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**The Feed-Livestock Nexus in Tajikistan:
Livestock Development Policy in Transition**

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The Feed-Livestock Nexus in Tajikistan: Livestock Development Policy in Transition

Executive Summary

A livestock development policy for Tajikistan should focus the attention of the government and the donor community on the fundamentals of sound livestock development for rural poverty alleviation. The purpose of this study is to analyze the main problem for the sustainable development of the livestock sector in Tajikistan--adequate and accessible supplies of feed.

As in all CIS countries, the end of the 1980s and the beginning of the 1990s in Tajikistan signaled the deterioration of the socialist system of livestock production. This system was based on three important pillars--(1) an elaborate organization for procuring animal feed for winter feeding based on intensively-cultivated feed crops raised in large-scale state and collective farms, (2) sizeable imports of concentrates and (3) an organized structure of pasture management and utilization. The deterioration and elimination of these three pillars transformed the livestock husbandry system in Tajikistan from one based on intensive livestock farming to one based on extensive livestock husbandry (**Table 1**). Today livestock relies primarily on grazing supplemented by limited cultivated feed crops and minimal concentrates. Nevertheless, livestock inventories have now grown to levels higher than in the pre-independence period with over 90 percent of inventories held in household farms (**Figure 4**). The rise in inventories coupled with the fall in feed supplies mean that feed per animal has fallen dramatically (**Table 6**) along with livestock productivity (**Figure 5**).

Extensive livestock production systems can lead to a vicious cycle of ever-lower animal yields and rural incomes in which the legitimate desire of livestock farmers to increase their production by adding animals creates greater demand for limited feed, leading to a further deterioration in the feed per animal ratio and a further fall in animal yields. Because of the risk of a persistent decline in yields and rural incomes, the transition from an intensive to an extensive livestock production system in Tajikistan carries a significant danger of pervasive and continuing rural poverty.

Breaking the downward spiral of animal yields and poverty requires the gradual implementation of policy measures to address the feed shortage in the country. The first step to define appropriate measures is to understand whether there is an imbalance between the supply and demand for feed and what lies at the root of this imbalance. An initial attempt to estimate the disparity between livestock feed supply and demand indicates that feed resources in Tajikistan currently meet only 62 percent of demand for feed (**Table 3**). However, this crude estimate does not take account of the fact that two thirds of feed demand in Tajikistan is associated with beef and dairy cows which spend the majority of their time in pastures near villages and eating cultivated feed or concentrates (**Table 4**). A more nuanced picture of feed supply and demand emerges when account is taken of the structure of feed demand and the seasonality of supply—while Tajikistan has more than enough summer pastures it has a deficit of feed from other pastures and a significant deficit of cultivated feed (**Table 10**). This conclusion implies that policies designed to lessen the feed demand overhang in Tajikistan

should concentrate on two issues—(1) raise pasture yields for fall-spring, winter and all-year pastures and (2) raise cultivated feed yield and area.

Raising pasture yields depends vitally on a proper system of pasture management with the necessary resources to ensure maintenance and rehabilitation of pastures. The pasture management system in Tajikistan remains largely unchanged since Soviet times with the exception that the lowest rung in the management system (corporate farms) no longer has adequate resources for pasture upkeep. Although this system seems to cover many of the functions of a pasture management system, it is not well adapted to administering and maintaining a public good such as pastures in the post-independence period when over 90 percent of animals are held in household farms. One way of ensuring that the maintenance and rehabilitation needs of pasture users are considered in pasture management is the pasture users association. The Kyrgyz Republic has recently adopted pasture legislation that changes the system of pasture management to one which may be better suited to the environment of smallholder agriculture. **Table 12** gives a side-by-side comparison of the Kyrgyz and Tajik systems. In the Kyrgyz system pastures are state-owned public goods, just as in Tajikistan. However, the management, including permission to use pastures, pasture rehabilitation, fee assessment and collection has been decentralized to the level of the pasture users association. Though the system is still being introduced, in principle the idea of decentralizing such decisions puts the users themselves in control of the public good they require to graze their animals. Thus, it could be expected that pasture users would have an intrinsic interest in better husbandry of pasture resources. Though the pasture management system in Kyrgyzstan is yet unproven, it deserves careful study by the Government of Tajikistan.

In order to understand the importance of better pasture management on livestock performance it is possible to project the effects of continuous, small enhancements in pasture yields over a 10-year time period. For this purpose **Table 13** illustrates the effects on feed adequacy and milk yields of increases in yields of winter, fall-spring and all year pastures of 5, 10 and 15 percent per year. Increasing pasture yields by 5 percent per annum for 10 years would nearly ensure adequate supplies of feed in fall-spring fields, and increasing pasture yields by 10 percent per annum for 10 years would ensure adequate supplies of feed from fall-spring and winter pastures. Only all year pastures (with their quite low yields) would remain in short supply.

In order to illustrate the importance of cultivated feed crop yields and area for livestock performance it is possible to project the effects of (1) a restoration of cultivated feed crop yields to their level of 1991 and (2) a 10 percent increase in feed crop area (**Table 15**). As a result of an increase in cultivated feed crop yields—without increasing concentrates produced domestically or imported—milk yields of Tajik cows would rise by an astounding 44 percent to 972 liters per cow per year. Adding 10 percent to cultivated feed crop area through crop rotation with cotton would increase milk yields to 1,025 liters per cow per year. This level is slightly higher than that achieved in 1991. Cultivated feed crop adequacy for the entire livestock herd in the two scenarios would climb from a dismal 37 percent of demand in 2007 to 62 (scenario 1) or 66 percent (scenario 1+scenario 2) of demand.

The feed-livestock nexus is only one of a number of issues that should be addressed under a sustainable livestock development policy. Other issues such as the establishment of a viable plan for supplying livestock advisory and health services and a livestock breeding policy should also be part of such a policy. However, this study has concentrated on a first-level constraint on rural incomes that, unfortunately, has not received the attention it deserves. It is

hoped that this study has shed some light on this issue and provided some basis for beginning a dialogue between the Government of Tajikistan and donors on a sustainable livestock strategy for the country. A comprehensive livestock development strategy for Tajikistan could use these measures as cornerstones of a programme for improving the feed-livestock nexus for Tajikistan.

Introduction

The purpose of this study is to analyze the main problem for the sustainable development of the livestock sector in Tajikistan and to suggest policy measures that could be a focus of donor and government attention. A sustainable livestock development policy addresses the key challenges in the livestock sector: (1) adequate supplies of feed for livestock, (2) sufficient livestock services (including husbandry services and livestock health), (3) marketing and livestock product safety as well as the (4) environmental impact of livestock. The present study considers the first key challenge of livestock policy—adequate and accessible supplies of feed for livestock. The reason for this focus is a concern with the *first level constraint* on income from livestock husbandry. Previous studies have concluded that livestock product marketing and safety, advisory and health services and environmental impact issues do not represent first-level constraints on farm incomes in Tajikistan.¹ Instead, most studies conclude that the feed-livestock nexus is the most immediate problem for sustainable livestock development, though little has been written on this problem.²

A livestock development policy for Tajikistan should focus the attention of the government and the donor community on the fundamentals of sound livestock development for rural poverty alleviation. According to the World Bank, 55 percent of rural inhabitants in 2007 lived in poverty, a full 5 percent higher than urban poverty. One of the causes of low rural incomes is exceptionally low livestock yields. In fact, livestock yields in Tajikistan are the lowest in the CIS. The low-productivity livestock held in household farms form an important part of livelihoods in rural Tajikistan.³

This study discusses livestock development policy in the context of the transition that has taken place in Tajikistan from intensive to extensive livestock husbandry since the late 1980s. The structure of feed demand and supply in Tajikistan in the post-independence period is discussed in order to understand the driving factors behind feed imbalances. Feed demand in Tajikistan is driven primarily by beef and dairy cows. Over sixty percent of total feed demand stems from cows, while only 24 percent is attributable to sheep and goats. Potential feed supply, however, is situated largely in alpine pastures, which are inappropriate for cows. This demand-supply mismatch is the predominant cause of the poor nutrition of livestock inventories and low milk and meat yields in Tajikistan. Measures to address feed shortages with projections to indicate anticipated effects are analyzed. A comprehensive livestock development strategy for Tajikistan could employ these measures as cornerstones of a programme for improving the feed-livestock nexus for Tajikistan.

¹ Bravo (2005), World Bank (2007).

² Nolan (2005, 2006), O'Mara (2006), Bravo (2005) and FAO (2009) are the main sources on livestock development issues to date.

³ 43 percent of the value of household agricultural production in 2007 derived from livestock products.

A. The Transition from Intensive to Extensive Livestock Husbandry in Tajikistan, 1991-2007

As in all CIS countries, the end of the 1980s and the beginning of the 1990s in Tajikistan signaled the deterioration of the socialist system of livestock production. The changes that transpired during those years transformed the livestock husbandry system in Tajikistan from one based on intensive livestock farming to one based on extensive livestock husbandry.

1. The intensive socialist livestock production system

The socialist intensive livestock husbandry system relied on three separate sub-systems for support of livestock (FAO (2009), pp. 29-32). The first consisted of livestock inventories (predominantly milking herds) in large scale enclosures on state and collective farms, as well as in complexes attached to industrial concerns. Along with these large-scale holdings went the livestock of employees (predominantly dairy cows) on individual subsidiary plots. The animals in this sub-system fed on hay, mixed feed and cut feed all year. The second sub-system consisted of livestock inventories that spent the winter-spring period in enclosures and the summer-fall period in pastures. This was predominantly the beef cows, beef cattle, animals of certain alpine regions without winter pastures, and animals in the majority of northern regions. This sub-system required 210 days of cultivated forage for feeding in large enclosures. These first two sub-systems included the large scale industrial livestock complexes of Tajikistan, including 180 dairy complexes, 4 hog complexes and 10 industrial poultry feeding complexes.

The third sub-system was entirely pasture-based, with transhumance grazing of livestock in summer, spring-fall and winter pastures throughout the year. This system covered all sheep, goat and horse inventories of the absolute majority of regions in the south, Khatlon oblast and the Regions of Republican Subordination (RRP). For this sub-system it was necessary to hold only an emergency stock of cut feed. Intensive livestock husbandry in Tajikistan was based on use of chemical fertilizers and irrigation for grains resulting in significantly increased yields. Higher grain yields freed up area for planting feed crops, which were also fertilized and irrigated. Central Asia as a whole, including Tajikistan, was also a net importer of feed and food grains. Mixed feed imports assisted in filling the winter feed gap.

In addition to these “technological” aspects of intensive agriculture, the government of the Tajik Soviet Socialist Republic also made great efforts to properly manage pasture maintenance, utilization and transportation, and to supplement pasture feeding with adequate cultivated fodder. This involved matching feed demand and supply through feed balances which took account of use of summer, spring-fall and winter pastures and the procurement of sufficient fodder to fill the winter feed gap.

2. The causes of the deterioration of the Soviet livestock production system and transition to an extensive system

The Soviet three-tier system of animal feeding was based on (1) an elaborate system of procured animal feed for winter feeding based on intensively-cultivated feed crops raised in large-scale state and collective farms, (2) sizeable imports of concentrates and (3) an organized system of pasture management and utilization, including pasture maintenance, transportation along established routes, clear assignment of pasture rights, animal veterinary points, shepherd supply facilities along the routes and an established schedule of transhumance pasturing. **Box 1** explains the elements of the livestock feed base in Tajikistan.

Box 1. The livestock feed base in Tajikistan

Feed	Definition
Cultivated feed crops	Crops raised specifically for feeding domesticated livestock. Includes (1) Dry forage (perennial grasses, harvested as hay, haylage (from alfalfa) and straw), (2) Green chop (Lucerne (a legume), annual grasses, corn and other silage (fermented, high-moisture fodder that can be fed to ruminants, such as cattle and sheep. Usually made from grass crops, including corn, sorghum or other cereals, using the entire green plant (not just the grain).) and (3) Succulents without silage (feed roots and melons, sugar beets for feed).
Domestic and imported concentrates	(1) Coarse grains such as corn, barley and oats, as well as (2) Bran (the hard outer layer of grain, a by-product of milling in the production of flour), (3) Oil meals (in Tajikistan, cotton meal) and (4) Mixed feed, feed additives and other concentrated feed mixtures (grass flour, etc.).
Pasture	Pasture is land with low-growing vegetation cover used for grazing of livestock. Pasture growth can consist of grasses, legumes, other forbs (such as clover or milkweed), shrubs or a mixture.

In the Soviet period area under *cultivated feed crops* grew from 7 to 30 percent (1940 to 1985) of total sown area, allowing for the rapid growth of the livestock sector. The primary feed crops raised in irrigated fields of collective and state farms were Lucerne, corn, sorghum and sugar beets. Feed crops were raised through a variety of multiple cropping techniques in order to maximally utilize the long vegetative period in Tajikistan. These techniques included planting two harvests of silage per year, adding feed roots to land sown with corn, planting of Lucerne together with feed grains and other methods. In the Soviet period there were 14 specialized seed farms for supplying Lucerne seeds for rotation with cotton. Tajik farms practiced rotation of Lucerne with cotton in order to raise cotton yields, secure ample supplies of fodder and to guard against verticillium wilt in cotton growing areas of Tajikistan.

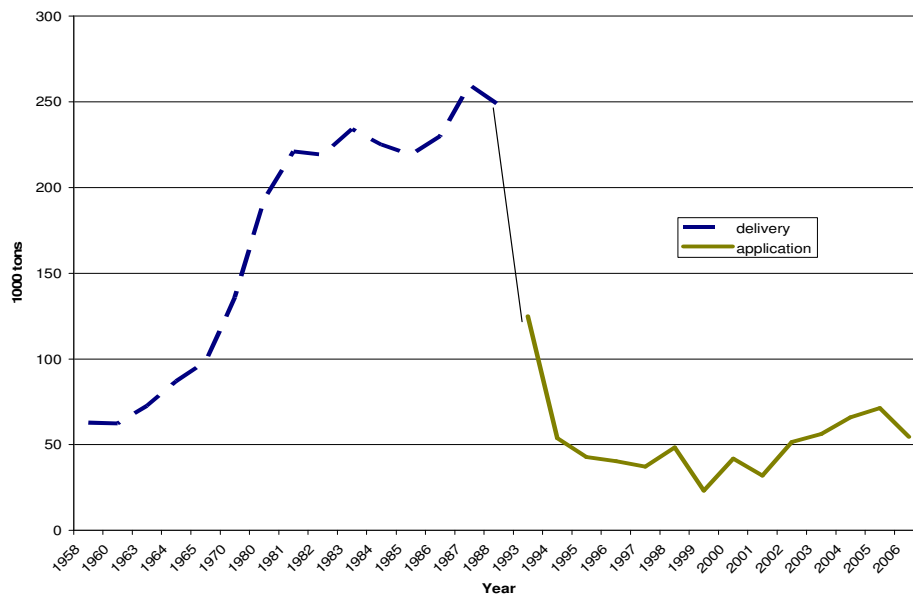
Concentrates refer to feed that has a higher concentration of energy than a forage diet. These are coarse grains, wheat, oil meals and feed mixtures. A concentrate diet is the primary basis of intensive livestock production in developed countries.

In addition to cultivated feed crops Tajikistan has ample *pasture* land used for grazing livestock. In mountainous countries as Tajikistan pastures are classified according to their season of use depending predominantly on their altitude. Summer pastures in Tajikistan are located from 2,200 to 3,400 meters above sea level and are used between June and August. Spring-Fall pastures are usually located between 900 and 1,500 meters above sea level and are used from March to May and September to November. Winter pastures are used between November and March and are located 500 to 1,200 meters above sea level. All year pastures are located at the same level as winter pastures but used all year round.

After 1991 the three pillars of support of the Tajik livestock feeding system collapsed causing a transition from an intensive livestock feeding system to an extensive one. The first pillar, intensively-cultivated feed crops fell because both yields and area in feed crops declined. The fall in yields was largely connected with diminished fertilizer applications. **Figure 1** shows two disjointed curves approximating total fertilizer use in Tajikistan. The grey curve up to 1988 represents fertilizer quantities delivered to agriculture; the black curve starting in 1994 represents quantities applied by farms (enterprises up to 2000, all farms from 2001 to 2006). In the transition period, fertilizer use appears to have dropped to levels not seen since 1960, but it is difficult to make firm quantitative conclusions on this count because of inconsistent definitions of fertilizer use between the two periods. After 1994, fertilizer application seems to have stabilized at 48,000 ton on average. Given an average cropped area of 850,000 ha in this period, we estimate fertilizer application rates at around 56 kg per hectare of sown area.

These rates appear to be lower than the averages in the early 1960s (around 80-100 kg/ha), and they are also much lower than the fertilizer consumption rate in the U.S. (95 kg/ha in 1987-1988).

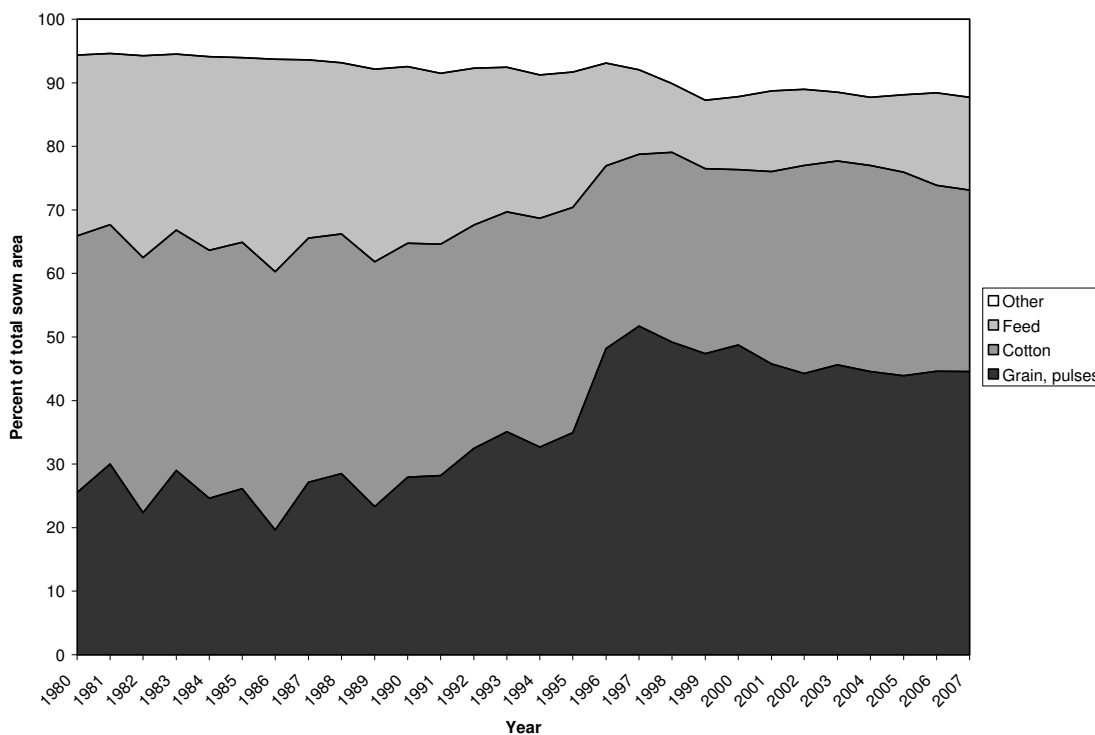
Figure 1. Fertilizer use 1958-2006 (1000 tons nutrient matter)



Sources: *Sel'skoe khoziaistvo respubliki Tadjikistan: statisticheskii sbornik* (2001, 2002, 2003, 2004, 2005, 2006, 2007); *Narodnoe khoziaistvo Tadjikskoi SSR: statisticheskii ezhegodnik* (1961, 1965, 1971, 1972, 1976, 1977, 1978, 1979, 1980, 1981, 1984, 1985, 1988).

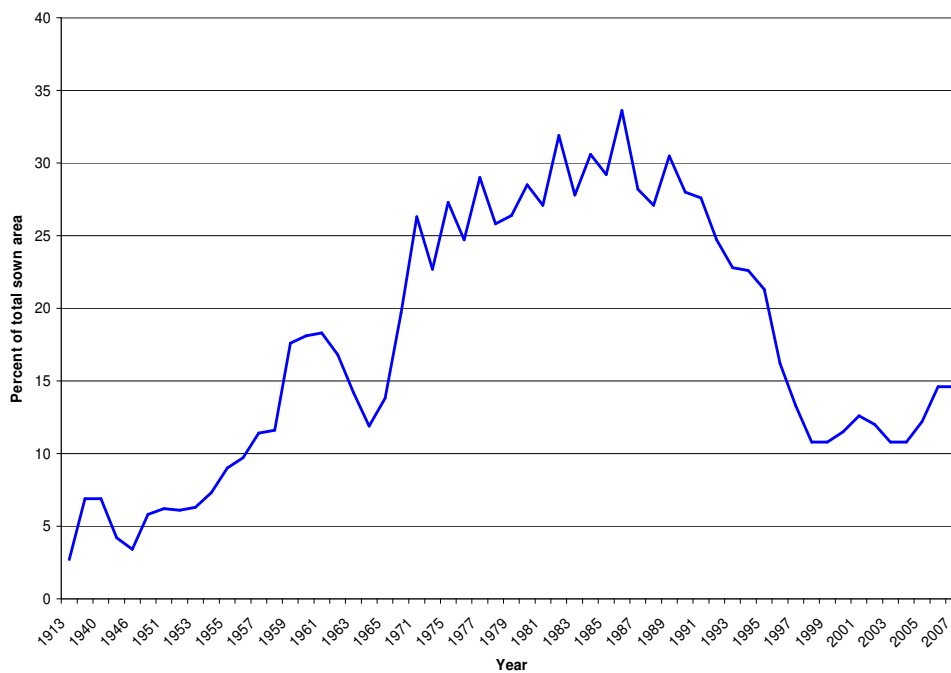
The area in feed crops also fell, beginning in 1989 or 1990 (**Figure 2**), to be replaced by grain and pulses. After 1998 or 1999, however, the area in feed crops increased a bit and levelled off. Still, over the entire period from 1991 to 2007 the area in feed crops fell by 43 percent. A more long term look at feed area shows that feed area in 2007 as a portion of total sown area is now on the level of the late-1950s in Tajikistan when livestock inventories were about 44 percent of their level in 2007 (**Figure 3**).

Figure 2. Sown area in Tajikistan, 1980-2007



Source: CISSTAT (2008).

Figure 3. Portion of sown land in feed crops in Tajikistan, 1913-2007 (percent)



Sources: *Sel'skoe khoziaistvo respubliki Tadjikistan: statisticheskii sbornik* (2001, 2002, 2003, 2004, 2005, 2006, 2007); *Narodnoe khoziaistvo Tadjikskoi SSR: statisticheskii ezhegodnik* (1961, 1965, 1971, 1972, 1976, 1977, 1978, 1979, 1980, 1981, 1984, 1985, 1988).

Falling area and yields caused a collapse in the production of cultivated feed crops in Tajikistan (**Table 1**). Between 1991 and 2000 the total cultivated feed available to livestock in Tajikistan fell by 79 percent. Thus, the first two pillars supporting 1.6 million standard head of animals in 1991 were eliminated nearly entirely within nine years, and probably by 1995. The largest fall in feed availability came from the near elimination of imported concentrates. However, cultivated feed crop production also fell precipitously. Though there was some recovery in the availability of feed in Tajikistan after 2000, it is today a mere 44 percent of what it was in 1991. Feed per head of livestock also fell and has not recovered. Thus, total feed availability from cultivated feed and concentrates per standard head fell by 73 percent between 1991 and 2007 and total feed per cow (the primary consumer of cultivated feed and concentrates) fell by 77 percent.

Table 1. The collapse of available cultivated feed and concentrates in Tajikistan (in tons of feed units), 1991-2007

No.	Feed source	1991	2000	2007	Percent Change, 1991-2000	Percent Change, 1991-2007
1	Total from cultivated feeds and concentrates (feed units, tons)	2,196,062	458,131	738,744	-79	-66
a	Total cultivated feed crops	1,500,404	274,858	386,748	-82	-74
b	Domestic concentrates	368,658	182,954	344,439	-50	-7
c	Imported concentrates	327,000	319	7,557	-100	-98
2	Feed availability per animal (feed units/head)*					
a	Feed per standard animal head**	13	4	5	-69	-73
b	Feed per cow***	38	8	9	-78	-77

*This measure is incomplete, because it does not include feed consumed through grazing in pastures.

**Cow units.

***Only cows.

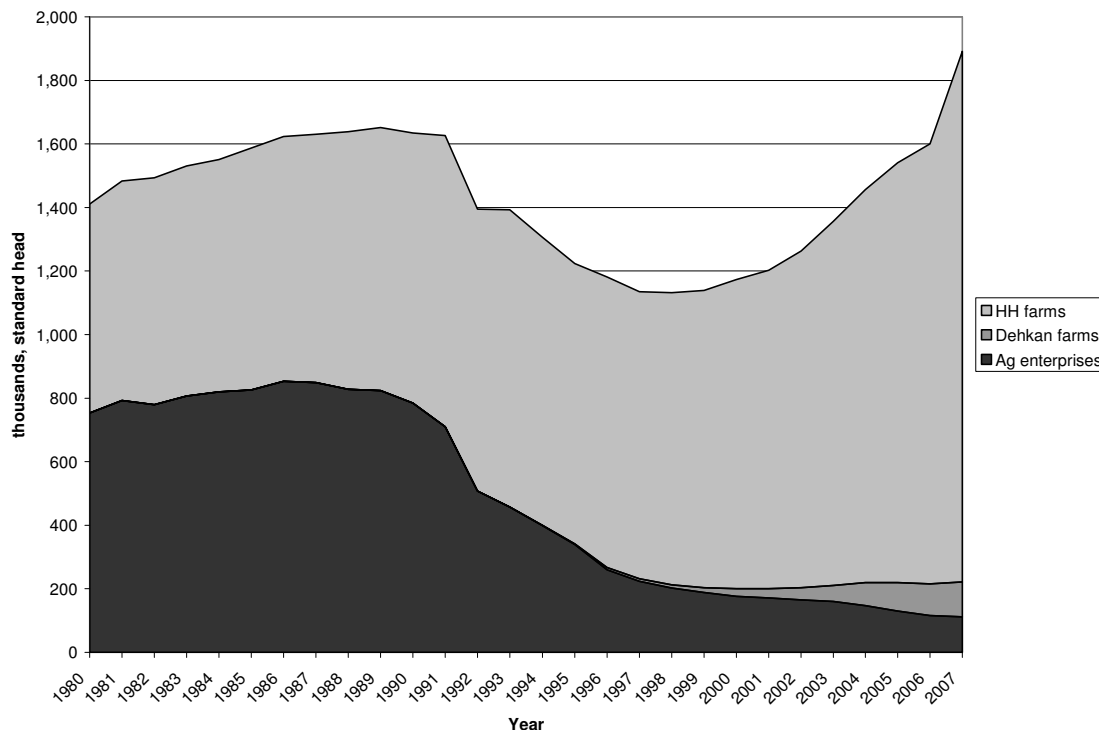
Sources: FAO (2009), p. 22. *Sel'skoe khoziaistvo respubliki Tadjikistan: statisticheskii sbornik (2007)*.

The deterioration of the feed base in Tajikistan caused an unprecedented initial fall in livestock inventories. In the period 1991 to 1998 livestock inventories in Tajikistan fell by 30 percent. The initial fall was nearly exclusively due to liquidation of livestock inventories in agricultural enterprises, as evidenced in **Figure 4**. Inventories on household plots, not directly supported by the socialist industrial feeding system, remained predominantly untouched by this initial downturn.

The disintegration of the Soviet intensive agricultural system and the resulting fall in both crop and livestock production led to the decision to partially privatize agriculture. The first legal acts on land reform and farm restructuring in Tajikistan were issued in 1992, but land reform began in earnest only in 1995, with a presidential decree allocating additional land to household plots. In parallel (1995-1996) Tajikistan moved to reorganize the traditional collective and state farms into new corporate forms in the hope that restructuring would improve productivity in a notoriously inefficient sector. When this largely cosmetic restructuring failed to produce efficiency gains, the government switched the focus of its attention to dehkan (peasant) farms as a model of family farming. Since 1999, dehkan farms have largely supplanted the corporate farms – limited liability companies, leaseholding enterprises, joint stock companies, and agricultural cooperatives – as the main agricultural land users.

The above reforms led to two crucial changes for the livestock production system in Tajikistan: (1) the virtual complete individualization of livestock inventories and (2) an initial fall and then rapid growth of livestock numbers. The individual sector in Tajikistan controlled most livestock even back in the Soviet era. In 1990 62% of livestock was held outside of corporate farms (**Figure 4**). But by 2007 the share of household plots in livestock had risen to over 90% (measured in standard head), so that the household farm sector now dominates livestock production, while enterprises and dehkan farms remain minor players. This situation is not unique to Tajikistan: a similarly extreme concentration of livestock production in household plots is also observed in Uzbekistan.

Figure 4. Livestock inventories by farm type, 1980-2007 ('000 standard cow head).



Source: CISSTAT (2008).

The rapid individualization of livestock herds and the end of hostilities in Tajikistan ushered in a new era of rapid growth in livestock inventories based on household farms. Overall livestock inventories in Tajikistan increased by 82% from 1998 to 2007, nearly exclusively as a result of growth in household farms (**Figure 4**). The rapid recovery of livestock inventories after 1998 meant that (using official published statistics) by 2007 total livestock inventories were 16 percent higher than in 1991. The rapid expansion of livestock inventories despite the fall in feed availability has kept feed availability per animal (**Table 1**) extremely low.

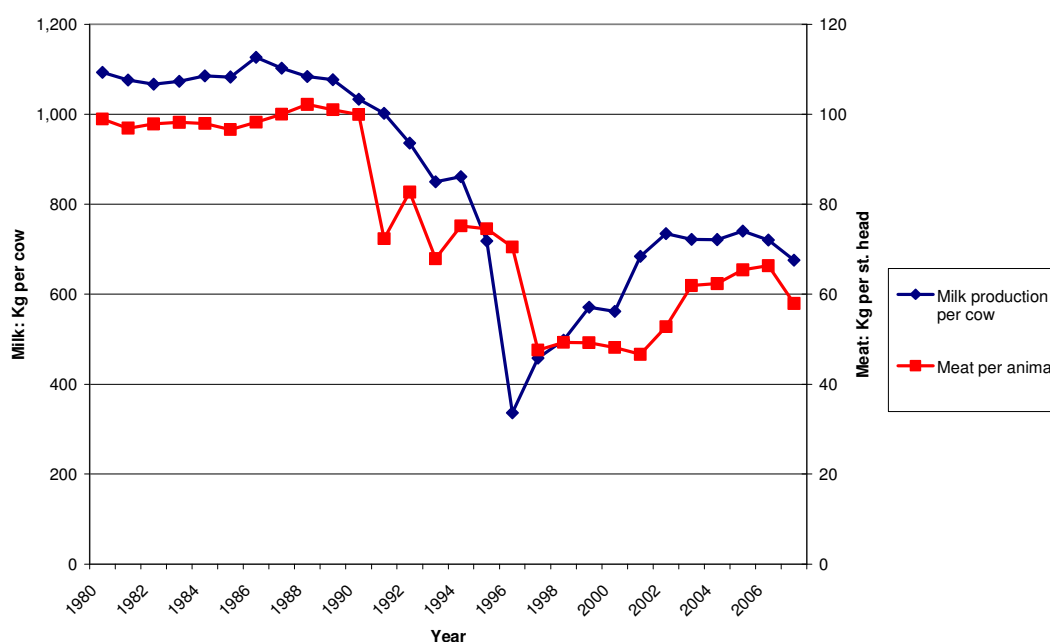
Taken together, the above changes signify no less than the transformation of the livestock husbandry system in Tajikistan from one based on intensive livestock farming to one based on extensive livestock husbandry. Intensive farming or intensive agriculture is an agricultural production system characterized by the high inputs of capital, labor, or heavy usage of technologies such as pesticides and chemical fertilizers relative to land area. In Tajikistan intensive livestock farming was conducted in large dairy and meat complexes where cultivated feed and concentrates were fed to hogs, poultry and dairy cows. These feeds were

raised in corporate farms and procured through the state animal feed supply system to ensure adequate feed. Since these complexes depended on procured animal feeds they liquidated their inventories when the feed supply system collapsed. The livestock production system existing today in Tajikistan relies primarily on grazing of livestock with limited feeding of cultivated feed and concentrates.

3. Livestock yield changes

The hallmark characteristic of an intensive farming system is relatively high output per unit of input. In livestock this meant that meat production per animal and milk produced per cow in Tajikistan were at all-time highs in the 1980s (**Figure 5**). The decline began in the end of the 1980s when milk per cow and meat per animal started declining gradually. After 1990 this gradual decline turned into a free fall that lasted through 1997, after which both indicators began to rise and level off. Today both productivity indicators have recovered somewhat from the severe decline of the early nineties, but have stopped rising since 2003.

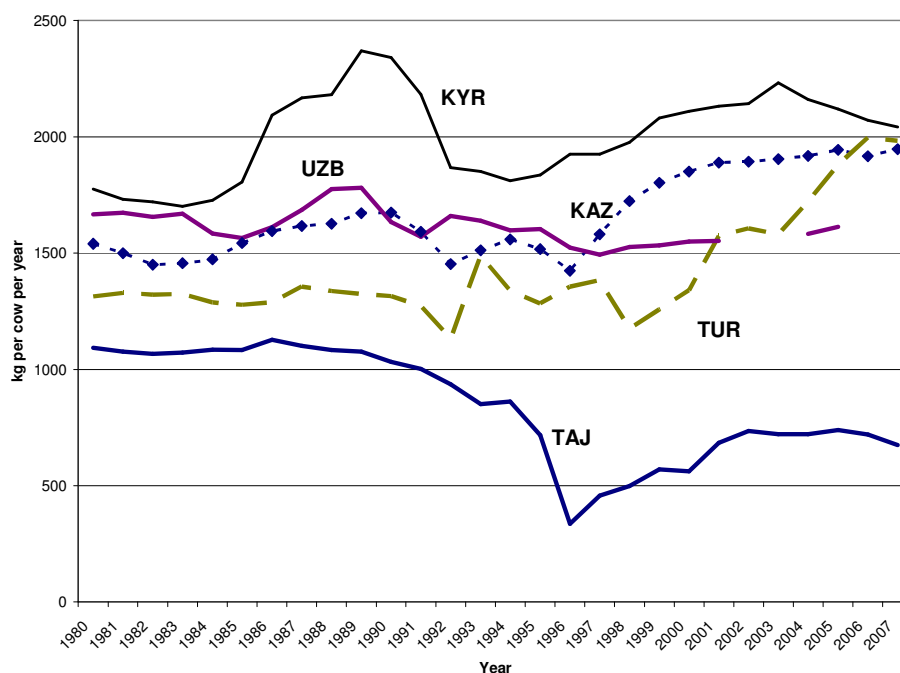
Figure 5. Animal productivity in Tajikistan, 1980-2007



Source: CISSTAT (2008).

Despite recent increases, there is a generally low level of livestock productivity in Tajikistan. Milk yields are representative of the problem. Though milk yields recovered and have remained fairly constant since 2002, their recovery and stabilization does not appear to be directly linked to improvements in animal nutrition. The availability of feed crops per cow declined sharply from 1991 to 2000 and then stabilized (**Table 1**). At less than 700 kg per cow per year, milk yields in Tajikistan are far below yields in Western countries and rock bottom in the CIS (**Figure 6**). Even during the heyday of Soviet Tajik agriculture milk yields were far below those of the other 15 republics.

Figure 6. Milk yields for Tajikistan and other Central Asian countries, 1980-2007.



Source: CISSTAT (2008).

B. Carrying capacity of feed resources in Tajikistan, 2007

Extensive livestock production systems can lead to a vicious cycle of ever-lower animal yields, contributing to ever-lower returns from livestock husbandry. The reason is that extensive livestock systems encourage the expansion of livestock inventories in an effort to increase revenues without a concomitant expansion of feed resources. Adding animals creates greater demand for limited feed, leading to a further deterioration in the feed per animal ratio and a further fall in animal yields. Underfed animals are also more susceptible to disease, are less fertile and die more easily. Most importantly, the only way to increase family income in extensive livestock systems is to increase animal inventories which further deteriorates the feed per animal ratio. A look at **Figure 4** illustrates that since 2000 animal inventories in household farms have increased at ever faster rates.

Breaking the downward spiral of animal yields and poverty requires a vision of the future of the livestock sector and the gradual implementation of policy measures to support progress toward that vision. The foundation of the vision is a country with adequate feed resources to support the current livestock production in the country. However, in order to suggest policies to address the feed shortage in the country it is necessary to understand how much feed is available per animal and, if there is an imbalance between the supply of feed and animal demand, what lies at the root of this imbalance.

The first step in understanding the specifics of feed inadequacy in Tajikistan is a measurement of the carrying capacity of the feed resources of the country. The carrying capacity of a biological species in an environment is the population size of the species that the environment can sustain in the long term, given the food, habitat, water and other necessities available in the environment. An alternative way of using the carrying capacity concept is to express the food resources (in feed units) available as a percentage of the desired resources in order to sustain the species in the desired health, weight and physical capacity. An estimate of the

carrying capacity of feed resources is a starting point for an analysis of livestock development in a country.

1. Estimate of carrying capacity

An estimate of carrying capacity involves three distinct steps. (1) First an estimate is made of the total supply of available feed resources in the country, including cultivated feed, concentrates and pasture; (2) next, an estimate of feed demand is derived from feeding norms applied to the total animal population in the country; (3) last, the balance between feed demand and supply is calculated, rendering a livestock feed sufficiency ratio. In order to sum the available feed material from different types of cultivated feed, concentrates and pasture, the estimated nutrient weight of these feeds must be expressed in a common *feed unit equivalent*. Livestock inventories must further be expressed in a common unit, so-called standard head, which itself is based on feed consumption estimates. The feed resources required to adequately feed the animal population is based on the nutrition requirements of the common unit animal used in the calculations, in this case beef cows.

The feed resource base in Tajikistan is based on (1) cultivated feed, (2) domestic and imported concentrates and (3) pasture (see **Box 1**). Estimates of the feed unit equivalents of domestic and imported cultivated feed and concentrates in 2007 obtained from FAO (2009) are found in **Table 1**. The conversion to feed units is based on standard Soviet feed unit conversion rates (Kalashnikov and Kleimanova, 1988; Zharkov and Zhukov, 1971).

An estimate of the feed unit equivalent of the third component of feed supplies in Tajikistan (pastures) is much more difficult and speculative. Nolan (2005, pp. 63-64) and O'Mara (2006, pp. 20-21) attempted to estimate the volume of feed obtained by animals from pastures for 2003. FAO (2009) also contains figures which can be used to estimate the feed unit equivalent of Tajik pasture feed supply. **Table 2** reports estimates of the feed unit equivalent of Tajik pasture feed supply in 2007 based on Nolan (2005) and FAO (2009). In order to obtain total consumable feed from pasture, the area in pasture (**Table 2**, line 1) was multiplied by an estimate of the average pasture yield (**Table 2**, line 4) to obtain total consumable tons of dry matter (DM) per year. In order to convert this dry matter to feed equivalents it was converted to oat unit equivalents. According to research on the nutrient value of pastures conducted in the Republic of Tajikistan, 1 kg of pasture dry mass contains from 0.34 to 0.6 kg oat feed units (Safaraliev, 2009). A conversion rate of 0.5 kg oat unit equivalents/kg pasture dry mass is used in this calculation. The resulting estimate of the oat unit equivalent of consumable pasture feed in 2007 is shown in **Table 2**, line 6.

The main point of difference between Nolan (2005) and FAO (2009) is in pasture yields (**Table 2**, line 4). Nolan (2005, p. 60) estimated an average pasture yield in Tajikistan of 2.0 tons of dry matter per ha per year. However, not all pasture production is normally consumed. According to O'Mara (2006, p. 20), "pasture utilization is never 100%--allowance must be made for natural senescence, trampling underfoot, unpalatable pasture which animals avoid, and undergrazing of certain areas." Nolan assumes an average uptake or utilization rate of 50%. This means that average yields of consumable dry matter were estimated at 1 ton per hectare (line 4). FAO (2009) estimated average pasture yields in Tajikistan to be 50% higher. This estimate is of edible or consumed dry mass, so that it apparently already integrates an uptake rate into the calculation. These divergent estimates imply divergent estimates of the consumable feed produced in Tajik pastures in 2007 obtained in **Table 2**.

Table 2. Feed unit supply equivalent from Tajik Pastures, 2007

Source of yield and uptake estimates	FAO (2009)	Nolan (2005)	Intermediate
1. Pasture area in 2007 (ha)* ⁴	3,223,045	3,223,045	3,223,045
2. Yield (tons of dry matter (DM) produced/ha)		2	
3. Uptake rate (%)		50	
4. Yield of consumed DM (t/ha)**	1.53	1.0	1.27
5. Total consumable tons DM/year (line 1*4)	4,931,259	3,222,921	4,028,807
6. Total consumable feed in 2007 in tons of feed units	2,465,630	1,611,460	2,014,404

*2.9 million ha of pastures in agricultural production units and 32.5% of 938 075 ha of pastures in other state ownership.

**FAO (2009) states yields in terms of edible or consumed dry mass.

Sources: Nolan (2005), p. 63; FAO (2009), pp. 12-15.

To summarize the resulting differences in production estimates between Nolan and FAO: Nolan's (2005) yield assumption implies total consumable DM/year (**Table 2**, line 5) of 3.2 million tons, while FAO (2009) assumptions imply a total figure of on 4.9 million tons. The resulting estimate of the oat unit equivalent of consumed pasture feed in 2007 (line 6) based on FAO (2009) is 50 percent higher than that based on Nolan (2005). Because of this wide variation **Table 2** includes an intermediate calculation of the feed unit equivalent of Tajik pasture feed supply in 2007 based on the average of yields from Nolan and FAO. This yields a total consumable feed in 2007 of about 4 million tons of dry matter or 2 million tons of feed units.

Table 3 presents estimates of the carrying capacity of the feed base in Tajikistan. In line 1 the total supply of feed from all sources (cultivated feeds, concentrates and pasture) is presented based on **Tables 1 and 2**. Line 2 presents an estimate of feed demand based on feeding norms for the beef cattle equivalent of total livestock inventories in 2007 from FAO (2007). According to FAO (2009), each cattle equivalent requires 2.12 tons of oat feed per day in order to lead a normal life. Line 3 presents the carrying capacity of feed supplies in Tajikistan as the ratio of feed supply to demand (line 1/line 2) and expressing it as a percent.

The conclusion from **Table 3** is that Tajik livestock obtain only between 53% and 72% of their required dietary needs from the feed resource base available. The estimates obtained from these figures are comparable to the one obtained by O'Mara (2006, p. 21) for 2003 using a similar method. O'Mara estimated that for 2003 the percent of required feed met by feed resource base totalled 67%.

⁴ According to statistics from the Agency for Survey, Cartography and Land Tenure, there were 2.9 million ha of pastures in agricultural production units and 938,075 ha of pastures in other state ownership (e.g., State committee on forestry resources, environmental preservation lands, historical-regional studies sanatoria, ministry of energy, state land fund and others). Though the latter pasture resources are not officially used FAO (2009) estimates that 30-35 percent of these resources are leased for short periods to farmers and other individuals particularly in the summer months. Estimated pasture area is therefore 3.2 million ha (line 1), including 2.9 million ha of agricultural land and another 305 thousand in other lands.

Table 3. Calculation of Carrying Capacity of Tajik Feed Resources, 2007

Source	FAO (2009)	Nolan (2005)	Intermediate
1. Total feed supply (tons of feed units)	3,204,373	2,350,204	2,753,147
----from cultivated feed and concentrates	738,744	738,744	738,744
----from pastures	2,465,630	1,611,460	2,014,404
2. Total feed demand (tons of feed units)	4,448,837		
----livestock inventories (beef cattle equivalents)	209,851		
----Feed units required per annum (tons per standard head)	2.12		
3. Carrying capacity measure			
Feed demand met by feed supply (line 1/line 2, percent)	72	53	62

Sources: Tables 4, 5; FAO (2009), p. 22.

2. Limitations of the carrying capacity calculation

The above calculations of carrying capacity should be understood as rough estimates without pretensions to exact accuracy. They do, however, establish that animals are underfed in Tajikistan because inventories have outstripped feed resources using current technology, though this fact is obvious to anyone who has observed animals on the ground. The severity of the undernourishment of livestock has led Nolan (2005), O'Mara (2006) and FAO (2009) to believe that this is the key issue impeding improvements in livestock productivity in Tajikistan. However, the carrying capacity calculation is only the beginning of an analysis of the reasons behind low livestock productivity in Tajikistan, as this section will illustrate.

The carrying capacity concept has three important limitations in Tajikistan. The first important limitation to the carrying capacity concept is that 42 percent of total livestock feed demand comes from milk cows which are unlikely to be pastured at a great distance from the village, while an additional 24 percent derives from beef cattle whose movement away from the farm is also limited (**Table 4**). Thus, at least 42 percent of total feed demand falls on cultivated feed and fields located close to the village. Sheep and goats, the classic small ruminant pasture animals, represent a mere 26 percent of total feed demand.

Table 4. Feed demand based on animal inventories in Tajikistan, 2007

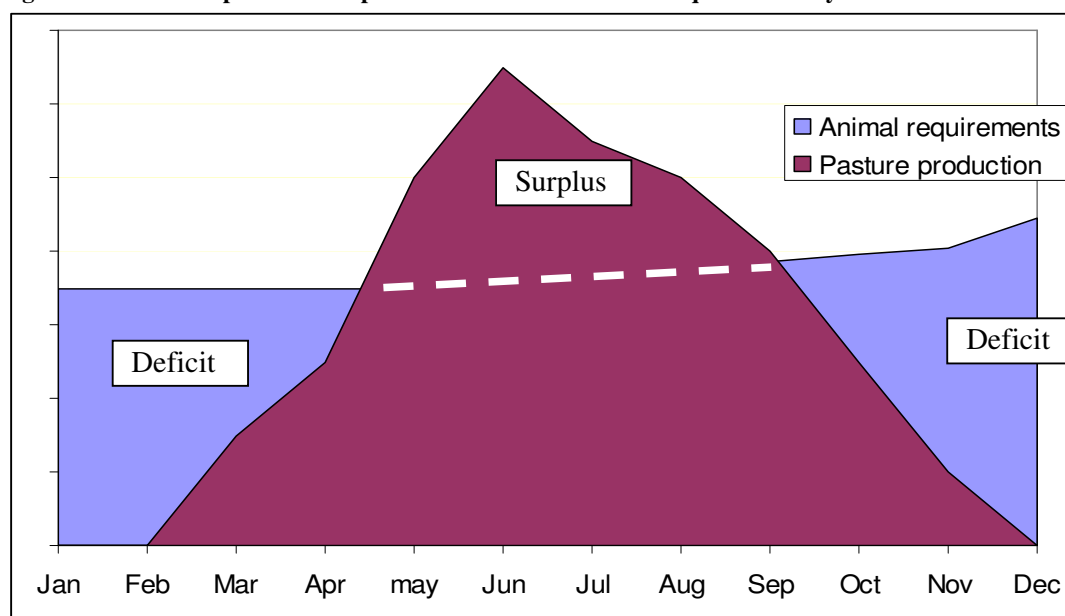
Livestock	Livestock inventories (1000s)	Beef cattle Equivalent	Total beef cattle Equivalents (1000s)	Feed units required per year (tons)	Percent of total demand
Beef Cattle	838.2	0.6	502.9	1,066,190	24
Dairy Cows	864.3	1.0	864.3	1,832,316	42
Hogs	0.6	0.4	0.2	445	0
Sheep and goats	3,798.4	0.1	531.8	1,127,365	26
Poultry	3,280.4	0.0	65.6	139,089	3
Horses	78.5	1.0	78.5	166,420	4
Yaks	15.2	1.0	15.2	32,224	1
Total demand			2,058.5	4,364,050	100

Note: Beef cattle equivalents are Soviet era coefficients still used in Tajikistan to calculate standard head in beef cattle units. Required (oat) feed units are based on 2.12 tons of oat units required for feeding cattle per year. Most beef cattle in Tajikistan are calves, so that the equivalent used for them (0.6) is less than that for full-grown bulls (1.0).

Source: *Sel'skoe khoziaistvo respubliki Tadzhikistan: statisticheskii sbornik (2007)*.

The second limitation of the carrying capacity calculation regards the differing availability of feed over the course of the year. In all pasture-based feeding systems it is the winter feed requirement that presents the most difficult challenge. While animal feed demand is relatively constant throughout the year, gradually increasing as animals grow, the availability of pasture feed is nearly nil during the winter, limited in the spring and autumn and peaks in the summer months. **Figure 7** illustrates the mismatch between pasture feed production and animal feed requirements by month. Winter feeding depends on the availability of cultivated feed (cut hay, silage, feed crops) and concentrates (grain, oilseed meal and wheatfeed) during the winter, spring and fall months. Though animals, fattened from summer feeding in alpine pastures, are able to store food in the form of fat, the winter feeding bottleneck is still the major limiting factor on livestock nutrition in Tajikistan.

Figure 7. Outline of pasture feed production and animal feed requirements by month



Source: O'Mara (2006), p. 15.

The importance of the winter feeding issue leads to the belief according to a study of pasture issues in GBAO that “winter fodder, rather than pasture area or quality, is the major problem affecting livestock production and that livestock numbers are naturally limited by this winter bottleneck (Mountain Societies, 2007, p. 5). This statement from GBAO would indicate that the development of the livestock sector in Tajikistan depends vitally on efforts aimed at increasing the production and availability of winter fodder, rather than in increasing the production of pasture resources in Tajikistan.⁵ Though GBAO is hardly representative of the whole of Tajikistan, the statement about the winter bottleneck is still valid for the country as a whole in the following sense: The seasonal nature of feeding implies that Tajikistan may have an *oversupply* of feed in the summer and an *undersupply* of feed during other seasons. This would mean that not all summer pasture resources would be utilized, making the total volume of feed actually consumed far less than is assumed in the simple carrying capacity calculation.

⁵ The two issues are closely connected: restricted access to pasture feed in spring, summer and autumn increase the winter feed bottleneck.

The third limitation to the carrying capacity concept is that it takes no account of the unequal distribution of livestock inventories and feed resources in Tajikistan. **Table 5** illustrates the extreme concentration of feed resources in agricultural enterprises and dekhan farms. Only 36 percent of cultivated feed resources is raised in household farms while 90 percent of animal inventories is owned by households.

Table 5. Estimated distribution of cultivated feed and concentrates in Tajikistan, 2007

Cultivated feed in Tajikistan	Household farms (percent)	Agricultural Enterprises and dekhan farms (percent)
Total cultivated feed	36	64
Dry forage		
hay	26	74
straw	42	58
haylage	n.d.	n.d.
Green chop*	10	90
Succulents without silage*	10	90
Concentrated feed:		
Corn	75	25
Barley and oats	36	65
Bran	42	58
Cotton and other meals	40	60
Imported concentrated feed	0	100

*There are no data on these feeds. It is assumed that 10% of green chop and succulents is raised in household farms.

Source: FAO (2009), p. 22.

The extreme mismatch between feed and animals is illustrated in **Table 6** which shows that household farms raise only 7 percent of required feed on farm, and must utilize the pastures of agricultural enterprises or dekhan farms or must purchase cultivated feed raised on enterprises and dekhan farms. Agricultural enterprises and dekhan farms, however, have nearly 5 times the feed resources required to support their livestock inventories.

Table 6. Distribution of total feed resources in Tajikistan, 2007

Item		Total	Household farms	Agricultural Enterprises and dekhan farms
1	Cultivated feed and concentrate availability, 2007 (tons of feed units)*	738,744	265,247	473,497
2	Pasture production, 2007 (tons of feed units)**	2,014,403	0	2,014,403
3	Total available feed resources, 2007 (tons of feed units)	2,753,147	265,247	2,487,900
4	Standard head (beef cattle units) of animals in Tajikistan (Jan 1 2008)	2,098,508	1,888,657	209,851
5	Feed units per std head per year (tons, 3/4)	1.31	0.14	11.86
6	Feed units required per std head per year (tons)	2.12	2.12	2.12
7	Deficit (surplus) (6-5) (tons of feed units/std head/year)	0.81	1.98	(97.4)
8	Percent of requirement met (5/6, percent)	62	7	559

*From **Table 1**, production and imports in 2007.

**Using intermediate estimate of pasture yields.

Sources: Tables 1.4, 1.5, FAO (2009), p. 22.

3. Alternative Calculation of Demand Pressure on Pastures and Forage Crops

An alternative way to calculate demand pressure on pastures and forage supplies is by analyzing the demand and supply for each type of pasture and forage crops separately. A comparison of the demand and supply for each feed source gives a much more nuanced view of the carrying capacity of feed resources in Tajikistan which incorporates seasonality and differentiated demand by animal type. This more nuanced view is able to resolve the question of whether the main problem of animal feeding in Tajikistan is a scarcity of forage crops or a scarcity of pasture resources or both.

Pastures in Tajikistan are divided into those utilized in winter, spring-fall, summer and year round. **Table 7** illustrates the various types of pastures and their characteristics.

Table 7. Pasture Types in Tajikistan

Pastures	Winter	Spring-Fall	Summer	All Year
Altitude (meters above sea level)	500-1,200	900-1,500	2,200-3,400	500 to 1,000-1,200
Use months	Nov-Mar	Mar-May, Sep-Nov	June-Aug	Jan-Dec
Use days	120-150	90-110	80-90	300-330
Total area (1.1.08) (1000 ha)	699.0	675.9	2,081.3	400.0*
Percent of total pasture area (%)	18	18	54	10
Of which, in farm units (1000 ha)	625.0	598.6	1,334.6**	360.0
Yield average (tons/ha of edible dry mass)	0.35	1.15	2.25	0.29
Distance from villages (km)	0.8-1.4 to 4-5	1.2-1.8 to 30	200-600***	less than 1 km

*85-90% degraded.

**76.2% of area in dekhani farms.

***6-8 weeks per year are spent travelling from winter to summer to winter pastures by animals using summer pastures per year.

Source: Safaraliev (2009).

Feed demand

Different animals spend their time feeding from different sources during the course of the year. Small ruminants, such as sheep and goats, pasture for a long period during the year (often in quite distant alpine pastures), while milk cows spend their time eating forage and grazing in nearby pastures. **Table 8** illustrates these differences by animal type in Tajikistan.

Table 8. Animal feeding throughout the year, by animal type and feed source (percent).

Animal types	Percent of time through year by animal and feed source (%)					Total
	Summer pasture	Fall-spring pasture	Winter pasture	All year pasture	Cultivated feed and concentrates	
Beef cows	18	16	7	21	38	100
Cows	0	16	4	22	58	100
Hogs	0	0	0	0	100	100
Sheep and goats	22	18	12	24	24	100
Poultry	0	5	0	41	54	100
Horses	13	14	11	32	31	100
Donkeys	0	14	10	45	31	100
Yaks	34	2	38	26	0	100

Note: This table is distilled from a larger table of feed days in Tajikistan by region by animal.

Source: Safaraliev (2009).

By distributing the feed requirements of each animal over pasture and forage resources according to **Table 8**, the total feed requirements by animal type by source of feed can be estimated (**Table 9**). The resulting calculations illustrate an important mismatch in Tajikistan between demand and supply of pasture feed. For instance, though Tajikistan has ample summer pasture land available (over 50% of total pasture area), most demand pressure in the country is on all-year and fall-spring pastures. Conversely, only 10% of pasture land in all year pastures serves the pasture feeding needs of 43% of total livestock feed demand. Clearly, this mismatch between demand and supply for pasture resources is a source of problems for livestock development.

Table 9. Feed demand in Tajikistan, by animal type and source, 2007

Feed demand (tons of feed units)	Pasture					Cultivated feed and concentrates
	Total Pasture	Summer	Fall- spring	Winter	All year	
Beef cows	643,771	182,352	172,915	72,722	215,783	401,713
Cows	768,389	0	293,258	72,782	402,350	1,061,275
Hogs	0	0	0	0	0	436
Sheep and goats	856,990	246,057	203,692	137,864	269,377	268,788
Poultry	64,221	0	6,992	0	57,229	74,670
Horses	115,336	20,996	22,989	17,563	53,788	50,908
Donkeys	249,934	0	50,560	34,884	164,490	112,671
Yaks	32,136	11,021	514	12,266	8,334	0
Total feed demand	2,730,777	460,425	750,920	348,082	1,171,350	1,970,459

Source: **Table 8**.

Feed supply

FAO (2009) and Safaraliev (2009) give pasture yield estimates differentiated by region and pasture type. Thus, it is possible to calculate the adequacy of pasture feed resources by type of pasture (**Table 10**). The results illustrate that, though total pasture resources in Tajikistan may be adequate in total, this calculation carries very little meaning. While summer pastures are in excess supply, pastures grazed during other seasons meet very little of demand. Moreover; demand for forage crops is satisfied by only one-third.

Table 10. Feed supply and feed adequacy in Tajikistan, by source, 2007

	Feed Supply	Pasture					Cultivated feed and concentrates
		Total Pasture	Summer	Fall- spring	Winter	All year	
1	Pasture area in 2007 (ha)	3,856,246	2,081,287	675,909	699,003	400,047	n/a
2	Yield of edible dry mass (t/ha)	1.53	2.27	1.15	0.36	0.39	n/a
3	Total edible t DM/year	5,910,608	4,723,750	780,246	248,759	157,853	n/a
4	Feed in 2007 (tons of feed units)	2,955,304	2,361,875	390,123	124,379	78,927	738,744
5	Feed adequacy coefficient (ratio of supply to demand, %)	108	513	52	36	7	34

Note: this table is derived from a larger table of pasture area and yield by region.

Source: Estimates based on Safaraliev (2009).

C. Policies to bring the feed-animal relationship into balance

Table 10 implies that policies designed to lessen the feed demand overhang in Tajikistan should concentrate on two issues:

1. Raise pasture yields for fall-spring, winter and all year pastures.
2. Raise forage yields and area.

1. Pasture management and yields

Raising pasture yields depends vitally on a proper system of pasture management with the necessary resources to perform pasture maintenance and rehabilitation. Unlike in some other CIS countries (e.g., Azerbaijan), pasture lands in Tajikistan have not been transferred into a separate category of municipal lands with a municipal management structure. Like all agricultural land in Tajikistan, pastures are under state ownership and mainly held by agricultural enterprises and dekhan farms. Pasture resources are classified as agricultural lands, and are used by farms (state agricultural enterprises, dekhan farms and household farms) to pasture their animals for livestock production.

The pasture management system in Tajikistan (as opposed to pasture holdings described above) remains largely similar to that of the Soviet era with the exception that the lowest rung in the management system (corporate farms) no longer has adequate resources for pasture maintenance and management. There is no special legislation defining a workable system of pasture management adapted to post-land reform situation in the country. According to existing legislation on pasture management the following institutions are responsible for the rational utilization of pasture resources in Tajikistan.

- Local executive organs of the state in GBAO, the oblasts, cities and regions.
- Republican, oblast, urban and regional state organs of land surveying
- Competent officials of local Jamoats
- Competent officials of the state committee on environment

By default, the following system of pasture management responsibilities exists in Tajikistan (**Table 11**).

Table 11. De facto System of Management of Pasture Resources in Tajikistan

Geographic zone	Pasture type, land area	Types of pasture	Slope	Grazing system and season	Use period	Livestock type	Managerial and utilization responsibility
Lowland valleys	Winter-spring and fallow around populated areas	Desert and semi desert pastures (ephemerals, steppe sagebrush, certain woody grasses, fallow, small grasses).	flat	Free, all year	all year	all types	Jamoat leadership, regional land surveyors, environmental experts
Low foothills and middle belt	Winter-spring and fallow around populated areas	Desert and semi desert pastures (ephemerals, steppe sagebrush, cereals, vetch, beans, soft fallow)	flat, gentle slopes and river floodlands	Free, all year	all year	all types	Jamoat leadership, regional land surveyors, environmental experts, pasture rehabilitation trust of the Ministry of Agriculture
Low mountainous and middle belt	Fall-winter and seasonal migration paths	Semi desert steppe pastures (soft fallow, steppe woody grasses, cereals, grassy steppes, also beans)	Slopes of various degrees	Free, spring-summer	Spring, summer, fall	sheep, goats, horses, beef cattle	Regional, oblast land surveyors, environmental experts, pasture rehabilitation trust of the Ministry of Agriculture
High mountain belt	Summer mountain and high mountain	Barley grasses (often overgrown with bushes, meadow), meadow grasses (mountain, high mountain and high mountain various cereals)	Slopes of various degrees, steep slopes, gentle slope, flat lands	Free, used with pasture rotation	Summer, early fall	sheep, goats, horses, beef cattle	Regional, oblast and interregional land surveyors, environmental experts, pasture rehabilitation trust of the Ministry of Agriculture
High mountain alpine and sub-alpine belt	Summer high mountain pastures (seasonal)	steppe (alpine various, high mountain various, high mountain various cereals), meadow grasses (alpine, meadow various)	Slopes of various degrees, gentle slope	Free, used with frequent pasture rotation	summer	sheep, goats, sometimes horses	Oblast and interregional land surveyors, environmental experts, pasture rehabilitation trust of the Ministry of Agriculture
Animal migration byways	seasonal	Desert, semi desert (ephemerals, cereal-bean and various)	Slopes of various degrees, flat lands	Used during animal migration	spring, fall	all types	Central and regional specialists of the pasture rehabilitation trust of the Ministry of Agriculture

Source: Safaraliev (2009).

Table 12. Description of legal responsibilities for pasture management in Tajikistan and Kyrgyzstan

Tajikistan	Kyrgyzstan
Ownership	
All pastures owned by the state	All pastures owned by the state
Land users	
Physical or juridical persons of Tajikistan	Physical or juridical persons of Kyrgyzstan or foreign country (by international agreement or intergovernmental agreement)
Pasture border demarcation	
Madzhlisi Oli (Parliament)	Carried out by local commission appointed by the local state administration. The government of Kyrgyzstan establishes a commission to settle disputes.
Pasture management	
The Tajik national government is responsible for the organization, development and realization of government and intergovernmental programmes for the rational use of pastures, raising productivity and soil fertility and for environmental protection. It also has responsibility for general management of pasture resources, establishment of the plan for cadastre works and for monitoring pasture resources.	The local self government body has responsibility for management of pasture resources except for the right of disposal.
Oblast level government organs (goskomzem, giprozem and their local organs) are responsible for cadastre, monitoring the state of pastures, improvements in management within existing legislation and the development of legislation for state management of pastures.	The interference of state organs and local state administrations in the work of local self government bodies and the pasture users associations in the area of pasture utilization is forbidden, except in cases foreseen in legislation (article 4).
The Jamoat (municipality), the local representative organ, is to control the utilization of pasture and protect pasture lands.	The pasture users association represents the interests of the users from within a certain territory. This association draws up a community pasture management plan on an annual basis.
Local regional government administrations within the administrative boundaries of their region are to propose pasture use plans to the local government, control the use of pasture and protect pasture lands. Also responsible for the establishment of agricultural land, state forest land and other lands for pasture use.	The executive committee of the pasture users association is the Jayit which consists of representatives of pasture users, deputies of local self government bodies, heads of executive local self government bodies. Pasture users elect their members to the jayit. The authority of the Javit is to develop community pasture use plans, annual pasture use plans, implement these plans, monitor pasture conditions, issue pasture use tickets according to the plans, fix and collect pasture fees, resolve disputes, and manage pasture revenue for pasture improvement.
Pasture users are responsible for the protection of pastures as well. They are responsible for the rational use of pastures, rehabilitation of soil fertility, protection of pastures from water and wind erosion, other soil damage, and protection from weeds, all to prevent degradation.	Community pasture use plan: includes pasture utilization, maps for boundaries, stock routes, protected areas, watering places, pasture infrastructure, pasture conditions and quality; also contains a map of carrying capacity of various pastures, plans for the development of pastures, maintenance operations, plans for the reconstruction of infrastructure. These plans are updated annually, and are approved by local self government bodies.
The Pasture Trust of the Ministry of Agriculture is responsible for state control of pasture use and protection.	The annual pasture use plan includes a list of pasture users holding tickets for the year and an inventory of their livestock, a list of animal health measures that users

	must carry out in order to exercise their grazing right, a map of seasonal grazing routes, a pasture rotation plan, herd movement routes, cattle pens, etc.
Establishment of a list of pasture users	
The Tajik government has the right to grant and confiscate pasture plots for government purposes in Tajikistan in agreement with local executive authorities.	The executive committee of the pasture users association is the Jayit. The Jayit develops community pasture use plans, annual pasture use plans, implements these plans, monitors pasture conditions and issues pasture use tickets according to these plans. Only ticket holders can use pastures, and tickets are available only after paying the fee.
Oblast level government organs (goskomzem, giprozem and their local organs): state registration of right to use pasture, issue of land certificates for pasture use	The annual pasture use plan includes a list of pasture users holding tickets for the year with an inventory of their livestock.
Local government (oblast and regional) grants pasture plots for agricultural production, grants and confiscates plots when used not according to their prescribed use, including pasture land use rights.	In order to change from the old Tajik-like system to the new system all lease contracts must be exchanged for pasture use tickets. Any leases which were not properly concluded are invalid.
The Jamoat, the local representative organ makes proposals to local governments on granting pasture use rights, on the establishment and approval of tax norms within the bounds established by tax legislation. The Jamoat also keeps a list of pasture users and pasture lease agreements and regulates the use of additional pasture land established from non-pasture resources.	
Local regional government administrations propose pasture use plans to local governments; establish the uses of agricultural land, state forest land and other lands within the administrative boundaries of the region.	
The Pasture Trust of the Ministry of Agriculture is responsible for state control of pasture use and protection.	
Jamoats are supposed to grant pasture use rights to citizens with livestock from reserve land, forest land, urban land, and agricultural land, though need to gain consent of various organizations that are responsible for that land.	
Pasture use fees	
Payment for pasture use is made yearly in the form of a flat land tax. The proceeds of the land tax are distributed according to the tax laws of the country. Tax proceeds for use of pastures and hayfields are used for the protection and rehabilitation of pastures, for maintenance of soil fertility, for monitoring of pastures, etc.	The Executive Committee of the pasture users association, the Jayit, fixes and collects pasture use fees and manages pasture revenue for pasture improvement. Only ticket holders are can use pastures, and the annual pasture ticket is available only after paying the fee which is based on the number and type of animals. Tickets are issued for each type of pasture according to the carrying capacity.
	Pasture use fees are used for the maintenance of the jayit, for pasture improvement and the development of pastures. A portion of pasture use fees are transferred to local budgets.

Sources: Tajikistan: *Land Code of the Republic of Tajikistan* (2008), Kyrgyzstan: *Law on Pastures* (2008).

Although the *de facto* system in **Table 11** seems to cover many of the managerial functions of a pasture management system, it does not seem well suited to involve the end-user in the management of pasture resources, and suffers from a persistent lack of resources. In short, it is not well adapted to managing a public good such as pastures in the post-socialist period when over 90 percent of animals are held in household farms. In other countries pasture land is state owned, just as in Tajikistan, but the management of pasture land, as for other public goods, such as irrigation works, involves significant involvement of and financial contributions from users.

One way of ensuring that pasture management incorporates the needs of pasture users is the pasture users association. The Kyrgyz Republic has recently adopted pasture legislation that changes the system of pasture management to one which may be better suited to the environment of smallholder agriculture. **Table 12** compares pasture legislation in Tajikistan and Kyrgyzstan. In the Kyrgyz system pastures are state-owned public goods, just as in Tajikistan. However, the management, including permission to use pastures, pasture rehabilitation, fee assessment and collection has been decentralized to the level of the pasture users association. Though the system is still being introduced, in principle the idea of decentralizing such decisions puts the users themselves in control of the public good they need to graze their animals. Thus, it could be expected that pasture users would have an intrinsic interest in better husbandry of pasture resources. Though the pasture management system in Kyrgyzstan is yet unproven, it deserves careful study by the Government of Tajikistan.

In order to understand the importance of better pasture management on livestock performance it is possible to project the effects of continuous, small enhancements in pasture yields over a 10 year time period. For this purpose **Table 13** illustrates the effects on feed adequacy and milk yields of increases in yields of winter, fall-spring and all year pastures of 5, 10 and 15 percent per year.

Line 1 of **Table 13** shows the total feed presumably consumed by cows in 2007 in Tajikistan (in tons of feed units) as the sum of lines 1a and 1b. The estimate of cultivated feed consumption in line 1a is derived by applying the share of cow demand in total demand for cultivated feed to the available supply of cultivated feed and concentrates. The estimate of pasture consumption in line 1b is derived by summing the presumed consumption from the winter pasture, fall-spring pastures and all year pastures. Each of these lines was estimated by applying the share of cow demand in total demand for each type of pasture to the available supply of feed from that pasture type. Cows in Tajikistan produced 583,600 tons of milk in 2007 yielding 675 liters per cow (lines 4 and 5, **Table 13**). The average feed conversion rate of cows in 2007 under these assumptions is approximately 1 kg DM for 1 kg milk (line 1/line 4). This rate will be used in later calculations to estimate the effect of adding additional feed.

Scenario 1 assumes that pasture yields are improved by 5 percent per year for 10 years. After 10 years pasture production (in feed units) will have increased by 63 percent, producing an additional 1,292,207 tons of feed for dairy cows above 2007 levels (line 2). This additional feed is sufficient for an increase in milk production of 129 thousand tons, raising milk yields in Tajikistan to 825 liters of milk per cow per year, a 22 percent increase over 2007 (line 3).

Scenario 2 (3) assumes that pasture yields are improved by 10 (15) percent per year for 10 years. After 10 years pasture production in feed units will have increased by 159 (304) percent, producing an additional 3,274,707 (6,257,793) tons of feed units for dairy cows

above 2007 levels. This additional feed is sufficient for an increase in milk production of 327 (626) thousand tons, raising milk yields in Tajikistan to 1,054 (1,399) liters of milk per cow per year, a 56 (107) percent increase over 2007.

Table 13 also illustrates how better pasture management resulting in increased yields can impact on the feed adequacy coefficients shown in **Table 10**. Increasing pasture yields by 5 percent per annum for 10 years would nearly ensure adequate supplies of feed in fall-spring fields, and increasing pasture yields by 10 percent per annum for 10 years would ensure adequate supplies of feed from fall-spring and winter pastures. Only all year pastures (with their quite low yields) would remain in short supply.

Table 13. Productivity and feed adequacy effects of increasing pasture yields by 5, 10, and 15 percent per year for 10 years

Indicator		2007	Raise pasture yields in three pasture types		
			Scenario 1 by 5%/year	Scenario 2 by 10%/year	Scenario 3 by 15%/year
1	Total feed presumably consumed by cows in 2007 (tons of feed units)*	603,354	732,575	930,825	1,229,134
a	Of which, from cultivated feed	397,882	397,882	397,882	397,882
b	Of which, from pastures	205,473	334,694	532,944	831,252
	----Of which, Winter pasture	26,007	42,363	67,456	105,213
	----Of which, Spring-fall pasture	152,355	248,170	395,170	616,361
	----Of which, all year pasture	27,111	44,160	70,318	109,678
2	Additional feed for cows (tons of feed units) as a result of scenario		129,221	327,471	625,779
3	Additional milk production (1000 tons)**		129	327	626
4	Total milk production (1000 tons)	583.6	713	911	1,209
5	Yield (liters/cow/yr)	675	825	1,054	1,399
6 Feed Adequacy Calculations					
a	Summer	513	513	513	513
b	Fall-spring	52	85	135	210
c	Winter	36	58	93	145
d	All year	7	11	17	27
e	Forage	37	37	37	37

*Portion of feed demand pressure from dairy cows by pasture type applied to available pasture feed supplies.

**Assumes a milk/feed conversion rate of 1 kg DM for 1 kg milk.

Source: Estimates based on *Sel'skoe khoziaistvo respubliki Tadjikistan: statisticheskii sbornik (2007)* and Safaraliev (2009).

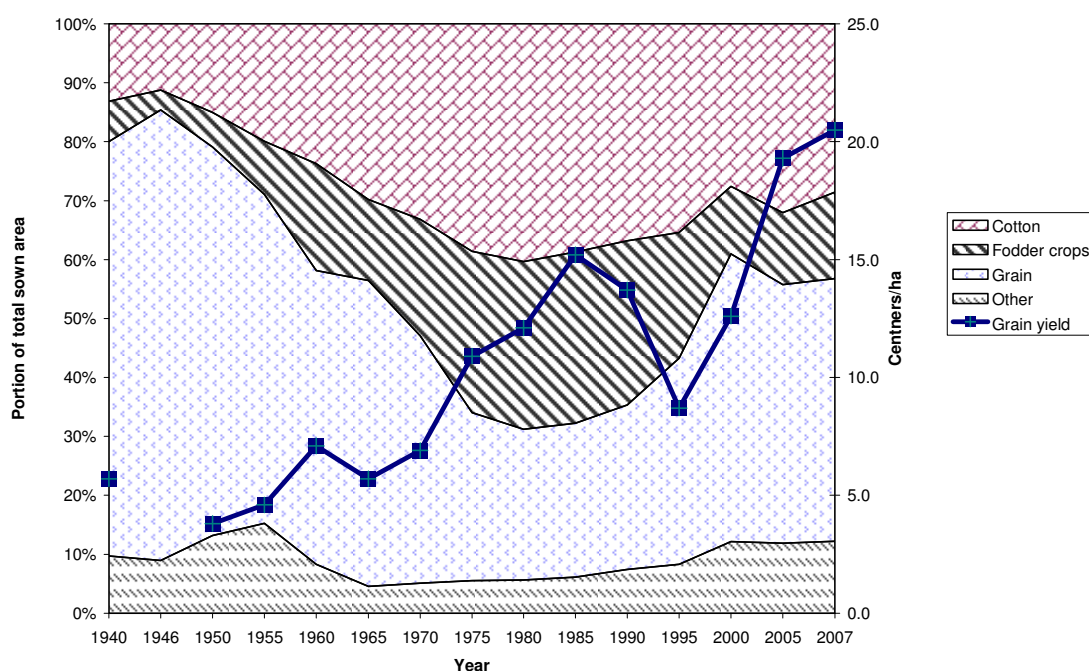
Table 13 does not show the entire effects of each scenario. It only traces out the effects on cows. Similar effects can be expected for meat yields for other animals. Moreover, better fed animals can be expected to be healthier, reducing morbidity and mortality rates. The above scenarios give a rough indication of the important role that even marginal increases in pasture yields could have on feed adequacy and on livestock yields.

2. Forage crop yields and area

There is little doubt that the structure of sown area is ill-suited toward supporting current animal inventories, with its emphasis on cows. In order to support such a large cow inventory forage crop area and yields should grow. However, the area in forage crops in Tajikistan has

historically been linked to the area sown to the other two important crops in Tajikistan, grain and cotton. **Figure 8** illustrates that the area under grain during the Soviet period shrank as grain yields increased. As grain area shrank, area in cotton and fodder crops was able to grow. When grain yields fell after 1985 it was natural that grain area would grow at the expense of fodder and cotton area. However, by 2005, though Tajik grain yields had surpassed peak levels during the Soviet period, grain area remained high. In fact, grain production and production per person in Tajikistan were at all-time highs in 2007, yet sown area remained at nearly 50 percent of total sown area, rather than at 26 percent as it had been in 1980 and 1985.

Figure 8. Tajikistan crop areas and grain yields, 1940-2007 (in percent of total sown area)



Sources: *Sel'skoe khoziaistvo respubliki Tadjikistan: statisticheskii sbornik* (2001, 2002, 2003, 2004, 2005, 2006, 2007); *Narodnoe khoziaistvo Tadjikskoi SSR: statisticheskii ezhegodnik* (1961, 1965, 1971, 1972, 1976, 1977, 1978, 1979, 1980, 1981, 1984, 1985, 1988).

The persistence of high grain area in Tajikistan is in line with the state policy of food self-sufficiency. The reason why grain area remains historically high in Tajikistan is because Tajikistan today imports far less grain than during the Soviet period (**Table 14**). Because of significantly lower grain imports, the domestic production of grain in Tajikistan required to attain Soviet levels of grain availability is far higher than under the USSR. Whereas during the late Soviet period Tajikistan imported 1.3 million tons of grain each year from other areas of the USSR, in 2003 less than 300 thousand tons of grain were imported. Given the grain import level of 2003 (the latest figures available to the author), in order to attain Soviet grain availability (production+imports) levels Tajikistan today would need to produce 1.34 million tons of grain per year, more than three times that produced in the late Soviet period and 130 thousand more tons per year than was produced in 2007. Most importantly, because of population increases, the per capita availability of grain is today half of what it was in the late

Soviet period. This very important constraint implies that it may be unrealistic to consider any sizeable increase in forage crop area by moving area out of grain at this time.

Table 14. Grain area, production and imports in Tajikistan, 1988-2007

Year	Grain area (1000 ha)	Grain production (1000 tons)	Grain Imports (1000 tons)	Availability* (1000 tons)	Imports (% of availability)	Per capita grain availability (kg/cap/year)
1988	242	303	1,320	1,623	81	324
1989	187	322	1,300	1,622	80	314
1990	230	252	1,350	1,602	84	302
1991	232	286	1,250	1,536	81	283
1992	264	257	1,000	1,257	80	227
1993	279	253	795	1,048	76	188
1994	255	212	820	1,032	79	184
1995	265	233	750	983	76	174
1996	384	536	158	694	23	121
1997	419	545	323	868	37	149
1998	407	490	401	891	45	150
1999	403	476	279	755	37	125
2000	421	543	346	889	39	144
2001	389	487	267	754	35	119
2002	364	692	280	972	29	151
2003	405	872	280	1,152	24	175
2004	404	892				
2005	396	935				
2006	402	912				
2007	397	931				

*Production plus imports.

Sources: *Tadzhikistan: 15 let gosudarstvennoi nezavisimosti: statisticheskii sbornik (2006)*;

USDA, Economic Research Service, Former Soviet Union Commodity Balances

(<http://www.ers.usda.gov/data/archive/95008/>); FAOSTAT Supply utilization accounts

(<http://faostat.fao.org/site/355/>).

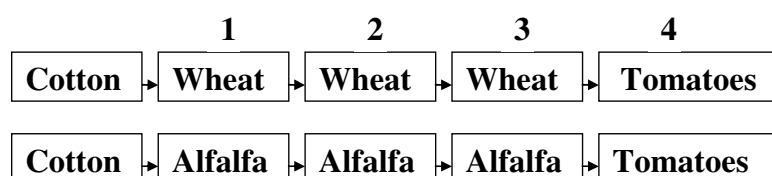
Because of food security concerns it is more realistic to concentrate on increases in cultivated feed crop yields, and these should be the target of increased government and donor attention in Tajikistan. **Table 1** indicated that cultivated feed crop production fell by 74 percent between 1991 and 2007. This was a result of a 43 percent fall in area combined with a 55 percent fall in yields. There is therefore much room for increasing yields of cultivated feed crops.

An additional method of obtaining more area for feed crops without removing area under grain is to take it temporarily out of cotton area through increased rotation of feed wheat or legumes with cotton. Rotation of cotton with legumes would also raise cotton yields by rebuilding soil fertility and organic matter content, which would compensate at least partially for the temporary loss of cotton area. Organic matter can be reintroduced through planting green manure crops and plowing down of vegetative matter.⁶ Moving from cotton to a fall

⁶ Green manure is a type of cover crop grown primarily to add nutrients and organic matter to the soil. Typically, a green manure crop is grown for a specific period, and then plowed under and incorporated into the soil. Examples of green manure crops are winter cover crops such as oats or rye, clover, vetch, Lucerne and others.

seeded green manure crop (rye) for a season followed by grain crops (wheat) and leaving a portion of the stubble in the field would help rebuild soil. Legume crops can also be used more widely to help bring up nitrogen levels. Legumes can be grown for a few years before switching back to cotton cultivation. Such rotation would offer saleable livestock feed while at the same time replenishing nitrogen supplies. **Figure 9** shows two simplified cropping regimes which would allow soil rebuilding to occur. With the wheat program, a farmer would use Tajikistan’s long growing season to double crop wheat with other profitable crops. In the alfalfa scenario, 4 harvests are possible in one year, again because of the long growing season. These two crop regimes should rebuild organic matter and nitrogen supplies, thus raising cotton yields when the area is reseeded with cotton. The increased cotton yields would mean that the fall in cotton production over a number of years would be minimal.

Figure 9. Possible Soil Building Crop Regimes



Source: FAO, 2008.

In order to illustrate the importance of cultivated feed crop yields and area for livestock performance it is possible to project the effects of (1) a one-time improvement in cultivated feed crop yields and (2) a small increase in feed crop area. For this purpose **Table 15** illustrates the effects on feed adequacy and milk yields of two scenarios: (1) returning yields of cultivated feed crops to their levels in 1991 and (2) doing (1) and, in addition, increasing feed crop area by 10 percent through increased rotation with cotton.

Columns 1 and 2 of **Table 15** show the total available feed units derived from cultivated feed crops and concentrates (line 1), total milk production (line 2), yield (line 3) and cultivated field crop area and yield (line 4) in 1991 and 2007. Column 3 of **Table 15** shows the effects of scenario 1, returning cultivated feed crop yields to their levels of 1991. Yields in **Table 15** (line 6a) are shown in terms of feed units per ha. As a result of an increase in cultivated feed crop yields—without increasing concentrates produced domestically or imported—milk yields of Tajik cows would increase by an astounding 44 percent to 972 liters per cow per year. Adding 10 percent to forage crop area through crop rotation with cotton (scenario 2) would increase milk yields to 1,025 liters per cow per year. This level of milk yields is slightly higher than those achieved in 1991. Cultivated feed crop feed adequacy for the entire livestock herd in the two scenarios would climb from a dismal 37 percent of demand in 2007 to 62 (scenario 1) and 66 percent (scenario 2) of demand.

Table 15 does not show the entire effects of the two scenarios. It only traces out the effects on dairy cows in detail. Improvements in meat productivity can also be expected for animals fed on forage, though the effects on cows are perhaps the strongest because they are fed mainly on forage crops. As in the previous scenarios, better fed animals can be expected to be healthier, reducing morbidity and mortality rates. The above scenarios give a rough indication of the important role that increases in forage crop yields could have on milk yields and overall feed adequacy in Tajikistan.

Table 15. Yield and feed sufficiency effects of increasing forage crop yields and area in Tajikistan

		1991	2007	Scenario 1	Scenario 2
				1991 yields, 2007 area	1991 yields, 10% increase in 2007 area
1	Feed crop and concentrate availability (tons of feed units)	2,196,062	738,744	1,214,381	1,300,619
a	Of which, cultivated feed crops (tons of feed units)	1,500,404	386,748	862,385	948,623
b	Of which, domestic concentrates (tons of feed units)	368,658	344,439	344,439	344,439
c	Of which, imported concentrates (tons of feed units)	327,000	7,557	7,557	7,557
2	Additional feed for cows (tons of feed units)			256,175	302,622
3	Additional milk production (1000 tons)			256	303
4	Total milk production (1000 tons)*	587.2	583.6	840	886
5	Yield (liters/cow/yr)	1,002	675	972	1,025
6	Note:				
a	Cultivated feed crop area (1000 ha)	227	130.3	130.3	143.3
b	Cultivated feed crop yield (feed unit/ha)	66	30	66	66
7	Feed adequacy calculations				
	Summer		513	513	513
	Fall-spring		52	52	52
	Winter		36	36	36
	All year		7	7	7
	Forage crops		37	62	66

*Assumes a milk/feed conversion rate of 1 kg DM for 1 kg milk. This is the average feed conversion rate of cows in 2007. See **Table 13**.

Sources: Estimates based on *Sel'skoe khoziaistvo respubliki Tadjikistan: statisticheskii sbornik (2007)* and Safaraliev (2009).

D. Toward a sustainable livestock strategy for Tajikistan.

A sustainable livestock development policy should aim toward implementing all the scenarios considered here by (1) establishing a workable and institutionally viable pasture management system in order to stop and reverse the detrimental fall in pasture yields that has been progressing in Tajikistan since 1991, (2) raising cultivated feed crop yields and (3) considering further crop rotation with cotton in order to increase feed crop area. **Table 16** illustrates the combined effects of the scenarios considered in this study: (1) increasing pasture yields each year for 10 years, (2) raising cultivated feed crop yields to their 1991 level and (3) expanding cultivated feed crop area by 10% through increased rotation with cotton crops. These changes would dramatically improve livestock feeding and milk yields in Tajikistan.

In **Table 16** the columns indicate the values in the 2007 base year and then the effects of the scenarios discussed earlier. The effects of the scenarios are cumulative. Line 1 of the Table indicates the additional feed and milk produced as a result of the scenarios. Lines 2 and 3 indicate the resulting changes in milk production, yield and feed adequacy. The detailed calculations for line 1 are contained in **Tables 13 and 15**.

Table 16. Yield and feed sufficiency effects of implementing the scenarios in this study in Tajikistan

		2007 base	Raise cultivated feed crop yields and area per Table 15	Add: Scenario 1 from Table 13	Add: Scenario 2 from Table 13	Add: Scenario 3 from Table 13
1	Additional feed and milk production from scenario above 2007 base					
	----Additional feed for cows (tons of feed units)		302,622	431,843	630,093	928,401
	----Additional milk production (1000 tons)		303	432	630	928
2	Milk production, cow inventories and milk yield					
	----Total milk production (1000 tons)	584	886	1,015	1,214	1,512
	----Total cow inventories (1000)	864.3	864.3	864.3	864.3	864.3
	----Milk yield (liters/cow/yr)	675	1,025	1,608	1,922	2,395
3	Feed adequacy (%)					
	Summer pastures	513	513	513	513	513
	Fall-spring pastures	52	52	85	135	210
	Winter pastures	36	36	58	93	145
	All year pastures	7	7	11	17	27
	Forage crops	37	66	66	66	66

Sources: Tables 13 and 15.

Table 16 illustrates that the most direct and largest effect on milk yields in Tajikistan could be gained by improving cultivated feed crop yields and increasing their area. Increases in pasture yields would impact on milk yields as well, though to a lesser degree. However, a combination of raising cultivated feed crop yields and area and restoring pasture yields would raise both milk and meat yields in Tajikistan, improving livestock health and raising rural incomes.

 The feed-livestock nexus is only one of a number of issues that should be addressed under a sustainable livestock development policy. Other issues such as the establishment of a viable plan for supplying livestock advisory and health services and a livestock breeding policy should also be part of such a policy. However, this study has concentrated on a first-level constraint on rural incomes that, unfortunately, has not received the attention it deserves. It is hoped that this study has shed some light on this issue and provided some basis for beginning a dialogue between the Government of Tajikistan and donors on a sustainable livestock strategy for the country.

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