpluses or deficits in LU or domestic feeds by the years 2000 and 2025? In economic terms, the answer would require projections of income, relative prices and preferences. These are not available. Instead, we make the assumption of a constant annual per capita flow of goods and services from 0.2 LU (or about 2.22 sheep). This is the median level (1989) supported by domestic feeds and pastures for the 14 WANA countries in *Figure 5*. Six countries are below, six above and two at this level.

Selection of a constant per capita livestock inventory, such as 0.2 LU, as a basis for discussing surpluses and deficits ignores economics in terms of comparative advantages, purchasing power, market-clearing prices, etc. It is simply an arbitrary baseline for graphic presentation of our projections.

In *Figure 6*, we have plotted human populations for 1989, 2000 and 2025 (World Bank, 1991) on the horizontal axis, against surpluses or deficits in Livestock Units on the left-hand vertical axis. The right-hand vertical axis, labeled “Feeds, million metric tons”, is a translation of the LU scale on the left-hand side, based on our assumption that each 500 kg LU will consume feed of dry weight equivalent to 3% of liveweight each day for 365 days a year. This amounts to 5475 kg. Thus, each LU requires 5.475 t of feed each year.

Ethiopia, Sudan, Pakistan, Turkey and Iran appeared to support relatively large livestock populations

Figure 5. Livestock Units per Capita Supported by Domestic Feed Production in Selected WANA Countries for the Years 1989, 2000 and 2025

Figure 6. Projected Surpluses and Deficits in Livestock Units (LU) of Feeds Assuming Constant Demand of 0.2 LU per Capita, with Population Projections for the Years 2000 and 2025, for 14 Selected WANA Countries

with domestic feed sources (above 0.2 LU per capita in 1989, *Figure 5*). This is reflected in *Figure 6* where these countries show "surpluses" of LU and feed in 1989. Taking projected growth of human populations into account in *Figure 6*, only Sudan appears to hold promise of maintaining surpluses in the year 2025. Both Ethiopia and Turkey will see their surpluses above 0.2 LU per capita shrink to zero by 2025. Pakistan and Iran will face very large deficits indeed (over 15 million LU or 80 million tons of feed) if our projections are correct.

Egypt is the WANA country showing the greatest total deficit in domestic feed in 1989, and projected for the year 2000 *(Figure 6)*, though it may be far surpassed by Iran and Pakistan 25 years into the next century.

Several other countries of the region are projected to face substantial feed deficits in the coming years: Morocco, Algeria, Iraq, Saudi Arabia, Syria, Libya, Tunisia and Jordan, in proportion to their populations. Due to their smaller populations, these countries are clustered to the left side of *Figure 6*; projections for them are repeated on a more appropriate scale in *Figure 7*.

Libya, Tunisia and Morocco in 1989 appeared to be at or slightly above the zero-deficit line of 0.2 LU per capita. The other countries (Jordan, Saudi Arabia, Syria, Iraq and Algeria) were already in deficit. Unbridled population growth in these, as in all the other WANA countries, is projected to result in great feed deficits over the coming three decades.

For those countries able to export mineral, agricultural or manufactured products, or labor, the import of feed and/or livestock products will be a matter of market choice. Our calculations (excluding Pakistan) suggest deficits of 7.6 million LU in 1989, 18 million LU in the year 2000 and 60 million LU in 2025 for the WANA countries. Alternatively, these deficits may be expressed as 42, 99, and 325 million tons of feed for the years 1989, 2000 and 2025.

It is unlikely that these “deficits” will be fully met with imports of feeds or livestock products to all the countries. More likely will be reductions, especially by the poor masses, in per capita access to livestock products and services. Our estimates of per capita levels of LU's supported by domestic feeds *(Figure 5)* overstate the levels LU's available to the poor in each country while understating those of the middle and high income sectors. Studies to investigate the disaggregated picture are needed to arrive at more accurate projections of feed or LU demand for the future.

VII. – Future Increases in Concentrate Feeding of Livestock and Poultry

Concentrate feeding, whether of poultry for egg or broiler production, of dairy animals, or feedlotting of cattle, sheep or swine, is practiced around the world only when and if it pays farmers in the short run to do so. Rates of production are controlled by diet quality (digestibility of feed energy, and balance of other nutrients with energy), among other management factors. Young, growing animals have high potential efficiency of feed conversion to muscle growth but are very sensitive to diet quality, including protein and mineral content. Dairy animals with high genetic capacity for milk production are similarly sensitive (Anthony Goodchild, personal communication, 1993). Low quality diets mean slow production and poor efficiency of feed use as larger proportions of feed go for body maintenance rather than growth.

In many countries there is a stratification of ruminant livestock production, with breeding/dairy stock making good use of pastures and crop residues throughout the rural districts. The young stock, mainly males but including females not recruited to the breeding herd/flock, are destined for the slaughter market. The most profitable means farmers find for handling these animals will vary from country to country, and district to district, depending on relative price ratios among all factors of production and outputs. Where meat prices are high relative to feed grains and other concentrates from any source, there exist irresistible incentives to feed these materials for fast and efficient weight gains (Brokken et al., 1980).

This feeding needs not take place in confinement *per se*; the point is to offer a diet of higher energy digestibility and quantity than is required for maintenance. It may be done in the form of hand-feeding concentrates to growing animals on rangeland, in cases where it is practical to keep other animals away from the feed intended for the growing animals. Confinement feeding is a way of increasing labor efficiency, reducing energy waste in trekking, and increasing security from predators.

Sources of feed grains and concentrates include domestic production and imports. According to Sarma (1986): “Promoting cultivation of feed grains, especially coarse grains, can be justified from an equity standpoint because coarse grains are usually grown on poorer lands by poor farmers.” Khaldi (1984) showed that shifts toward coarse grain pro-

Figure 7. Projected Surpluses and Deficits in Livestock Units (LU) or Feeds Assuming Constant Demand of 0.2 LU per capita, with Population Projections for the Years 2000 and 2025, for Eight Selected WANA Countries

duction, with better technology, would partly reduce WANA's deficits of 5.6 million tons of meat, 25 million tons of milk and 0.5 million tons of eggs, projected for the year 2000. Where countries are fully integrated into the world market, they will produce the things for which they have comparative advantages and import those which can be purchased more cheaply outside. This logic holds in most places but needs the qualification that it may not extend to subsistence cropping areas, and certainly not to areas of human starvation, except where reliable coarse grain crops are also used directly in human diets.

Transport costs will generally limit feed imports to concentrate feeds of one kind of another, typically feed grains with good value for weight. Of course something more than “need” is required to bring about imports: effective demand, or ability to pay. This can be modified by direct food aid, which overlaps with “dumping” of underpriced grains by developed countries on the markets of less developed countries. These latter sources of feed grain are unreliable but can be used profitably in the short run.

Another option for countries with feed deficits is to buy cheap feed grains on the world market. A few WANA countries have this as an easy option due to their oil wealth; others are enabled by their growing industrial production and exports.

Where we see prospects of human starvation in a few states, for whatever reason, there is little sense in discussing how to fill gaps in grain feeding to livestock. Crop residues and grazing resources in these areas and elsewhere, however, are likely to remain vitally important because, through ruminant livestock, these materials yield high quality products for human use.

The character of concentrate feeding in general, and feedlotting of cattle and sheep in particular, which many people find most objectionable is the “waste” of grains which could be consumed directly by humans. Put another way, it is the “waste” of resources used in feed production which could instead be directed to growing food for humans (Barkin et al., 1990, Durning and Brough, 1991, and Rifkin, 1992). These are added justifications for finding the most efficient feeding systems for local livestock and feeds.

But whose job is this? We argue this is chiefly the business of the people most interested in it… the farmers and merchants who are investing their own capital in feedlotting… and the NARS looking after the interests of their countries' agriculture and consumers. The same arguments apply to research on poultry production. Though egg and broiler production in WANA is likely to continue expanding rapidly, ICARDA's involvement in this area of agribusiness would be very difficult to justify.

VIII. – Indications for ICARDA and NARS Research Programs

As mentioned earlier, farmers' decisions to feed grain to animals (including poultry) for slaughter or higher output is one based upon calculations of profits in the short run. As grain and livestock prices change from year to year, the feedlotting and broiler businesses will expand or contract, though we expect general expansion over the next three decades. But this business is likely to take place largely “off the land,” outside the dryland farming districts which are ICARDA's central focus.

Apart from the all-important price considerations, several management factors are likely to have an effect on the profitability of feedlotting: diet quality, efficiency or waste in diet delivery, and health factors. We consider that much research has already been done on sheep fattening in other countries and that it is easy enough for NARS in WANA to pick this up where it adds to the already considerable indigenous knowledge. We also think most NARS of WANA have the ability to conduct most of the locally needed research on fattening, and that a great deal of private experimentation is done by farmers who see the opportunity to make a profit. Results of private experimentation, however, often take on the status of “trade secrets” and may not be disseminated very quickly among farmers.

ICARDA lacks detailed information on feedlotting practices outside Syria (Nygaard et al., 1982) and Jordan (Nabulsi et al., 1992), and lacks statistics showing disaggregated feed use in the various countries. Such statistics are generally neither collected nor published by the states of the WANA region. ICARDA should instigate (with NARS) rapid surveys of livestock management, feed and grazing resources, feeding practices and farm economics in advance of committing itself to long running field trials to improve these things in any particular district. The national feed and livestock data summarized here, and given in detail by Nordblom and Shomo (1993b), are inadequate for specific field trial planning owing to their nature as national aggregates derived by rather tenuous assumptions on conversion factors, etc. These data should be disaggregated, corrected, completed and updated, in partnership with NARS, for districts in countries where collaborative projects are envisaged.

We would not agree that ICARDA itself should engage in comparative feedlot fattening research as allowed by Nabulsi et al. (1992). We believe that research on confinement feeding is simple, inexpensive (if the end product is marketed) and ideal for small research units or university MSc projects. Advice by ICARDA to NARS on the design of such trials could be offered upon demand.

Only where issues in feedlotting efficiency are identified which are beyond the capacity of individual NARS to tackle, and which hold the promise of reducing feed wastage substantially, should ICARDA become involved. Such issues have not been identified to date. In the mean time, ICARDA should continue its focus on dryland livestock and farming systems, dealing mainly with sustainable and more productive management of crops, pastures and flocks.

Concentrate feeds are most efficiently used in poultry, dairy and feedlot production. Growth in these sectors of the livestock economy will, if anything, cause even greater pressure on natural pastures and forest grazing resources and on use of crop residues and forage crops. The challenge is obvious for ICARDA in helping find ways to manage these traditional feed sources more fully, yet in environmentally sustainable modes.

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Notes

1. Small ruminants, bovines, draft animals and poultry.
2. Crop residues & forage crops, pasture & forest grazing and feed grains & other concentrates.
3. Afghanistan, Algeria, Egypt, Ethiopia, Iran, Iraq, Jordan, Libya, Morocco, Pakistan, Saudi Arabia, Sudan, Syria, Tunisia and Turkey.

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