§ 1. Introduction: Considerations of early dairy technologies

Healthy, full-grown cows will calve on average once each year, regardless of the area in which they are herded. The milk production of...

The technological considerations made here owe much to the correspondence and to the collegial discussions — in particular at the 1993 meeting of the Sumerian Agriculture Group in Wassenaar, Holland — I have enjoyed with Michael Teuber, former director of the Institute of Microbiology of the Federal Institute for Milk Research, Kiel, and currently professor at the Institut für Lebensmittelwissenschaft of the Swiss Federal Institute of Technology, Zurich. The understandable predominance of technical publications with data on fertility, gestation and lactation of dairy cows from modern breeds on which such discussions are based may tend to skew our view of the probable difficulties in successfully exploiting cows in semi-arid regions such as Mesopotamia of the third millennium b.c., but must, given the fragmentary information in early texts, be used in an attempt to bridge the many gaps in our knowledge of pre-classical dairying techniques. For instance, data on the exploitation of and feed given milk cows in areas which are unlikely to have supported a substantial vegetative cover over extended periods would be of particular interest, since our cuneiform textual material is almost completely silent about the feeding of cows under such circumstances (green reed growth [gigibi and gizi] may have gone in part to dairy operations). However, cattle in such areas — for example, in modern Iraq — have as a rule either been exploited more for meat and draft than for milk and so exhibit expectedly low dairy production, or have been given supplementary and enhanced feeds, and tended according to modern agri-business standards, together hampering meaningful comparison of modern ethnographic reports with data in accounts from third millennium Mesopotamia. This situation stands in contrast to the generally valid inclusion of modern ethnological research in discussions of cuneiform material insofar as it bears on questions of Near Eastern pastoralism. Still, modern technical data do give a rough idea of the practical necessities in dairy farming and with these caveats have been considered here.

Fertility rates do, of course, vary widely, dependent on health and fodder of the animals (see, for example, the data gathered on African breeds by G. Dahl and A. Hjort, Høvding Herde: Pastoral Herd Growth and Household Economy [Stockholm Studies in Social Anthropology 2; Stockholm 1976] 35-36; pastoral fertility rates of 40-80% are reported). The gestation period of the domesticated cow Bos taurus is, dependent on breed, ca. 9½ months; about a month after birth of the calf, the cow enters heat again in cycles of three to four weeks and can be led to the mount. As a rule, they are served in the second cycle, that is, fifty to sixty days after birth and so kept on a yearly schedule.

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such cows in semi-arid climates, however, is substantially below that of selectively bred dairy cows from European stocks which can, under normal conditions, reach 4000 liters and more per animal per year; cows under rudimentary care and not selectively bred for milking have been shown to produce just 700-800 liters per year, dependent above all on the quality of feed of the animals. Of this amount, about half — 350 liters — may be required for the rearing of the calf, leaving between three and four hundred liters of so-called ‘excess milk’ per animal for the owner-herder of suckling cows. Although lactation periods of up to five years after calving have been reported, the norm is between four and eight months and daily production does decline beginning about six weeks after parturition. Herders more interested in milk than in increasing the size of the herd can best augment production of excess milk with the forced weaning or early slaughter of calves, after which continued lactation can be insured if the cows are milked out twice daily.

Milk in countries with hot climates and no means of refrigeration keeps for about half a day and so must be immediately consumed, or processed to prevent it from spoiling and from losing its nutritive value in fat, proteins and minerals. One means of ‘processing’ milk can consist of simply boiling it or allowing it to sour in a controlled environment, after which it will keep for about a week. More involved processing of milk takes many forms, but two procedures have been of primary use in all cultures possessing primitive technologies (see figure 1). In the first, sour or boiled and fermented milk is

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3 Statistics show that countries lying in temperate zones, including those in northern Europe, the United States, Argentina/Chile, Australia and New Zealand, are best suited for dairying, production falling with increasing proximity to the equator. Production in the United States and Holland has averaged about 4300 kg since the late 1960s, somewhat less in Germany and Denmark (the German Federal Office of Statistics, Fachserie B, Reihe 3, shows the Land Lower Saxony achieved the best production numbers in the Federal Republic for the year 1976 with 4742 kg).

4 The average measured milk production among normally healthy stocks in Turkey, Kurdistan and Africa, for example, was between 400 and 650 liters; added to the 350 liters of milk required for rearing the calf, the total milk production per cow was ca. 750-1000 liters (B. Yalcin, "Local Cattle and Sheep Breeds in Turkey and Their Performance", in: Mediterranean Cattle and Sheep in Crossbreeding [FAO Animal Production and Health Paper 6; Rome 1977] 32-35; H. Buitenhui, “Some Remarks on the Possible Development of Bos taurus Breeds in the Near East”, in: J. Clutton-Brock and C. Grigson, eds., Animals and Archaeology 3: Early Herders and Their Flocks [BAR International Series 202; Oxford 1984] 213-221; P. Watson, Archaeological Ethnography in Western Iran [Viking Fund Publications in Anthropology 57; Tucson 1979] 112; G. Dahl and A. Hjort, Having Herds [43-448]. This is about the same as production figures from the Middle Ages and not substantially higher than the production of wild races. The occasionally cited very low production of Indian zebus (Bos indicus; see K. Krüger, Natur und Wirtschaft der indischen Union [Vienna ca. 1960] 87-88: one-tenth of European production) are the result of starvation diets with low-quality fodder and poor care.


6 The agent involved in this preservation is the lactic acid resulting from the action of bacteria on milk sugar. A high content of lactic acid in soured milk prevents the growth of the pathogenic bacteria and microbes causing spoiling.
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Figure 1: Simplified diagram of the steps employed in nonindustrial production of dried cheese and butter oil in the Near East.

beaten in churns, shaken or rolled in leather bags, etc., all mechanical actions leading to the breakdown of the membranes of fat globules suspended in the milk, causing them to coalesce into lumps of butter. Since it is the existence of water in butter which leads to rancidity, the butter must further be heated to near boiling to force off as much of the water as possible, leaving pure

7 Ca. 16% of butter is water; heating to 80°-110° centigrade for four hours can reduce the wa-
butter oil. Once this oil contains less than 1% water, it can be kept for up to a year without becoming rancid. In the second, the butter milk, that is, the milk remaining after all or part of the fat has been removed, can be processed through actions of yeasts or moulds into nutritious drinks or yoghurt-like products, or the solids can be drained from the whey as curds and, as desired, mixed with rennet or a number of plant agents which act to prevent the growth of pathogenic, or to enhance the growth of desirous bacterial flora, and dried. This latter processing results in the myriad of high-protein cheeses found in all countries with milk-bearing domestic animals. In the Near East, completely dried cheeses are known, variously called kašk in Syria, kušuk or baql in Iraq, or ekī on the Arabian peninsula, which can be kept for years and even decades without spoiling*.

Dairy milk from cows consists of approximately 87% water and 13% solids; of these 13%, 3-5% are fat — we know the regulated whole milk count of 3.5%, but healthy Jerseys reach 5.7% in the first weeks after parturition (not the colostrum produced in the first days!) — and the remaining 8-9% are other solids: ca. 5% lactose, 3-3.5% casein, and 0.5% each of whey protein and minerals. In other words, from 100 liters of cow milk you might reasonably expect to derive 3-5 liters of butter oil and perhaps 7 liters of kašk cheese, assuming in both cases the water has been removed and the specific gravity of dried cheese balls consisting of casein is ca. 0.6 (0.6 is based on my rough measurements of Syrian kašk; the balls had a diameter of 1.5–2.5 cm). These figures are apposite to the topic of this paper, for they bear a striking resemblance to the delivery quotas of the butter oil known as i nun* and the cheese

*The word kašk is derived from Persian ḥūšk (‘dry’), probably borrowed via Aramaic (information kindly provided by C. Ott; the word, according to J. Pokorny, *Indogermandisches etymologisches Wörterbuch* 1 [Bern 1959] 880-881, originally from Indo-European *sau-*, *sus- [Sanskrit śāka-, Avestan hūška-], was reborrowed in Persian as kašk). The processing of this cheese is, as described in ethnological literature, in most cases the same. See the references cited by P. Steinke, *Quaderni di Semitistica* 18 (1992) 249*, M. Abdalla, “Milch and Its Role in Assyrian Culture”, *Journal of the Assyrian Academic Society* 6/2 (1992) 12-36, esp. 25-34, and the summary by S. A. Abu-Donia, “Microbial Flora and Chemical Composition of Bk Cheese”, *Egyptian Journal of Dairy Science* 6 (1978) 49-52. As described by A. Kanafani-Zahar, *La conservation alimentaire traditionelle au Liban* (Paris 1994) 49-58, a form of (often fermented) kašk made in the Near East (kašk in Lebanon) contains burgul (cooked and ground barley) and either yoghurt or butter milk. Note the possible connection between Akkadian eḫdu and ekt (see fn. 10), and that the term gamid, ‘solid’, is also known in Arabic to refer to kašk.

* Akkadian gamidu, of unclear etymology (see the dictionaries, and D. Edzard, *ZA* 72 [1982] 83-84). Arguments of a primarily technical, rather than philological, nature have heretofore dominated the discussion of the meaning of i nun in the Ur III period (and its Old Sumerian correspondences i ab se.gà/dé.a, Old Akkadian i ab — i nun in the Old Akkadian period apparently referred only to the corresponding product from goat’s milk, for example, in T. Donald, *MCS* 9/1, no. 251, cited B. Foster, *Umma in the Sargonic Period* (Hamden
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1982) 136-137; note also the clear referent 'goat' of the b-variant form of the archaic sign nun, ATU 2 s.v., last sign of the Uruk IV column, ATU 5 s.v., and compare ATU 5 sub 'LAGAR,..NUN, = UDUN..NUN, further ATU 2, p. 129 —, variously translated as 'butter', 'ghee' and 'nun-fat', 'rissen' or 'princesse fat'. In my opinion, there should be no doubt that a form of 'ghee' (also 'run' or 'clarified butter', 'butter oil/fat'; see K. Butz, "Kononzentrations wirtschaftlicher Macht im Königreich Larsa: Der Nanna-Ningal-Tempelkomplex in Ur", WZKM 65-66 [1973-1974] 379) is meant, and not butter (as still argued by I. J. Gelb, JCS 21 [1967] 68; clarified butter is, against Gelb, a semi-liquid at temperatures below 50 centigrade, much like lard kept at room temperature in kitchens today), not only due to the impossibility of dealing with butter in warm climates and to the relative non-perishability of dairy oil, but also as a necessary consequence of an understanding of the terminology for soured milk and the relation of butter oil and cheese which can be derived from it, now found firmly documented in Ur III texts (see below). Literary texts dealing with herding and the uses of dairy products, for example, the dispute between the herder Dumuzi and the farmer Enkimdu (J. van Dijk, La sagesse suméro-akkadienne [Leyden 1953] 65-85; Y. Safati, Love Songs in Sumerian Literature [unpubl. dissertation, Bar-Ilan University; Ramat-Gan 1985] 368-389 [reference P. Altinger]), or the Dumuzi laments (see, for one concerning milk products, T. Jacobsen, 'Lad in the Desert', JAOS 103 [1983] 193-200), are as 'bucolic' compositions not specific in their descriptions of mundane dairy processing and so of limited value in technical discussions of butter oil and cheese.

The sign combination ga šar is commonly read, following A. Falkenstein, JAOS 72 (1952) 42-43, in a review of A. L. Oppenheim, Catalogue of the Cowiform Tablets of the Wilbourforce Eames Babylonian Collection... (AOS 32; New Haven 1948), in Sumerian ga šar, and translated simply 'cheese', presuming that the verbal adjective šar is used in its sense from grain milling texts of 'ground' (the Akkadian correspondences are ēššu, from which later ši may have derived, and late Babylonian šubana, from Aramaic gubnā [Arabic gubnāh]). The final consonant of the reading of šar is shown to be 'r' in its usage together with ga in such texts as TUT 127 obv. ii 5 (Ur III Giru) and in P. Michalowski, The Lamentation over the Destruction of Sumer and Ur (Witnica Lake 1989) 56, l. 334 (preserved only in UET 6, 131 [Old Babylonian]; see M. Stol, "Milk, Butter, and Cheese", Bulletin of Sumerian Agriculture 7 [1993] 105). The texts TCS I, 169 (= M. Sigrist, Messenger Texts from the British Museum [Potomac 1990] no. 312) obv. 11 (letter, Ur III period), and UET 5, 630 obv. 2 (Old Babylonian; cited Stol, RIA 8/3-4 [1994] 198-199) seem to attest the form gašar of the word, in the latter text, moreover, immediately after a notation representing a measure of lunn and standing in a 'neo-Sumerian' relation to this butter oil of very nearly 2:3 (284 sīla lunn to 420 sīla gašar). These texts may thus be added to the references made by Falkenstein, JAOS 72, 43, concerning the Old Babylonian i.ter.ē rd.ē series i.ter.ē rd.ē : ga šar (VS 2, 68 obv. 15-16), ga i.ter.ē rd.ē : ga šar gali (VS 10, 123 obv. iii 12-14) and i.ter.ē rd.ē : ga šar di.ši (VS 2, 10 rev. 2'-4'); to ga i.ter.ē rd.ē see Th. Jacobsen, JAOS 103, 197 ('buttermilk'; Stol, RIA 8, 198: 'butter'?), and compare the close parallels to this sequence in the lexical list šar - gubnūtu 24 and its Old Babylonian forerunners, MSL 11, 81:120-123, 122, § 8-4-9 and 157:347-351) and understood as indications of a phonetic form ga /ara/. This interpretation of the sign combination as literally 'milled milk (product)' would seem to make sense, given the fact that ga šar is not counted in discrete units, as may be expected of cakes of cheese and as was the case (for lak 490; see below, fn. 19) up to the Fara period, but rather is recorded in measures of the capacity system. Yet this excludes by no means the referent of small cheese cakes, since the same capacity system was used to qualify apparent breads ninda, and a number of fish or fish products, of which the best known from the Ur III period are ku4 šar, 'smoked/cooked fish,' and ku4 gur ti4 šar, 'fish' (see my Organisation und Verwaltung der Ur IV-Fischerei [BBVÖ 10; Berlin 1990, in the following abbreviated Ur IV-Fischerei] 215-221). Some caution in the reading ga šar is advised, however. The two known Ur III forms of the word, ga šar and ga udgumū, must be phonetic and not, as suggested by T. Gomi, "On Dairy Productivity at Ur in the Late Ur III Period", JESHO 23 (1980) 2, and repeated by Stol, RIA 7, 102 (reading ga murub), and RIA 8, 199 (reading ga udgumū), dialectical variants, since they can appear in the same text clearly with the same referent (the Umma account MVN 15, 108, dis-
of cows and goats\textsuperscript{1}, as documented in administrative texts from Ur, Drehem and Umma in the Ur III period. With one possible exception, herders of state-owned cattle in these provinces were, according to such texts, required to deliver to central authorities the equivalent of 5 neo-Sumerian sīla (= 5 liters) of \textit{ga }\textit{ṭahar/ud-gunu} per adult cow per year (Ur III Lagash norms, in contrast, apparently one bān each of \textit{i nun} and \textit{ga }\textit{ṭahar} per cow-year\textsuperscript{2}). Not only

cussed below in detail, contains both \textit{ga }\textit{ṭaurnā} obv. 1 as part of the \textit{sī.l.tum}, and \textit{pas-sim}, and \textit{ga }\textit{ṭa har} rev. iv 112); cf. also the Umma text \textit{SET} 188, obv. i 13, ii 42, iv 65, rev. v 92, 105, vi 123 and vii 141 (according to the new transliteration offered by J. Carlsson and K. Hillard, \textit{ASJ} 15 [1995] 218-223), with \textit{ga }\textit{ṭa har }\textit{gəzi}, and, for example, such Umma texts as \textit{MVN} 16, 689, 725 and 1414, with \textit{ga }\textit{ṭa har}, next to \textit{MVN} 16, 673, 723, etc., with \textit{ga }\textit{ud-gunu} (all dating from late Sūlgi to Sī-Sīn), and see below. \textit{ṭaurnā} (\textit{= LAK} 157) is known with the reading \textit{murub}, or \textit{muru}, Akk. \textit{qabūli}, 'middle', 'waist' (not to be confused with \textit{nāṣag }\textit{= LAK} 159), and possibly \textit{ti}, (see J. van Dijk, \textit{Pr. Falkenstein} [HSAO 1; Wies-baden 1967] 248-250 [reading \textit{ti}, \textit{sag}, and \textit{usar}]); a reading \textit{mur}, of the sign, and of \textit{ṭa har }\textit{mur}, with the meaning 'feed' found in the combination \textit{mur }\textit{gu 4}, known from feed and seed texts, cannot be reconciled with the term \textit{ga }\textit{ra} cited above (but note the entry E. von Weiher, \textit{Spitthäufige Texte aus Uruk III} [Berlin 1988] 235-242, no. 116 = W 23280, rev. iv 8' [from the late Babylonian commentary series Hg XXIII-XXIV]: \textit{ga }\textit{ṭa har }\textit{x-ru }\textit{= e-}[qi-\textit{du}], \textit{x-} read by von Weiher \textit{gu}-or \textit{gab}-to \textit{ka/ubru}, 'thick' [presumably not \textit{gub-\textit{nā}}, read by M. Civil, \textit{Or} 56 [1987] 234', \textit{gur}-, without interpretation], nor is a reading \textit{aṭa}, of \textit{ṭaurnū} suggested by references known to me.

\textsuperscript{1} Surprisingly, products derived from ewe milk were not registered in \textit{Ur III} accounts (see below, fn. 45), nor are there to my knowledge records of the use of milk from water buffaloes, which with a high protein content of 5% and a very high fat content of 10% should, if available, have been prized by neo-Sumerian administration. R. Boehmer's positive identification in "Das Auftreten des Wasserbüffels in Mesopotamien in historischer Zeit und seine numerische Bezeichnung", \textit{ZA} 64 (1975) 1-19, of the buffaloes presumably brought into Agade from the Indus Valley — depicted in numerous cylinder seal friezes of the Old Akkadian period, and the animal \textit{ṭa }\textit{za }\textit{za} still attested in late \textit{Ur III} texts from Drehem (in particular, \textit{ANûR} 7, 154 \textit{[= MVN} 18, 154], dated to Amur-Suen 9; see N. Schneider, \textit{AfO} 14 [1941-1944] 70-72), with the domesticated water buffalo, was refuted by K. Butz, "Ur in altbabylonischer Zeit als Wirtschaftsfaktor", in: E. Lipinski, ed., \textit{State and Temple Economy in the Ancient Near East} 1 (OLA 5; Leuven 1979) 334-335\textsuperscript{28} (including literature concerning the exploitation of buffaloes), with the compelling argument that the horn span of the animal in the Old Akkadian seal depictions was compatible only with the very dangerous wild Anil water buffalo, and that the nutritional value of domesticated water buffalo milk together with the ideal conditions for their breeding in southern Mesopotamia (the beasts were until recently widely extant in the marsh Arab) make improbable their extinction following an assumed introduction in the Old Akkadian period. Butz conjectures with \textit{CAD} sub \textit{apaštu} that the \textit{ṭa }\textit{za }\textit{za} may have been the zebu, an Indian breed of cattle better known in the United States as the Brahman.

\textsuperscript{2} The exception in \textit{Ur} is found in \textit{UET} 3, 1214 (dated to Ibibi-Sīn 6), with norms of 5 sīla each per year and cow for the two products; see T. Gomi, \textit{JESHO} 23, 14. The texts \textit{MVN} 8, 145, and M. Sigrist, \textit{Toronto} 1, no. 7, are no exceptions to the rule, since they record the \textit{maš-da-ri-a} payment by 37 herders (reading in each case obv. 1: 37 \textit{uni} (\textit{abi-ki} \textit{lihīr}) of 2 sīla each of \textit{i nun} and \textit{ga }\textit{ṭa har}, nor are the texts \textit{CAD} 2, 256, and T. Fish, \textit{MCS} 8, 88, BM 105375, cited Gomi, \textit{JESHO} 23, 2: of the 37 cattle (\textit{ga }\textit{ṭa }\textit{ha }\textit{a}) recorded in the former account, (65 + 5 = 13, and of the 46 cattle in the latter, (90 + 5 =) 18 cows (confirmed through collation by T. Gomi, \textit{Orient} 17, 41) must have been inspected and certified as milk producers by the bookkeeper involved. Comparable notations are found in the \textit{Ur} text \textit{UET} 9, 1097. The yearly norms imposed on herders of state-owned dairy cows in Lagash seem to have been 1 bān each of butter oil and dried cheese, according to the pertinent texts \textit{CT} 5, pls. 25-26, BM 18346 \textit{pas-sim} (cp. the collations in
do these amounts correspond roughly to the optimal quantities of fat and dried cheese which can be derived from 100 liters of milk, but the constant relationship of 2:3 between the two dairy products — the same relationship holds generally for the milk products delivered by goat herders — is also reflected in the specific gravity of dairy fat compared to that of dry cheese: 1 kg of butter oil fills 1.1, and 1 kg of kašk fills 1.7 liters.

Neo-Sumerian accounts that have been recently collated or made available for study demonstrate that the dairy norms recorded in Umma accounts in fact corresponded to 100 šīla of the product called gaššuš.e.a in the same province. Assuming this latter product is either soured milk/yoghurt (Arabic labn) or creamed milk, the norms assigned Ur III herders (Sumerian ḫunu)\(^\text{13}\) from Umma and Ur will have represented

Figure 2: Contents of cow milk.

OrAnt 15, 142, CT 7, pl. 34, BM 18407 rev. 8-10, and B. Lafont and F. Yildiz, Tablettes cunéiformes de Tello au Musée d'Istanbul 1 (Leyden 1989) 878 passim (to be noted to my remarks in AFO 40-41 [1993-1994] 101-102), cited by G. van Driel, “Bones and the Mesopotamian State?: Animal Husbandry in an Urban Context”, BiOr 50 (1993) S58° (the ‘norm’ was designated i aš gari; compare Ur III-Fischerei 100). This represents effectively twice the norms elsewhere attested in the Ur III period and so possibly from two-thirds to the full production of the animals concerned, although the nanny goat milk product norms registered in the same texts of ½ (TCT 1, 878) — ½ (CT 7, pl. 34, BM 18407) šīla butter oil and cheese per year are comparable in quantity to those recorded in accounts from other Ur III provinces, but like the cow production figures exhibit a 1:1 ratio between butter oil and cheese, and not 2:3 as was the rule elsewhere (either ½ and ¼, or ½ and ½ šīla per goat-year, respectively). See below, fnn. 45 and 78.

\(^{13}\) For the reading of the sign combination ḫunu = ḫunu(d), ‘herder (of large cattle)’, to be contrasted with ṣaru and MIL.KU = šipa, ‘herder (of small cattle, pigs, dogs and fowl)’, see H. Waetzoldt, “Das Amt des ṣuttu”, in: G. van Driel et al., eds., Zikir Sumin (= Festchrift Kraus; Leyden 1982) 386-397.
from a third to a half of the milk production expected to remain after the suckling of the calves and so may be considered comparable to the third rental payment expected from the grain harvest of rented fields best known from the Old Babylonian period on, but now also attested for the Ur III and the Old Akkadian periods. The remainder of the dairy products — and these may have been much higher, dependent on the number of calves which the herders decided to keep alive or which the owner required added to the herd as part of the lease agreement with the herder — will have fallen to the lot of the herders in lieu of payment for their services in the form of food and clothing rations.

M. Stol published in 1993, in his usual concise form, a very insightful work on Ur III dairy products, in which some of these topics were discussed. Since I have been occupied for some years with accountancy in the early stages of the Babylonian state, among other facets concerning the administration of cattle and dairy products, it seems to me worthwhile to expand on his treatment in this paper, to correct some small failings and to demonstrate that close attention paid to the formal accounting practices employed in dairy record-keeping of the Ur III period can result in dividends which might have otherwise been lost to the Assyriologist.

§ 2. Research history

The first dairy accounts from Mesopotamia to arouse scholarly interest were among the tablets stolen by local robbers from the site Tello, ancient Girsu in southern Babylonia, and sold via the Baghdad antiquities market to individuals and institutions in Europe and America. The administrative texts — from the archives of Enentarzi, and from those of the

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BSA 7, 99-113; see also his article "Milch(produkte)" in RIA 8, 189-201.
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Contained accounts both of the age and sex make-up of cattle herds under the supervision of named herders and of the amounts of dairy products these herders were expected to deliver and really did deliver to the temple households of the wives of his successors Lugalanda and Urukagina, all city-state rulers from the pre-Sargonic period predating the Ur III Dynasty by some two centuries — contained accounts both of the age and sex make-up of cattle herds under the supervision of named herders and of the amounts of dairy products these herders were expected to deliver and really did deliver to the temple households.

The first of the two accounts found in figure 3, both of which are dated to the fifth regnal year of the ensi Enentarzi, records the apparently complete make-up of herds assigned the named herders Namdam, Mesagnudi and Ur-šugalama, including ‘milk cows’ (āb ga), immature cows (āb GAR.UD)\(^1\), calves and two breeding bulls (gu, ‘bull of the cow’). The second account records the delivery quotas expressed in quantities of the dairy products i āb sē.ga, ‘butter oil’ (literally ‘thrown cow oil’)\(^2\) and LAK 490\(^9\) (corresponding to later ga ṣAR)\(^10\) of the same herders.

\(^1\) See the early treatments of the texts in A. Deimel, “Produkte der Viehzucht und ihre Weiterverarbeitung”, OrSP 21 (1926) 1-14; id., AnOr 2 (1931) 96; J-M. Kientz and M. Lambert, “L’élevage du gros bétail à Lagash au temps de Lugalanda et d’Urukagina”, RSO 38 (1963) 93-117 and 198-218 (the dairy terminology was not understood by the authors, pp. 104-105); and K. Maekawa’s revision of Deimel’s analyses in Zinbun 15 (1979) 122-123.

\(^2\) The qualification GAR.UD is to my knowledge not attested in another dairy context which would help to clarify its reading and meaning. A. Deimel speculated ad sensum in OrSP 20 (1926) 3 that it might signify a type of fodder, reversing himself in AnOr 2, 93, with a reading ša.tam, in apparent reference to the office of the šatamma. Recent commentators have followed the suggestion of R. Scholz, MVAG 39/2 (Leipzig 1934) 35; that the term qualifies a ‘Trockenkuh’ (see J-M. Kientz and M. Lambert, RSO 38, 102; G. Selz, PAOS 15, [Stuttgart 1989] 441 to i; but also Deimel, OrSP 20, 31), that is, that GAR.UD is to be read nīg.laḫ/hād and the cows considered ‘dry’, ‘without milk’. The numbers in the pre-Sargonic dairy texts imply that the GAR.UD cows in fact corresponded to the sexually immature cows in Ur III texts qualified mu, ‘one-, two- and three-year-olds’, so that the term should refer either to their lack of milk or to their immaturity, but in both cases to ‘heifers’.

\(^3\) The distribution of the butter oil qualification sē.ga and dé.a, literally “thrown flat” and “poured”, between texts calculating the delivery duties of herders at the time of herd inspections (gūrum; for example, DP 273-275, and compare the texts Nik. 1, 259, TSU 37, and VS 25, 24) and those recording real deliveries (mu.du and i.dé; for example, DP 276, Nik. 1, 257, and RTC 64), respectively, led J. Bauer, Altsumerische Wirtschaftstexte aus Lagash (StPohl 9; Rome 1972) 327, to propose the terms were accounting termini technici. Their restriction to dairy management, in which both would make good technical sense in the processing and delivery of oil, need not speak against this interpretation, although it may be noted that only one account, Nik. 1, 257 (following on VS 14, 89; note to K. Maekawa, Zinbun 15, 137, n. 87), can be offered as evidence of partial delivery of assessed duties.

\(^4\) The archaic form of the sign (ḫ) see M. Green and H. Nissen, ATU 2 [Berlin 1987] 15, 257 (following on VS 14, 89; note to K. Maekawa, Zinbun 15, 137, n. 87), can be offered as evidence of partial delivery of assessed duties.

\(^5\) The now clear correspondence was first proposed in 1913 by the prescient Viennese scholar F. Hrozny in his Das Getreide im alten Babylonien 177. M. Civil, “Studies on Early Dynastic Lexicography III”, Or 56, 234\(^\dagger\), states that while the functional equivalence of LAK 490 and ga ṣAR is obvious, there remain doubts about reading the sign ga(ḫ)ar (see above, fn. 10) without corroborating phonological evidence.
for that year, from which it is possible to calculate — shown in the third column of the figure — the amounts the herders were to deliver per milk cow as ‘butter oil (and cheese), property of Enentarzi’. For example, according to DP 93 the first herd administered by the herder Namdam consisted of 43 animals, of which 13 were milk cows. The second account DP 274 = 275 proves that for each of these cows the administrator was required to deliver 10 Old Sumerian silla of butter oil per year, recorded as $(13 \times 10 = 130 \text{ silla} =)\ 6 \text{ dug} 10 \text{ silla}$, whereby the sign dug represents the metrological equivalent of the ceramic jar with a capacity of 20 silla

\[\text{DP 93 (Enentarzi 5)}\]
\[\text{DP 274-5 (Enentarzi 5)}\]
\[\text{delivery per milk cow/year:}\]
\[10 \text{ silla dug}, 18 \text{ silla LAK} 490\]

<table>
<thead>
<tr>
<th>i</th>
<th>13 db ga (&quot;milk cows&quot;)</th>
<th>i</th>
<th>6 dug 10 silla db sh.ga</th>
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<tr>
<td>20</td>
<td>db GAR.UD</td>
<td>1;2,3 LAK 490 gur sg+gd</td>
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</tr>
<tr>
<td>2</td>
<td>gir amar sig</td>
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<tr>
<td>6</td>
<td>gu_i amar sig</td>
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<td></td>
</tr>
<tr>
<td>1</td>
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<td></td>
</tr>
<tr>
<td>ŞUNIGIN 43</td>
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</tr>
</tbody>
</table>

| ii | 4b gir amar.bi.ta Nam.dam | Nam.dam |
| 8 | db ga 4 dug 1 | 8 \times 10 = 4 \times 20 = 80 silla |
| 16| db GAR.UD ii 1;0.0 LAK 490 | 8 \times 18 = 1;0,0 = 144 silla |
| 6 | gir amar sig | |
| 2 | gu_i amar sig |
| ŞUNIGIN '32' | |
| iii | Me.sg.nu.\'di' | Me.sg.nu.di |
| 4 | db ga 2 dug 1 | 4 \times 10 = 2 \times 20 = 40 silla |
| 14| db GAR.UD 0;2.0 LAK 490 | 4 \times 18 = 0;2,0 = 72 silla |
| 1 | gir amar sig |
| 3 | gu_i amar sig |
| i | gu_i db ŞUNIGIN 23 |
| Ur.Su.\' Ur.Su.(ga.lam.ma, DP 274) |
| ims db.\',me |
| ... | ... |

\[\text{Figure 3: Comparison of the two pre-Sargonic Girsu accounts DP 93 and DP 274-275. Note that the pre-Sargonic measure dug, 'jar', contained 20 silla.}\]

\[\text{\textsuperscript{21} The distinction of the adjectival use of the term ú.rum made by G. Selz, Altsumerische Wirtschaftstexte aus amerikanischen Sammlungen (FAOS 15,2; Stuttgart 1993) pp. 110-111, has no consequence for its meaning.}\]
Regulating Dairy Productivity in the Ur III Period

used to store fats\textsuperscript{22}; and 18 sīla (dry capacity) of the cheese represented by the sign \textit{LAK} 490, recorded as \((13 \times 18 = 234 \text{ sīla} =) 1 \text{ gur 2 (barig) 3 (bān)}\). A comparison of these figures with the neo-Sumerian delivery quotas of 5 and 7\%\textsubscript{2} sīla of butter oil and cheese, respectively, is dependent on the absolute sizes of the sīla measures involved. Since the most persuasive currently available evidence supports a rough correspondence

\begin{align*}
1 \text{ neo-Sumerian sīla} &= 1 \text{ liter, and} \\
1 \text{ Old Sumerian sīla} &= \frac{1}{2} \text{ liters}\textsuperscript{23},
\end{align*}

the Old Sumerian quotas seem to have been about three times the lower norms and half again as much as Lagash norms of the Ur III period, that is, ca. 5 and 7\%\textsubscript{2} liters of oil and cheese in the provinces Ur and Umma, 10 liters each of the dairy products in Lagash for the Ur III period, as opposed to 15 and 27 liters in pre-Sargonic Girsu. The difference in the numerical relationships between the two dairy products (1:1 and 2:3 in the Ur III period, 5:9 in pre-Sargonic Girsu) is likely due to accounting practices, namely that in the earlier period 10 and 18 sīla were, as approximations of realistic dairy production, chosen as specific administrative quantities due to the facility with which these measures could be numerically manipulated (10 liquid sīla = \(\frac{1}{2} \text{ dug}\), 18 dry sīla = 3 bān = \(\frac{1}{2} \text{ barig}\), or, for the bookkeeper, 2 cows = 1 dug 1 āb = 1 barig \textit{LAK} 490)\textsuperscript{24}.

\textsuperscript{22}Note the difference in notations between these (semi-)liquid measures and those of the dry capacity gur system, in which 10 sīla would have been written \((\text{bān}) 4 \text{ sīla}\) (it is assumed that the absolute size of the sīla was the same in both metrological systems). The relationship of this system with the notational system used in pre-Sargonic and Old Akkadian Lagash for measures of beer and wine, in which the jar dug was divided into two or three \textit{nīn} (read by M. Powell \textit{gur} \textit{gur} \textit{gur}, \textit{gur} in “Masse und Gewichte”, \textit{RLA} 7 [1987-1990] 506; cp. W. Sallaberger, \textit{Za} 84, 147) of, probably, 10 sīla each (against Powell, loc. cit.; compare the Old Akkadian texts \textit{ITT} 1, 1189, with 10 sīla = \(\frac{1}{2} \text{ dug [= 1 nīn?]}\) of high-quality beer, and from Adab, OIP 14, no. 152, with 5 + 5 = 10 sīla \textit{kās}, further OIP 14, no. 198 obv. 1, and no. 102 (summation 10 + 10 + 4 sīla = \(1 \text{ dug?}\))], remains unclear. The most reasonable assumption is that the fractions of the dug will have represented different types of jars used to store liquids and semi-liquids, respectively (the Old Akkadian text \textit{ITT} 1, 1372, suggests the notations 2 \textit{nīn}/\textit{nīn} might refer to two containers which corresponded to one dug and not to a dug of 3 \textit{nīn}, attested, for example, in \textit{ITT} 1, 1397, MVN 3, 114, etc.). In the archaic period, slightly different signs were used, namely, \textit{duq} (with a stroke representing a spout) for liquids (beer) and \textit{duq} (without a spout) for semi-liquids (butter oil). See my “Grain Accounting Practices in Archaic Mesopotamia”, in: J. Hayrup, ed., \textit{Changing Views on Ancient Near Eastern Mathematics} (Berlin forthcoming).

\textsuperscript{23}See \textit{Ur III-Fischerei}, p. XVII. In my opinion, the correspondence between delivery norms for butter oil exacted from Old Sumerian herders from Girsu and those apparently required of their neo-Sumerian successors, namely in both cases 10 sīla per year, is fortuitous. Most likely, the absolute size of the bān, and not that of the sīla, remained more or less constant in Lagash in the second half of the third millennium, representing a capacity of ca. ten liters.

\textsuperscript{24}The Old Babylonian rates in Ur may have been 12 sīla of \textit{l nun} and 18 sīla of \textit{gā har}, that is, more comparable to pre-Sargonic Girsu norms, according to the a.ru a text \textit{UET} 5, 821 (obv. 3-4: 0;1,0 \textit{l nun bi-la-si-na / 0;1,30} gā \textit{gār}, “(of five cows), 1 (barig)”.

Moreover, the posited absolute dairy product measures would, according to the technical considerations made above, represent the full milk production of those adult cows suckling calves, since 15 liters of butter oil can be processed from 300-400 liters of milk, dependent on fat content of the milk and water content of the butter oil. Assuming that the cows did in fact calve each year, this suggests that there may have been a crucial difference in the administration of dairy cattle in state herds in the Old Sumerian and the neo-Sumerian periods: herders in pre-Sargonic Lagash served merely as employees of the state, delivering the full or at least a high proportion of the production of their herds to central administrators, whereas neo-Sumerian herders acted as contractors who assumed full responsibility for the cattle assigned them by the state; these herders, comparable to the overseers (u g u 1 a) of other Ur III economic units, held state capital in lease, compensated the state for use of the cattle with a yearly payment of a fixed fraction of available dairy production, and remained, at risk of personal loss, responsible both for the current numbers of cattle given them by state agencies and for a certain growth in the herd.

That this expected herd growth in the Ur III period also bore an artificially defined relationship to the number of adult cows in assigned herds was apparent in a large account published more than 80 years ago. The tablet AO 5499 was sold in 1910 to the Louvre museum together with a large lot of tablets pilfered from neo-Sumerian levels of a site located in the north of the heartland of the Ur III empire. This text, published in 1911 in H. de Genouillac’s Textes cunéiformes du Louvre, vol. 2, came from the settlement Drehem, ancient Puzirs-Dagan, an administrative center south of Nippur established by Šulgi in his 39th regnal year to oversee the then instituted system of domestic and colonial tribute and exchange of the Ur III state as well as to guarantee the provisioning of the temples and thus the politically important priesthoods of cults in Nippur.

The tablet itself contained an account of the organization and administration of a herd of cattle dating from its establishment in the year Šulgi 39 — the year in which the king “built the house of Puzirs-Dagan” — through Šulgi 48, the year of the king’s death (see figures 4-5). For each year, the account records the number of cattle in the herd, differentiated according to sex and age, followed by notations representing measures of butter oil as their ‘yield/tax’, (together with) 1 (barig) 3 (bān) cheese”; see K. Butz, WZKM 65-66, 42, and note that the relationship 2:3 was maintained). Compare the unusual situation reflected in the Kassite text BE 14, 99a, of deliveries of 5 sīla i nān per cow with, and just 2½ sīla per cow without calf (possibly referring to a cow in its second year of lactation).
the butter oil i n u n and the cheese g a ḫ a r. For instance, the partially re­
constructed first section contains entries representing an initial stock of
four adult cows together with one heifer calf and one bull calf. The nota­
tions of the next two entries represent a butter oil equivalent (i. n u n. b i) of
2 (bān) = 20 sīla and a cheese equivalent (g a ḫ a r. b i) of 3 (bān) =
30 sīla. Division of the two numbers by the known quotas of 5 and
7/2 sīla of butter oil and cheese, respectively, shows that the amounts re­
represent the expected delivery of four milk cows. In succeeding years noted
in the account, more calves appear and the calves from the previous years
are noted, qualified by signs representing their advancing age (see figure 5
and the table below). The full-grown cows in their fourth years were ex­
pected to calve and produce milk for the first time25. Mentioned in passing
in A. Deimel’s treatment in 1926 of the cattle records from pre-Sargonic
Girsu26, this text was first analyzed more than half a century after its publi­
cation by the Chicago scholar I. J. Gelb, who recognized the highly in­
volved structure of the account and who, based on the terminology in the
text, was able to describe the key terms of cattle breeding and dairy pro­
duction of the Ur III period27.

Gelb’s analysis was nonetheless flawed in two ways. In the first case,
he misinterpreted the equivalents of numbers of milk-producing cows and
yearly delivered butter oil and cheese, basing the per-cow delivery on the
number of milk cows documented in the running rather than the previous
year. This logical mistake was corrected in a Japanese publication in
197728. In the second case, Gelb and following him the Japanese Sumerol­
ogists T. Maeda and T. Gomi assumed that TCL 2, 5499, was a real ac­
count; it was not. The fact that the text records only amounts of butter oil
and cheese deliveries which we know to be yearly production norms; that
the ten year span of the text saw no deaths of adult animals, indeed,
seemed to document the uninterrupted calving and milking of cows into

25 This rule of thumb for the Ur III period may well be based on the expected beginning of
the oestrus cycle among sedentary animals in southern Mesopotamia and not a reflection of a
conscious herding decision to delay calving into a more stable age. See G. Dahl and A. Hjort,
Having Herds 33-37; K. Butler, WZKM 65-66, 43
26 OrSP 21, 11-12; Deimel’s calculation of the cheese/silver equivalence was, however, in­
correct.
1977. The point is that beginning in Šulgi 43 (year 5 of the account) each year one heifer comes
of age, having calved and entered the category ẖ a m a h. This being the first year in which the
cow will have produced milk and assuming cows were serviced to calve late in their fourth
year, it was not included in the debit calculation of yearly deliveries of butter oil and cheese.
As is evident in figure 5, the first entry of the section recording the year following Šulgi 48,
Amar-Suen i, would have read 12 ẖ a m a h, since in this year for the first time two heifers
would have calved and entered the adult age category.
Figure 4a: Transliteration of the artificial account TCL 2, 5499, obverse face (the regnal years follow M. Sigrist and P. Damerow, *Mesopotamian Yearnames* [preprint Berlin 1991];  1 ab māḏ / gu₃ gal = "full-grown cow/bull", 1 ab/gu₄ mu₁/₂/₃ = "one-, two-, three-year-old heifer/bull", 1 ab/gu₄ amar ga = "heifer/bull calf [literally 'cow/bull-calf-milk']").

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<tr>
<td>4 ab māḏ</td>
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</tr>
<tr>
<td>1 ab mu₁</td>
<td>1 ab mu₁</td>
</tr>
<tr>
<td>1 ab amar ga</td>
<td>1 ab amar ga</td>
</tr>
<tr>
<td>1 gu₄ mu₁</td>
<td>1 gu₄ mu₁</td>
</tr>
<tr>
<td>1 gu₄ amar ga</td>
<td>1 gu₄ amar ga</td>
</tr>
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Šulgi 40

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<tr>
<td>1 ab amar ga</td>
<td>1 ab amar ga</td>
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Šulgi 43

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<td>6 ab māḏ</td>
<td>11 ab māḏ</td>
</tr>
</tbody>
</table>

Šulgi 41

their 15th year; that without exception calves were noted in successive years at a rate of one calf per two milk cows²⁹ and always in succession

²⁹ In years based on odd numbers of adult cows, the "half-calves" were disregarded. Note that the scribe made a mistake in Šulgi 46 of the account, recording just 3 instead of the 4 calves for the year required by the first entry 8 ab māḏ of the section, and that this mistake was not corrected in the following two recorded years; the calculated amount of cheese was, moreover, for this same year false (47½ sīla instead of correct 7 × 7½, or 35 × ½ = 52½). This latter miscalculation was, however, corrected in the totals of the text (reading rev. vi 5: SU+NIGIN 1;1,51,2~ = 37½ sīla ga 4gur [collated; from (30 × 5) + 37½ + 45 + 52½ + 60 + 67½]; this 'correction' resulted from a simple multiplication of the correct total of butter oil by ½).
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### Figure 4b: Transliteration of the account TCL 2, 5499, reverse face (column vi reads: "Together: 18 diverse cows, together: 14 diverse bulls, together: 4(barig) 3(bdn) 5 silla of butter oil, together: 1 gur (barig) 5(bdn) 2 1/2 silla of cheese; silver (equivalent) of the oil involved: 1/3 ma.na 7 1/2 gfn kà ga.ba 2 2/3 gfn 15 5e n.fg.kap,ak I-du-a dumu l-sá-á-rf-ik sanga Ísíran

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Suulgi 46

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Suulgi 47

bull calf – heifer calf – bull calf – etc.; that the text totals the ideal butter oil and cheese deliveries of all ten years and converts this total into a silver equivalent, a procedure which might be expected of an artificial account displaying the total return on a initial capital outlay and which has no counterpart in the tens of thousands of real Ur III administrative documents, but which moreover according to our understanding of these
accounts could not exist — all of these facts make clear the entirely theoretical nature of TCL 2, 5499.

Yet it is precisely because this text is a theoretical exercise that it is so important for our understanding of the terminology and the accounting procedures used in Ur III dairy administration. No less than the applied mathematics evident in many problem texts of the Old Babylonian period, TCL 2, 5499, represents an applied theory of accounting in which those elements of dairy administration expressed in the account that have attested counterparts in real ledgers prove a detailed correct knowledge of the accounting of the time. On the level of such details, for example, the silver equivalencies 1 shekel = 10 sîla i nûn and 150 sîla ga ăr, implicit in the final computation of the text, are found to mirror contemporaneous value norms.

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30 I first stated this conviction in *Ur III-Fischerei* 43-46 (and compare K. Butz, *WZKM* 65-66, 438; S. Dunham, *Ab 76* [1982] 41), and the point was further made in H. Nissen, P. Damerow and R. Englund, *Frühe Schrift und Techniken der Wirtschaftsverwaltung im alten Vorderen Orient* (Bad Salzdetfurth/Berlin 1991) 139-144 (available in English translation as: *Archaic Bookkeeping* [Chicago/London 1993] 97-102); see most recently J. Friberg, “Mathematik”, in: *RIA 7* (1987-1990) 542. Soft evidence for the artificial nature of AO 5499 may be found in the fact that the persons recorded in the text’s colophon are otherwise unknown in connection with dairies in Drehem or elsewhere in the Ur III period. It may be added, finally, that the inclusion of adult males in the books of a dairy herd would also be unheard of in such accounts, since these animals with the exception of one or two breeding bulls would have been castrated and set to the plow and thus transferred to another administrative unit, that of the *nâgar and nû bû nî da gu₄*. See generally I. J. Gelb, “Household and Family in Early Mesopotamia”, *OLA* 5, 18-22; K. Mackawa, “The Agricultural Texts of Ur III Lagash of the British Museum (IV)”, *Zinbun* 21 (1986) 91-103; id., “The Management of Domain Land in Ur III Umma”, *Zinbun* 22 (1987) 25-82, esp. 37-40.


32 The implicit equivalencies are found in the conversions of 0;4,3,5 = 275 sîla i nûn (rev. vi 6) and of 1;1,5,2 1/2 = 412 1/2 sîla ga ăr (vi 5) into 2 1/2 sîla (vi 7).

33 For dairy oil see D. Sharashenidze, *VDI* 1976/3, 110-111 (Amar-Suen 4, Umma), rev. 37: *SUNUGIN* 5 sîla 1 nûn kû.bi. 1/2 3 (thus 10 sîla oil per shekel silver), T. Gomi, *Selected Neo-Sumerian Administrative Texts from the British Museum* (Abiko 1990; in the following = *SNAT*) 382 obv. 5-9: 3 gin k̂i / 1,0,0 3u gu₄ / lun.ni.bi 0,0,4 / A.nu šu ba.ti (1 shekel silver = 1 gar grain = 1 ban 1 nûn) and the treatment below of the Umma text *MVN* 15, 108; note further the rate of 10 sîla per shekel silver in the Umma text T. Gomi, *SNAT* 302 (dated to Sulgi 48) obv. 1-2 (and compare the same rate of 1 shekel silver per ban dairy oil in Old Babylonian Ur in UET 5, 607 obv. 5, 36, rev. 40, 52 and 57), and the rate of 8 sîla per shekel for the oil 1 nûn 1/2 derived from goat’s milk attested *passim* in the Ur accounts UET 3, 1198, 1514 (both texts *Ibî-Sîn* 3) and UET 9, 916 (the qualification 1/2 of the goat’s butter oil recorded in Ur texts may indicate either a more highly prized oil or a regional value difference, since the cheese from the same goats’ milk was recorded with the silver equivalence of 150 sîla per shekel attested for cow milk cheese in TCL 2, 5499, and since according to the account SET 130 treated below and possibly the Girsu texts cited by G. van Driel, *BrOr* 50, 558 n., dairy products from nanny goats and cows were apparently value equivalent and possibly even mixed by herding supervisors in Umma and Girsu (this practice is common, for example, in modern Syria; see L. Sweet, *Tell Toquaan: A Syrian Village* (Anthropological Papers, Museum of Anthropology, University of Michigan no. 14; Ann Arbor 1974) 102); that our data from Umma derive from late Sulgi and Amar-Suen, those from Ur from Ibî-Sîn, during whose reign equivalence values became unhinged [see T. Gomi, “On the Critical Economic Situation at Ur Early in the Reign of Ibnîmain”, *JCS* 36 (1984) 211-242],
Regulating Dairy Productivity in the Ur III Period

Figure 5: Analysis of the artificial dairy herd account TCL 2, 5499, after H. Nissen, P. Demerow and R. England, *Archaic Bookkeeping* (Chicago 1993) 101, fig. 78. Note that two errors were made in the section representing Shulgi 46: three instead of four calves recorded as born, and 47 1/2 silla of cheese instead of the correct total of (7 x 7 1/2) = 52 1/2.

should be mentioned as factors possibly skewing the reliability of inferences drawn here. Dairy oil was thus in the expensive range for oils available through the exchange markets of the dam.gar. Vegetable oil was handled at a rate of 9-15 silla per shekel, lard at 20 silla and fish oil at 30 silla, for which see D. Snell, *Ledgers and Prices: Early Mesopotamian Merchant Accounts* (YNER 8; New Haven/London 1982) 151-154. For goat's cheese see UET 3, 1198, 1514 and UET 9, 916 (150 silla per shekel silver; see above), and, at a rate of 180 silla per shekel in Umma, Gomi, SNAT 302 obv. II 10-11. The only known reference for a silver correspondence to the cheese qualified ga urgunnī (certainly a variant of ga ṣur) is found in the text VDI 1976/3, 110-111, rev. 39: 3 silla ga urgunnī ku.bi 3 še, that is, also 180 silla per shekel, in conformity with the likely interchangeability of these qualifications of cheese from cow and goat's milk in Umma.
On a general level of administrative structures, state-controlled dairy production conformed, according to the text, to a rigid accounting format. The state acted as legal owner of herds of cattle, consisting of breeding bulls, adult cows, and male and female juveniles. Book was kept of the sex and age of the juvenile animals, recording the following categories:\n\begin{center}\begin{tabular}{l|l|l}
  & females & males \\
  adult & áb māḫ & gu, gal \\
  juvenile in 3rd year & áb mu.3 & gu, mu.3 \\
  juvenile in 2nd year & áb mu.2 & gu, mu.2 \\
  juvenile in 1st year & áb mu.1 & gu, mu.1 \\
  sucking juvenile & áb amar ga & gu, amar ga \\
\end{tabular}\end{center}

These living "capital resources" of the state were placed at the disposal of cattle herders who were to tend animals and thus guarantee for their well-being, care for the yearly calving of the adult cows and, once having calved, for the production of milk and its derived products butter oil and cheese. The state required, beyond the yearly increase of the herd at a rate of one calf per two adult cows, 5 sīla, i.e., ca. 5 liters, of the butter oil qualified i nīn and 7½ sīla (liters) of the cheese qualified gā hamar, or their equivalents — either in value or in inherent contents — in a number of different dairy products, including raw or soured milk.

§ 3. Recent publications concerning Ur III dairy accounts

In an article published in 1980, T. Gomi corrected the representations of Gelb of a fluctuating milk productivity attested in the large Drehem account AO 5499, and at the same time buttressed the assumed production norms of 5 sīla of butter oil and 7½ sīla of cheese in the Ur III period with an assessment of a large number of dairy accounts from Ur, most of which had been published some 43 years earlier. For example, the account UET 3, 1215 (Ibbi-Sin 8), apparently consolidates a large number of individual accounts of the delivery norms and real deliveries of named herders. Rev. vii 9-21 reads:

\[\text{Compare F. Kraus, \textit{Staatliche Viehhaltung im altbabylonischen Landa Larsa} (Amsterdam 1966) 42-44.}\]

\[\text{The halving of the nominally expected fertility rate of one calf per cow per year may have had a number of causes. The first should be a combination of expected fertility rates of the cows (see above, fn. 2) and the death rates of juvenile animals (10% is common with intensive husbandry; see G. Dab: and A. Hjoert, \textit{Having Herds} 37-38), but the accounting 'survival rate' may also have resulted from a conscious decision not to lead cows in heat to bull servicing and so to exploit a two-year lactation cycle, or from necessary or willful culling of juvenile animals from the herd in the course of breeding and feeding techniques, of deliveries to cult sacrifices or of compensation for the herders, as a result of which calves were simply removed from state books.}\]

\[\text{See above, fn. 10.}\]
Regulating Dairy Productivity in the Ur III Period

3 áb 3 (milk) cows,
I.bi 0;0,1,5 sîla the (butter) oil involved: (3 x 5 =) 1 (bân) 5 sîla,
Ga.HAR.bi 0;0,2,2 ½ sîla the cheese involved: (3 x 7½ =) 2 (bân) 2½ sîla.
Sà.bi.ta
0;0,1,4 sîla i Therefrom:
5¼ sîla ga HAR 1 (bân) 4 sîla oil,
0;0,1,5 sîla 10 gîn ga šeš(SIG) . a 5½ sîla sîla cheese,
I.bi 1 sîla 1 (bân). 5 sîla 10 shekels ... milk:
Ga.HAR.bi 1½ sîla the oil involved: (15¾ + 15 =) 1 sîla,
MU.DU the cheese involved: (1 x ½ =) ½ sîla, are the deliveries.
La+NI (erashur) l The deficit: (15 - (14 + 1) =) (nil) oil
La+NI 0;0,1,5 sîla 10 gîn ga har The deficit: (22½ - (5½ + 1½) =) 1
Lu.4Utú ānu (bân) 5 sîla 10 shekels cheese,
(Account concerning) Lu-Utu, the cow herder.

Similar accounts from Ur and Umma cited by Gomi demonstrate the systematization there of these norms in the Ur III period\(^{38}\), which he seems to believe represented actual production figures of the time\(^{39}\). The artificially even numbers evident as calculated delivery norms in debits sections of accounts contrast with the credits sections of the same accounts and with other texts — receipts and transfer confirmations — which record real deliveries of dairy products. In these accounts, the measures of oil and cheese are not evenly divisible by the known delivery norms of 5 and 7½ sîla, respectively, nor do they exhibit the relationship of 2:3 between oil and cheese expected in the former texts\(^{40}\).

Despite the advances in our understanding of Ur III dairy accounting made by Gomi, the broad structure of state-controlled herding, the entirely artificial nature of delivery norms and the concomitant importance of the equivalence values expressed in dairy accounts, and, as a crux in this discussion, the meaning of the product ga šeš(SIG) . a, which Gomi considered a type of cheese\(^{41}\), remained unclear. In a short examination published

\(^{37}\) For the reading and significance of the qualification see below, § 4.2.2.

\(^{38}\) See UET 3, 1216, UET 9, 894, 985, 1032 (all dated to Ibbi-Sin 7 or 8); for a general description of the accounting terminology found in Ur III dairy accounts see Ur III-Fischerei 1355. The deficit La+NI, as I have stated there, was an artificial equivalent value to be paid the state by the herders involved; for example, the account UET 3, 1218 (Ibbi-Sin 8.xii), records amounts of both l n.un and ga har, qualified (l. 3-6) La+NI lám / ūnume ne / in.pi.gal / su.su.dam, "... are the deficit, entered against the herders, to be replaced".

\(^{39}\) JESHO 23, 1.

\(^{40}\) See, for example, the texts UET 3, 1038, 1043, 1067, 1217; UET 9, 911, 1007.

\(^{41}\) See JESHO 23, 3\(^{4}\) and 5. The author seems to have assumed the position taken by A. L. Oppenheim, AOS 32, pp. 7-8 and 47, that ga in both ga sig, a and ga gazi was an abbreviation of ga har (the phantom ga .ara .sig, a in K. Butz, WZKM 65-66, 38, is to be stricken). Oppenheim’s understanding, loc. cit., of ga gazi as ga gáz, “crushed cheese”,

\(^{42}\) For the reading and significance of the qualification see below, § 4.2.2.
in 1990 of the accounting terms found in Ur III dairy accounts, I attempted to point out that the clear distinction in the managers’ books between products contained in the debits section of accounts described by the term sag.nig.gur₃-ra(k), literally ‘head of the goods’, and those contained in the credits sections described by the enclosing notation šâ.bi.ta ... zi.ga, ‘therefrom: ... deducted’, must be evident in any treatment of dairy terminology. Thus dairy accounts assume the same general form as accounts known from other administrative units of the Ur III economy:

1) DEBITS = sag.nig.gur₃-ra(k)
   a) si.i.tum: LA+NI of the preceding accounting period, expressed in standardized values
   b) (ūgu): state property given over to supervisors as ‘investment’, converted into standardized values

2) CREDITS = šâ.bi.ta ... zi.ga.ām
   delivered real products and real work and allowances, converted into standardized values

3) BALANCE: debits minus credits
   DEBITS greater than CREDITS:
   a deficit LA+NI (probably to be read lá.jâ) will appear as si.i.tum in the debits section of the following account, or be otherwise dispensed of
   CREDITS greater than DEBITS:
   a surplus diri will appear as diri (or diri nig.ka₃.ak) in the credits section of the following account, or be otherwise dispensed of

4) COLOPHON: “Account (nig.ka₃.ak) concerning ...”, Date

According to this scheme, the debits represent essentially artificial and state-owned, the credits real quantities and measures of goods and services delivered to the state by contracted managers. We might imagine the following arrangement between a representative of the central administration and a contracted herder in the Ur III period: the herder PN assumes responsibility of 10 milk cows and a breeding bull for one year from an administrator in Ur. At the end of the year, PN must prove he delivered to state agencies — to cult personnel, to exchange agents of the state, etc. — the equivalent of \((10 \times 5 =) 50\) sîla of the butter oil i nîn and of \((10 \times 7\frac{1}{2} =) 75\) sîla of the cheese ga ḫâr. Further, he must return or ac-

is, despite the likelihood that pulverized kâzik would fill approximately a third less space than the corresponding intact cheese balls, erroneous. The sign gâzi is not attested in this meaning in the third millennium, gâz is never found in Ur III texts together with ga (ḫâr), and the text MVN 2, 130, cited below, fn. 71, states that soured milk (ga še.a) was employed to make ga mûn.gâzi. The sign combination mûn.gâzi was a general designation of spices and herbs including the product gâzi. See also fn. 70 below.
count for the 11 head of cattle, possibly together with 5 calves born in that year. State accountants have issued receipts for the specific deliveries of the herder made during the accounting year, presumably each time in duplicate, one for the receiving agency and one for the herder or his supervisor. The products noted in these receipts are all the real dairy products which the herder has delivered, including soured milk and products derived from soured milk. These receipts are gathered and recorded in an account of the form discussed above, whereby in summations all dairy products other than i n u n and g a h a r are by means of known value equivalencies expressed in terms of butter oil and cheese. Let us assume our herder delivered in the year in question altogether 35 s i l a i n u n and 60 s i l a g a h a r, further 150 liters of the product g a s i g., a which, as we have seen above, corresponds to (150 + 15 =) 10 s i l a of dairy oil and (10 × 7½ =) 15 s i l a of cheese. The total of 45 s i l a butter oil is 5 below the required delivery and these 5 s i l a will be entered in the account as a deficit to be repaid the state; that of 75 s i l a cheese fulfills the required norm. How and in what form the herder replaces the 5 missing s i l a of oil is of no particular consequence to the state. He can deliver more oil to fulfill his quota, or he can submit an amount of another product or, for example, of silver to cover the debt. He can also again assume responsibility for the herd, and carry the debit into his second year; in this case, these 5 s i l a i n u n will appear as the first entry in the debits section of the account covering the second year, so that the total debit for that year will be (5 + (10 × 5) =) 55 s i l a butter oil and (10 × 7½ =) 75 s i l a cheese. We know from accounts of other Ur III economic entities — the best documented are those of the trade agents d a m. g a r 42 — that this procedure can and does go on year for year.

§ 4. New key texts in Ur III dairy accounting

Although Ur III dairy accounts known to me do not record the movement of the actual cattle, they do give ample evidence of the movement of artificial and real amounts of dairy products in full accordance with the example given above. Two texts in particular make very clear the nature of this dairy bookkeeping in the province Umma. The first account, SET 130, published a quarter of a century ago by T. Jones and J. Snyder, has only recently been the subject of more interest and is now, as a consequence of collations by J. Carnahan and K. Hillard 43 , much better understood. Follow-

42 See Ur III-Fischerei 34-35 m n s.
43 Collations of SET 130 were first published in 1986 by M. Cooper and J. Snyder (ASJ 8, 318); the authors, however, paid no apparent attention to the numbers in the account. Carnahan
ing a short discussion of this text, the second, and for an analysis of Umma dairy management more important account, MVN 15, 108, published in 1991 by D. Owen, will be more fully considered.

§ 4.1 SET 130

The Umma account SET 130, dated to Amar-Suen 4, records the activities of the high official Ur-e’e, supervisor of imposing herds of small cattle (sheep and goats) and responsible for the deliveries of their products. The account contains in standard format the sections 1-4 outlined above. In the first, debits section (obverse i 1 to vi 250), the supervisor assumes responsibility for sheep, goats and measures of butter oil and cheese (i nun and ga udgunu = ga ḫar) qualified as remaining arrears from the previous accounting year Amar-Suen 3, together, in his running account, with large numbers of sheep and goats and products from these animals44, including wool (siki), goat’s hair (siki ud) and, from the goat herders under his supervision, the same milk products butter oil and cheese45. As

and Hillard offered important and very detailed new collations in 1993 in ASJ 15, 207-210, with corrections and additions by the latter in ASJ 16 (1994) 309. I might take this opportunity to express my thanks to K. Hillard for his precise response to my inquiries after this text and for his considered rebuttal of several of my preliminary suggestions.

44 Note also the inclusion in this running debit account, obv. ii 64-68, of five shekels of silver, set in equivalence to 10 sheep with fleece, qualified further as the repaid arrears of the household of the en (5 gin kābabbar udu.bar./gāl.bi 10.am / LĀ+nī su.ga udu nam./en.na / ki PN.ta; nam.en.na is not bitru, see CAD B s.v., H. Waetzoldt, Untersuchungen zur neusumerischen Textilindustrie [Rome 1972] 31-32, and K. Butz, WZKM 65-66, 22-23). The same amount of silver was booked out of the credits section of the account, rev. ix 364-369, and into the running debit account of the Umma silver official and Ur-e’e’s son Lukala (ugu Lu.kal.la ba.a.gar; for the genealogical relationships among individuals named in the dairy accounts see below, fn. 52).

45 Obv. ii 89 – iii 119, ending with ki sipa ud, da.[k]a.n.e.t{a}. This section of the account contains the calculated deliveries of animals (ud, ma assimilated), milk products and goat’s hair from three named goat herders, from two other herders only amounts of goat’s hair. Since the amounts of butter oil and cheese recorded in these entries must be based on a yearly norm of ½ and ¾ sîla, respectively, per nanny goat (the same assumption must be made for the second section of AUCT 2, 391; to be noted to M. Stol, BSA 7, 102), it is possible to calculate the number of goats producing milk (see figure 6) and so to see that the first entry in each of the subsections must represent not the number of animals in the care of the individual herders, but rather the number of animals which they were required in the accounting year Amar-Suen 4 to deliver, through the office of Ur-e’e, to state institutions. It may be mentioned in passing that the mean exchange rate for small cattle, regardless of sex and age, was generally ½ shekel silver per animal [in MVN 17, 5, BM 12234, rev. ii 1-2, ½ shekel] for billy goats, as in the Old Babylonian period for sheep and goats; see F. Kraus, Staatliche Viehhaltung 62; K. Butz, WZKM 65-66, 21-22], and that this exchange rate represented approximately ⅔ of that current in the Ur III period for cow and goats; see P. Steinke, Sale Documents of the Ur-III-Period (FAOS 17; Stuttgart 1989) p. 138, table 11 and below, for this text and for Ur III and Old Babylonian references to oxen values], but compare the apparent value equivalence of 1 ġu and 10 sheep and goats in deliveries to Drehem, noted in P. Steinke, SAO 46, 30-35 [the sources of his standard livestock prices are not obvious], and in my “Ur III Sun-
Regulating Dairy Productivity in the Ur III Period

part of his debits, Ur-e'e also assumed responsibility for the milk production of four named cow herders with herds including from 6 to 25 milk cows (see figure 6). To each of the subtotals of dairy oil, that is, to that of the nanny goats and to that of the milk cows, is added an amount of oil corresponding to exactly \( \frac{1}{6} \) of the subtotals. These entries are qualified \( \text{šu.}	ext{gingum} \) and seem to refer to a type of surcharge assessed to the butter oil.

The credits of SET 130 (section 2 of the standard format; obverse vi to reverse xiii 543) contain the real deliveries made by Ur-e'e and his representatives. The registration of these deliveries includes notations representing the same animals and products recorded in the first section of the account, including variously qualified products such as \( \text{siki kur.} \text{ra} \), \( \text{siki} \text{gi} \) and \( \text{siki gu.} \text{na} \) (reverse ix 380-383, 393-394, xii 518), referring to the wool shorn from particular types of sheep (\( \text{udu kur.} \text{ra} \), \( \text{uli.} \text{gi} \) and \( \text{gu.} \text{na ku} . \text{ra} \)) (reverse ix 399 and 401, x 415 and 419), referring to a particular type of cheese and to raw or soured milk, respectively. The meaning of the latter terms is considered below. In summations, the scribe includes variously qualified products in the general categories of wool, goat's hair, butter oil...
### Debits

<table>
<thead>
<tr>
<th>Lines:</th>
<th>1 nun</th>
<th>ga UDgunā</th>
<th>milk cows/goats</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-7</td>
<td>0:4,4,5</td>
<td>4 1/2</td>
<td>= si. tum</td>
</tr>
<tr>
<td>90-92</td>
<td>0:0,3,6</td>
<td>30</td>
<td>0:0,5,4,45 (73)</td>
</tr>
<tr>
<td>96-98</td>
<td>0:0,3,3</td>
<td>30</td>
<td>0:0,5,0,15 (67)</td>
</tr>
<tr>
<td>107-109</td>
<td>0:0,4,2</td>
<td>30</td>
<td>0:1,0,3,45 (85)</td>
</tr>
<tr>
<td>116-117</td>
<td>0:0,0,7</td>
<td>30</td>
<td>(225 udg)</td>
</tr>
<tr>
<td>120-121</td>
<td>0:1,2,5</td>
<td>×3/2 = 0:2,0,7,30 (17)</td>
<td></td>
</tr>
<tr>
<td>123-124</td>
<td>0:1,1,5</td>
<td>×3/2 = 0:1,5,2,30 (15)</td>
<td></td>
</tr>
<tr>
<td>126-127</td>
<td>0:2,0,5</td>
<td>×3/2 = 0:3,0,7,30 (25)</td>
<td></td>
</tr>
<tr>
<td>130-131</td>
<td>0:0,5,0</td>
<td>×3/2 = 0:0,4,5 (6)</td>
<td></td>
</tr>
<tr>
<td>134</td>
<td>0:0,2,1</td>
<td></td>
<td>(63 ab)</td>
</tr>
<tr>
<td>225-226</td>
<td>0:0,3,2</td>
<td>0:0,4,5</td>
<td></td>
</tr>
<tr>
<td>242-247</td>
<td>2:2,5,3</td>
<td>4 1/2</td>
<td></td>
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### Credits

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<th>ga UDgunā</th>
</tr>
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<tbody>
<tr>
<td>396-398</td>
<td>0:3,4,7</td>
<td>32 1/2</td>
</tr>
<tr>
<td>399-400</td>
<td>0:0,0,4</td>
<td>18 1/2</td>
</tr>
<tr>
<td>401-405</td>
<td>0:0,0,4</td>
<td>18 1/2</td>
</tr>
<tr>
<td>414</td>
<td>0:1,4,0</td>
<td></td>
</tr>
<tr>
<td>415-417</td>
<td>0:2,0,7</td>
<td>30</td>
</tr>
<tr>
<td>418</td>
<td>0:0,5,9</td>
<td>1/2</td>
</tr>
<tr>
<td>419-422</td>
<td>0:0,0,2</td>
<td>30</td>
</tr>
<tr>
<td>535-540</td>
<td>1:0,2,2</td>
<td>11</td>
</tr>
</tbody>
</table>

### Balance

<table>
<thead>
<tr>
<th>Lines:</th>
<th>1 nun</th>
<th>ga UDgunā</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 2:2,5,3</td>
<td>4 1/2</td>
<td></td>
</tr>
<tr>
<td>+ 1:0,2,2</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>1:2,5,5</td>
<td>53 1/2</td>
<td></td>
</tr>
</tbody>
</table>

### Figure 6

Overview of the entries concerning milk products in the Uma account SET 130 (capacity measures are recorded ga,barig,ban,slla gfn; fractions of the slla have been converted into gfn); numbers have been corrected according to J. Carnahan and K. Hillard, *ASJ* 15, 207-210, and *ASJ* 16, 309. For each nanny goat (udg), 1/2 slla of butter oil i 1 nun and 3/4 slla of cheese ga UDgunā were to be delivered yearly from the goat herders (sipa udg,da), and for each cow 5 and 7 1/2 slla, respectively, from the cow herders (unu). Note that the presumable surcharges denoted SU.GIRgunā in the debits section of this account resulted from calculating 1/15 of the expected butter oil deliveries from the herders (7 1/2 slla in ll. 116-117 from 112 1/2, 21 slla in l. 134 from 315 slla).
and cheese, thereby demonstrating that these categories of goods represented different products which were of equal value in state accounts.

The balance of the account (section 3; reverse xiii 544 to 560) is calculated using the same terminology for animals and products as that found in section 1. As can happen with accounts based on a number of equivalence units instead of just one, for example, flour in milling texts or workdays in accounts of agricultural labor, both deficits (of sheep with fleece, lambs, goats and milk products) and surpluses (of shorn sheep and goat's hair) are found in the balance. These balance entries can be left unresolved as distinct measures, or utilizing the complex system of bookkeeping equivalencies of the Ur III period be resolved into one or the other accounting units. The final section 4 (colophon, reverse xiv 561-565) presents different products which were of equal value in state accounts, from which real deliveries of such products are deducted, proves that the milk of cows and goats were value equivalent. Note the marginally parallel structure of the text SET 130 and the two Girsu accounts CT 7, pl. 54, BM 18407, and TCTT 1, 878, cited above, fn. 12. The Girsu accounts, however, registered above all dairy products from cows (based on delivery norms of 1 ban each of butter oil and cheese per cow-year) and included substantially lesser quantities of such products expected from goat herders.

Deliveries of wool totaling 225 g = 9½ m a. n a canceled the debits total of the account, which, as J. Carnahan and K. Hillard stated in ASJ 15, 208, to II. 239-241, was in fact ½ m a. n a higher than the sum of the individual debit entries and which included no wool notation in its s i. l. t u m section. A high percentage of accounts whose debit totals are exactly canceled by credits also lack a s i. l. t u m, including, beyond the case of wool in SET 130, such texts as BIN 5, 272 (Umma, Amar-Suen 3, agricultural work teams, reckoning in grain and labor time), TCL 5, 5675 (Umma, Amar-Suen 4, agricultural work teams, reckoning in grain and labor time), ÑA 76 (Umma, Amar-Suen 4*, grain for d a m . g ā r), YOS 18, 123 (= D. Snell, ASJ 11 [1989] 204-216; Umma, Amar-Suen 9, d a m. g ā r silver account), MVN 15, 103 (Umma, Su-Sin 6, grain account) and 257 (Umma, n.d., grain account; balance 'booked in the debit account'). Some of these texts contain summation numbers so complex as to raise a suspicion either of bookkeeping manipulation, or, for instance in the case of wool in SET 130, of the specific use of a partial credit surplus (rev. xii 518-524) to strike debit entries from the books.

The account MVN 17, 83, BM 12137 (from Girsu, dated to Sargi 4/ii-xi), concerning the activities of a foreman charged with delivering bundles of reeds and manu-wood, is an interesting example of this phenomenon. The basis of calculations in the text is an implicit amount of labor time required to harvest and deliver given quantities of the products described: 1 'load' (gû) of manu-wood = 2 'bales' (k il il b) of manu-wood, and 1 bale of manu-wood = 10 'bundles of reeds' (a s gî; and, implicitly, 10 a gî = 1 workday). Whereas the s i. l. t u m entry of the debits section of this text (obv. 1-3) consisted of a notation representing only a large number of reed bundles, the complete debits include 17075 reed bundles and 1200 bales of the more valuable manu-wood (obv. 12 = rev. 1). Real deliveries of these products are then entered into the ledger and totaled, with the following resolution of the resulting surplus in reed bundles and deficit in manu-wood (rev. 11-17):

<table>
<thead>
<tr>
<th>Sukkak SIII 5.58.00</th>
<th>21480 minus 2 reed bundles, 21,720 bales of manu-wood deducted.</th>
<th>S III 12.32 kilil *ma.a.na</th>
<th>752 bales of manu-wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>zü. gî</td>
<td></td>
<td>21,720 bales of manu-wood</td>
<td></td>
</tr>
</tbody>
</table>
contains the name of the year for which, and of Ur-e'e\footnote{53} the supervisor (\text{iš/šûš})\footnote{54} about whom the account was written, and the notation nīg. \text{ka}/\text{ak} \text{ udu} \text{i} \text{siki} “account: small cattle, oil and wool”.

The appearance of a rather small number of herds of milk cows in the account \text{SET} 130 concerned primarily with sheep and goats was until re-
diri 1.13.23 \text{ sa} \text{gi} \text{ kilib/e} 10.\text{ta}

\text{kilib} \#\text{ma}.	ext{nu} \text{ LA+NI} \text{bi} 7.20\frac{1}{2}

diri \text{ LA+NI} \text{ gu},\text{i}
\text{LA+NI} 7\frac{1}{2} \text{kilib} \#\text{ma}.	ext{nu}

Surplus: \((21478 - 17075 =) 4403\) reed bundles, at 10 per bale, the corresponding deficit of manu-wood is \((4403 \div 10 =) 440\frac{3}{5}\) bales; let the deficit eat the surplus!

Deficit: \(((1200 - 752) - 440\frac{3}{5} =) 7\frac{3}{5}\) bales of manu-wood.

Comparable manipulations are found in many \text{Ur III} accounts (for a direct parallel see MVN 2, 5 [Girnu, Sulgi 45/xii], rev. 19, also with \text{diri} \text{ LA+NI} \text{ gu},\text{a}; further \text{TUT} 131 obv. ii 10', rev. iii 9 [\text{diri} \text{ LA+NI} \text{ ba}.,\text{ab} \text{ gu},\text{i}], UET 3, 1779 rev. ii 6 [\text{diri} \text{ LA+NI} \text{ ba}.,\text{ab} \text{ gu},\text{i}]).

\text{The text A. Archi and F. Pomponio,} \text{ Vicino Oriente} 8/1 (1989) p. 65, no. 64 (Sulgi 44/x), demonstrates that this official repaid, in silver, debts recorded in texts like \text{SET} 130 (obv. 1-5: \text{ma}.,\text{na} \text{ ku} \text{babbar / LA+NI} \text{ su} \text{ga} \text{l nun} \text{ ga} \text{jar / ki Ur.e',e,ta / Da.da.ga / šu bali,} \text{ma}.,\text{na} \text{ of silver did Dadaga receive from Ur-e'e as replaced deficit for butter oil and cheese}); the same applies to the cattle supervisor Atu discussed below, who also transferred silver equivalents for dairy fat debts to Dadaga (BIN 5, 333, Sulgi 46/vii; see below, fn. 80).

A topic only marginally related to those dealt with here but of some importance for the administrative history of the \text{Ur III} empire is the fact that as cattle supervisor Ur-e'e assumed an integral role in the decision-making hierarchy of Umma. In an important article dealing with \text{Umma} genealogies evident in the legends of extant seal impressions, D. McGuiness, “The Family of Giri\text{-}za\text{l}”, \text{RA} 76 (1982) 17-25 (the major results of which were repeated without apparent knowledge of this work by T. Maeda, “The Father of Akala and Dadaga, Governors of Umma”, \text{AJJ} 12 [1990] 71-78; see also G. Bergamini, “Neo-Sumerian ‘Vignettes’: A Methodological Approach”, \text{Mesopotamia} 26 [1991] 104-105, and compare the now outdated excursus on Ur-e'e in \text{SET}, pp. 322-344), demonstrated that this province was ruled at the highest levels by individuals belonging to one family, many of whom are encountered in the dairy accounts (compare the individuals cited in fn. 54 and 66 below):

\begin{center}
\begin{tabular}{c|c|c}
Giri\text{-}za\text{l} f\text{št} & Ur\text{,nù} g\text{ar} 4\text{št} & A.k\text{al}a \text{ én} \\
A.k\text{al}a \text{ én} & Ur\text{,e}',\text{e} 4\text{št} & Da\text{da} .\text{g}a \text{ én} \\
Da\text{da} .\text{g}a \text{ én} & L\text{ù}k\text{a} .\text{l}a & G\text{u} .\text{du} .\text{du} \\
\end{tabular}
\end{center}

This state of affairs must be kept in mind when considering whether high, related officials — Dadaga, chief silver agent in the years Sulgi 39 through Amar-Suen 1, was Ur-e'e's brother, and was replaced in this function by Ur-e'e's son Lūkala — were held to the same harsh standards of accountability as were the numerous u\text{гу}la and š\text{nu} below them. Note also in this regard the fact that the seal legends identify all of these officials as d\text{ub} .\text{šar}, i.e., as literate accountants. Cattle supervisors such as Ur-e'e and Atu (see below) were thus no less integral to the high-level administration very close to the office of the én\text{si} than were š\text{ba}ra, š\text{a}ng\text{a} and u\text{b}ǎ\text{nda}.

\text{Against the conventional readings sahar or kuš, see most recently R. Beale, “Is kuš, the Reading of is = kiaš”,} \text{NABU} 1992/48; further P. Steinkeller, \text{FAOS} 17, 180; A. Cavigneaux, \text{NABU} 1992/103.
Regulating Dairy Productivity in the Ur III Period

recently the only known record from the province of Umma which shared some features with the Ur accounts treated by T. Gomi. The following large Umma text, published by David Owen, is thus, as the only known account which deals exclusively with an economic unit in that city organized around the exploitation of milk cows and which, in contrast to the Girsu accounts, contains key information concerning nearly all known *termini technici* of debits and credits in Ur III dairy administration, of overriding importance.

### § 4.2.1. Debits in MVN 15, 108

MVN 15, 108 (see figures 7-15), is a large consolidated account concerning the activities of an official named Atu, supervisor (šūš) of cattle herders in Umma. The text, dated to the third regnal year of the king...
Figure 7a: Copy of the account MIV 15, 108, obverse face, reconstructed by the author (1:1, drawn after the original of D. Owen). Shaded areas are not preserved on the tablet; with the exception of reverse ii 10-11 (the signs SU+NIGIN representing 'grand total' are possibly to be corrected to SU+NIGIN or KIJB BA), however, the restorations are secure.
Figure 7b: Reconstructed copy of the account MVN 15, 108, reverse face.
Figure 8: Transliteration of the account MVN 15, 108.
Regulating Dairy Productivity in the Ur III Period

0;2,3,8 1/5 slla 1 nun
0;0,4,6 1/5 slla ga gazi
60) 0;1,1,2 slla ga UDgunâa
    gri Ur.ŠAKAN
1;3,0,8 slla ga SIG₃-a gur
0;0,5,4 slla ga UDgunâa
    gri Kaš, zii ga ba.ia. a nu ko gu za 4En.lJlid ba.dfm (Amar-Suen 3)

iii 1/5 ma. na 1 gin kš bab[bar]
    a.ri.1.kam
2/5 ma. na 8 1/2 gin kš.[babbar]a
    a.ri.2.kam
70) gri Lú.kal.la
9 gin kš.[babbar]\a
    gri Ur.Šíra 8a₃₃, du[b.ba]
9 1/5 gin 15 še [ki babbar]\a
    gri Lú.Zababal]\a
sag. na, bi 1 1/5 gin 2/5 še kš.[babbar]\a
1.num.bi 2:4,5,5 [2/5 \ slla] 12 gin gur
0,0",1,4' slla l nun
[0,0,2,2 slla ga.SIG₃-a]
    [sa.du, a.ru].1.kam
80) [0,0,0,3 \ slla] l nun
"[sa.dun] (a.ru).2.kam
0;1,0 ga SIG₃-a gibil.še
    kš.še.de.ia lugal Umrmu₃,še gin.na
kšilib. bi 4,šam
gu Ur. Lú.kul.la gš.gā.dam
0;1,1,8 1/5 slla l nun
0;3,0,5 1/5 slla ga UDgunâa
0;0,0,7 slla ga SIG₃-a
    kšilib Lú.kul.la
90) gu Ur.e₃, o gš.gā.dam
3;1,3,3 slla 2 1/2 gin l nun gur
1;3,5,2 1/5 slla ga gazi g[ur]
4;3,2,3 1/5 slla ga UDgunâa g[ur]
3;3,5 ga SIG₃-a gu[r]\a
    kšilib Ur.Šul.pa.ĕ
    (uninscribed)
iv (uninscribed)
ŠU+NGIN 7,3,4,6 1/5 slla 4 1/2 gin l nun gur
ŠU+NGIN 2;0,0,8 slla 10 gin ga guzi gur
100) ga.UDgunâ.bi 3;0,1,2 slla 15 gin
ŠO+NGIN 6;1,1,9 ga UDgunâ gur
ŠO+NGIN 7;1,5,5 slla ga SIG₃-a gur
1.num.bi 0;1,5/5 slla 5 gin
 ga.UDgunâ.bi 0;2,4,6 slla 7 1/5 g[f]u
    (uninscribed)
[ŠU+NGIN 6]+2;0,3,7 1/5 slla 9 1/2 gin l nun gur
[ŠO+NGIN 7]+2;4,1,7 1/5 slla 2 1/2 gin ga UDgunâ gur
zi, ga.lm
LÁ+NT₃ 3;3,5,7 1/5 slla 8 gin l nun gur
110) 10;4,3,1 1/5 slla 5 1/2 gin ga UDgunâ gur
LÁ+NT₄.lm
    mš.g.kap₃.a[k] 7'1 nun ga ḫAR
    a.lu ššš
    (uninscribed)
    mu kš gu za 4En.lJlid ba.dfm (Amar-Suen 3)
Amar-Suen, can be shown to be comparable to the Ur text UET 3, 1215, cited above. The account consists of an initial debits section (obv. i 1–ii 48), a credits section (obv. ii 49–rev. iv 108) and the balance and colophon (rev. iv 109-115).

Although the milk cows concerned are nowhere mentioned in the text in the clear form attested in UET 3, 1215, there is no doubt that MVN 15, 108, is indeed a dairy account. The debits section of the account records first in obv. i 1-3 notations representing large arrears of butter oil and cheese carried over from the preceding year Amar-Suen 2 (the term s. l. tum here corresponds to LA+NI from the balance of the previous account)\(^5\). In each of 13 following three-line subsections amounts of \(\text{nun}\) and \(\text{uqgunu}\) are registered together with an entry \(\text{ki PN.ta, 'from PN'}.\) Since in each case the numerical notations are 'nice numbers' divisible by 5 and \(7\frac{1}{2}\), respectively, it is obvious that the individuals named are herders and that the numbers represent the size of their dairy herds, recorded at the beginning of the year, multiplied by the amount of butter oil and cheese to be delivered per milk cow. Thus in the first such entry (see figure 9), the herder Lu-Zabala is to deliver \(1;1,5,5 = 415\) slla \(\text{nun}\) and \(2;0,2,2\frac{1}{2} = 622\frac{1}{2}\) slla \(\text{ga uqgunu}\). The first number divided by 5, and the second divided by \(7\frac{1}{2}\), equal 83; 83 is consequently the number of milk cows under the direct charge of this herder. The same relationships between amounts of butter oil and cheese and implicit numbers of milk cows hold for the following 12 individuals recorded obv. i 7–ii 43 (figure 10).

\(32\) slla \(\text{nun}\) and \(45\) slla \(\text{ga uqgunu}\) in the debit account of the supervisor Ur-e'e, and who, according to the seal of MVN 16, 965, 1103, etc. bore the full name En-kal\(^6\) (see W. Hallo, *HUCa* 29, 87\(^7\), with reference to N. Schneider, *OrSP* 16, 305).\(^7\)

\(^5\) The inclusion of the qualification sag.nig.gur\(\text{ru}:\),,ra.kam at the end of debits sections of Ur III accounts is optional; the debits of MVN 15, 108, conclude with the totals of butter oil and cheese recorded in the section. See for the same account format in Girau the texts cited above, fnn. 12 and 49. The closest parallel to MVN 15, 108, from the Girau texts is offered by CT 5, pls. 25-26, BM 18346, a debit account of dairy norms imposed on districts within this province. For instance, the first entries obv. i 1-3: \(0;4,3\) \(\text{nun}\) ab lagal / \(0;4,3\) ga t\(\text{ug}\) ar lagal / Alia dune Ad.da, \(4\) (barig) \(3\) (ban) butter oil from cow (milk, measured according to the) royal (standard), \(4\) (barig) \(3\) (ban) dried cheese (measured according to the) royal (standard), (from Alia, son of Adda\(^7\)), register a delivery requirement of \(270\) slla each of butter oil and cheese imposed on the herder Alia. These and all subsequent notations are evenly divisible by 10 slla, so that in our example Alia will have been entrusted by central authorities in Girau (obv. iii 5) with the care of a herd including 27 adult cows.

\(^6\) See *Ur III-Fischerei* 25-38. According to the silver equivalencies known for butter oil and cheese in Umma (see below, § 5), the two entries of these arrears corresponded to slightly more than 191 shekels (1910\% slla = 10) and 21\% shekels (3918\% slla = 180), respectively. Although judging from this text approximately half of these arrears may have been covered by deliveries of dairy products or silver in the early part of Amar-Suen 3, since the final deficit corresponds to a silver equivalent of ca. 132 shekels, the size of the debt owed by the supervisor Atu to the central administration was substantial. For an idea of the relative sizes of these debts and the consequences they had for those involved see *Ur III-Fischerei* 47-48\(^6\), and fn. 81 below.
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Figure 9: Major components of the debits section of MVN 15, 108, consisting of arrears from the preceding accounting year Amar-Suen 2, of expected deliveries of dairy products for Amar-Suen 3, and of presumable surcharges.

The debits section of MVN 15, 108, is completed with two entries representing amounts of butter oil which were thus added to the common load of the supervisor Atu. The second of these entries contains a notation representing 22½ slla of butter oil for the 'magur boat'. This amount of oil might have been required payment of the supervisor for the use of such a barge for the transportation of dairy products or animals, or it could have represented oil required for the sealing of the hull of such a boat. Why a high administrator of cattle would be required to submit payments for this latter work is not obvious.

57 Such payments are as a rule in grain, reckoning a given amount of grain per boat capacity and transportation distance. For instance, the texts P. Michalowski, OrAnt 16 (1977) 292-293, ASM 2080, and M. Sigrist, AUCT 2, 307, base their calculations on a rental rate of 1 slla barley per gur boat capacity per danna traveled. Other texts, for example, AnOr 1, 61, 290 (see D. Charpin and J.-M. Durand, Documents édifiiformes de Strasbourg [Paris 1981; in the following DCS] pl. 67, Sch. 61, and pl. 78, 290), G. Contenau, Umma sous la dynastie d'Ur (Paris 1916) 49, MVN 16, 730, etc., which register the compensation paid the boatmen involved, seem to follow no such established payment rules.

58 This seems the more likely alternative. The Umma text OrSP 47-49, 420 (dated to Amar-Suen 9/10), a receipt for 3 bān of 1 nun mā.gur, Ṣārā / ba.su.a.bi.3, “butter oil with which the magur of Sarā will be sealed”, demonstrates that dairy oil was used as a wood sealant for ostentatious cult vessels, the same as the less highly valued fish oil for mundane boats registered, for example, in the Umma text TCL 5, 5673. Since according to this text fish oil was used at a rate of 1 slla per 2 gur boat capacity (and compare the similar relationships between the sealant fish oil and the caulking agent bitumen in the ship-building account CT 7, pl. 31, BM 18390, from Girsu), the 22½ slla of dairy oil recorded in MVN 15, 108, would suffice to seal the hull of a boat of approximately 45 gur capacity.
Deficit (LĀ+Nī = šilītarum) from the preceding year Amar-Suen 2:

\[
\begin{align*}
6;1,5 & \quad 17 \ 1/2 \ \text{šilītarum} \\
13;0,1,8 & \quad 48 \ \text{gūnu}
\end{align*}
\]

Expected performance of the dairy cattle assigned to herders under the supervisor Au

<table>
<thead>
<tr>
<th>(milk cows)</th>
<th>(x_1) = (1) nun delivery</th>
<th>(x_2) = (2) nun delivery</th>
<th>(x_3) = (3) gūnu delivery</th>
<th>from the cowherd:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(33)</td>
<td>1;1,5,5</td>
<td>2;0,2,2,1/2</td>
<td></td>
<td>Lu-Zabala</td>
</tr>
<tr>
<td>(61)</td>
<td>1;0,0,5</td>
<td>1;2,3,7,1/2</td>
<td></td>
<td>Ur-Ma'lī</td>
</tr>
<tr>
<td>(41)</td>
<td>0;3,2,5</td>
<td>1;0,0,7,1/2</td>
<td></td>
<td>Lu-kīšu</td>
</tr>
<tr>
<td>(24)</td>
<td>0;2,0</td>
<td>0;3,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(17)</td>
<td>0;2,1,2</td>
<td>0;2,0,7,1/2</td>
<td></td>
<td>Ur-Ma'mī</td>
</tr>
<tr>
<td>(15)</td>
<td>0;1,1,5</td>
<td>0;1,5,2,1/2</td>
<td></td>
<td>Ur-Ninī</td>
</tr>
<tr>
<td>(14)</td>
<td>0;1,1</td>
<td>0;1,4,5</td>
<td></td>
<td>Uš</td>
</tr>
<tr>
<td>(13)</td>
<td>0;1,0,5</td>
<td>0;1,3,7,1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10)</td>
<td>0;0,5</td>
<td>0;1,1,5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10)</td>
<td>0;0,5</td>
<td>0;1,1,5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>0;0,4</td>
<td>0;1,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>0;0,4</td>
<td>0;1,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>0;0,2</td>
<td>0;0,3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(308)</td>
<td>5;0,4</td>
<td>7;3,3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{Zī'-GīRGUNUNI:} \ 5;0,4 \ (\text{total of expected dairy fat } 1 \ \text{nun}) \div 15 = 0;1,4,2 \ 2/3
\]

\[
0;0,2,2,1/2 \ \text{sila} \ 1 \ \text{mā.gūru-ra} \ (\text{barley rental, converted into } 1 \ \text{nun, or used to treat hull?})
\]

\[
\begin{align*}
\text{1 nun} & \quad 6;1,5 \quad 17 \ 1/2 \ \text{gīnu} \\
\text{debit} & \quad 5;0,4 \\
\text{Zī'-GīRGUNUNI} & \quad 0;1,4,2 \ 40 \\
\text{mā.gūru-ra} & \quad 0;0,2,2 \ 30
\end{align*}
\]

\[
\begin{align*}
\text{Totals:} & \quad 11;4,3,5 \ 27 \ 1/2 \ \text{gīnu} \\
\text{gūnu} & \quad 13;0,1,8 \ 48 \ \text{gīnu} \\
\text{sum} & \quad 7;3,3
\end{align*}
\]

Figure 10: Table of the individual entries of the debits section of MVN 15, 108, with summations of the dairy products 1 nun and gūnu (entries concerning delivery requirements of the individual herders have been listed according to size of presumed herds).

The first of the final debits entries records an amount of nun oil described as ‘the zī'-GīRGUNUNI involved’. A comparison of the amount of

\[\text{The sign combination was read} \ \text{sū-gi-r in Y. Nakahara, The Sumerian Tablets in the Imperial University of Kyoto (Kyoto 1928) no. 19, sīg-mū in SET 130, then read zī mū and interpreted by M. Stol, BSA 7, 103, as ‘flour (and) salt’, in RIA 8, 196, apparently following a discussion of the term at the 1992 Barcelona meeting of the Sumerian Agriculture Group with W. Heimpel, ‘flour-salt’ (presumably meaning ‘rock salt’) added to the butter oil. Recollation by K. Hillard of the text SET 130, on which Heimpel seems to have based his reading, has shown that the signs in line 116 and 134 are in fact sū.gūru-ri, as is also found in the texts Kyoto 19, and J.-M. Durand, Documents cunéiformes de la IVe Section de l’École pratique des Hautes Études 1 (Geneva/Paris 1982) 417, cited below. These readings make suspect the copy and transliteration, respectively, of the references to zī in the texts MVN 15, 108, and Umma.} \]
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102½ sīla with the total amount of butter oil expected of the 13 named debit-herders of 5;0,4 = 1540 sīla (see figure 10) demonstrates that the oil qualified ‘its zīl.gīr.gumū’ was exactly ⅝ of the total of dairy oil set as the delivery quota for 308 milk cows in the accounting year involved, just as was the case with oil qualified šu.gīr.gumū in the account SET 130 seen above. In discussing the meaning of this sign combination, it must be stressed that, in accord with all we know about neo-Sumerian running accounts, the debits represented essentially artificial administrative quantities.

It thus makes no sense to speak of a product zīl.(or šu).gīr.gumū which ‘could be added to the ghee’ unless at the least zīl.gīr.gumū is found in contexts identifying it as something other than an administrative measure. Of the references known to me — all from Umma dating to Amar-Suen 3 through 8 —, this sign combination always represents an administrative measure of ⅝ of an amount of butter oil either from cows or from nanny goats and is never attested referring itself to a real product, but rather, if in an account, appears only in the debits section:

Y. Nakahara, Kyoto 19 (Amar-Suen 5)

the calculations:
i 6ff. 4 sīla 10 gin i nun
šu.gīr.gumū.bi 16½ gin

... nidba ʾEn.līl.lā

F. Yuldiz and Gomi T., Umma 3, 1908 (Amar-Suen 8)
i 1ff. 4 sīla 10 gin i nun
zīl.gīr.gumū.bi 16½ gin

... nidba ʾEn.līl

J.-M. Durand, Documents cunéiformes 417 (Amar-Suen 4)
i 7-8 0;3,0 i nun (sā.du, for one year = ½ sīla per day)
šu.gīr.gumū.bi 0;0,1,2 sīla
3 barīg + 15 = 12 sīla

i 11-12 0;0,1,5 sīla i nū[n] (sā.du, for one month = ½ sīla per day)
šu.gīr.gumū.bi 1 sīla
15 sīla + 15 = 1 sīla

3, 1908. The matter is further confused by the fact that after having confirmed the new reading of the SET 130 sign combination, Hilliard inspected the entries cited to mun, ‘salt’, in D. Snell, Ledgers and Prices 157-158, and found all to be gīr.gumū; see ASJ 16, 309, n.1. This product, not salt, is according to its position in the trade agent texts a type of resin (note that for instance in TCL 5, 6037, this gīr.gumū is found in obv. iv 18-19 among substances known to be resins and essences in a section following one qualified obv. iii 12 as nīg.kā, mun gazi ʾug. ā gā.gā.dān, ‘Account of salt and gazi, to be carried over to the debts (account of the trade agents)'), but need not be connected to our zīl/mun.

* Even in the case of the trade agent accounts, the domestic products listed in the debit sections are always lost in silver equivalents and are thus no longer real products. This point is made sufficiently clear with the mixing in debit totals of silver equivalents of superficially real products with arrears equivalents which unquestionably represent debt and nothing comparable to ‘stock on hand’.

* M. Stol, RIA 8, 196, reading zl.mun.
SET 130 (Amar-Suen 4; see figure 6 above)
part of debit (sag.nig.gur.usa.ta.aka)
total: 0;1,5,2½
iii 116 šu.girgunu l.nun.bi 7½ sila
part of debit
total: 1;0,1,5
iii 134 šu.girgunu l.nun.bi 0;0,2,1
MVN 15, 108 (Amar-Suen 3; see figure 10)
part of debit
total: (5;0,1 nun gur)
ii 44 zif.girgunu.bi 0;1,4,2½
milk-producing nanny goats
(225 ud₃ × ½ = 112½ sila)
112½ sila + 15 = 7½
milk-producing cows
(63 ab × 5 = 315 sila)
315 sila + 15 = 21
Milk-producing nanny goats
(225 ud₃ × ½ = 112½ sila)
315 sila + 15 = 21
milk-producing cows
(308 × 5 = 1540 sila)
1540 sila + 15 = 102½
The accounting contexts of this sign combination — its qualification of a cultic sacrifice in the first two texts is entirely unclear — are suggestive more of an administrative tax or 'adjustment' against the interests of the supervisor concerned, comparable to the saggiliš discussed in a masterful article by K. Veenhof, than of an object designation⁶².

§ 4.2.2. Credits in MVN 15 108
Real object designations and real transactions, on the other hand, are registered in the credits section of MVN 15, 108 (see figures 11-12). Transactions of this sort consist on the whole in the movement and receipt of goods or services and are recorded in separate texts which have been sealed and dated by a receiving agent. Numerous Ur III accounts demonstrate how this was done: the scribe must gather and sort all receipts (šu b a.ti or i.dab texts) issued by an official, concerning whom credits — deliveries of goods or services to temple households, to the households of the ensi or other high state officials — are being consolidated. He then enters the essential information of these texts into his ledger, noting whether the goods were delivered to a transferring agent and thus qualified in the account as giri (cor-

⁶² See K. Veenhof, "SAG.GILA = saggilu, ‘Difference Assessed’ on Measuring and Accounting in Some Old Babylonian Texts", in: J.-M. Durand and J.-R. Kupper, eds., Miscellanea Babylonica (= Pesschrieff Bilot; Paris 1985) 285-306. One might on the other hand speculate that managers transferred to the herders a set quantity of condiments — for instance, salt or the gazi discussed below — necessary for the production of particular dairy products, and that these were reckoned in value units equivalent to measures of butter fat. In the case of gazi, for every 150 sila of i nun required of the herders, 300 sila of gazi might have been transferred to their stores by state agents, since 150 × ½ = 10 sila l nun, and 10 sila l nun and 300 sila gazi were both equivalent to 1 shekel of silver (see below, § 5). The paucity of planned dairy production accounts from the Ur III period, however, makes it difficult to examine the probability of a relationship between the possible products represented by butter fat value units qualified zil³ušu.činguni in the debits, and the amounts of derived dairy products in the credits sections of such accounts; even if it could be demonstrated that no relationship obtained between the two, the inclusion of set amounts of foreign products in the debits of dairy accounts would not preclude their being disposed of in a fashion other than in the processing of specific dairy products.
Regulating Dairy Productivity in the Ur III Period

<table>
<thead>
<tr>
<th>Deliveries of Dairy Products to Transferring Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>1</td>
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<tr>
<td>1</td>
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<tr>
<td>70</td>
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<table>
<thead>
<tr>
<th>Deliveries of Silver to Transferring Agents</th>
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<tr>
<td>iiii</td>
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<tr>
<td>70</td>
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<tr>
<td>9</td>
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<tr>
<td>9</td>
</tr>
<tr>
<td>12</td>
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<table>
<thead>
<tr>
<th>Deliveries of Dairy Products to Receiving Agents</th>
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</thead>
<tbody>
<tr>
<td>90</td>
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<tr>
<td>90</td>
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<tr>
<td>90</td>
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<td>90</td>
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<td>90</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Totals and Equivalents of Dairy Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
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<td>100</td>
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<td>100</td>
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<td>100</td>
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<table>
<thead>
<tr>
<th>Consolidated Totals of Dairy Product Deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
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<tr>
<td>100</td>
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<tr>
<td>100</td>
</tr>
</tbody>
</table>

Figure 11: Major components of the credits section of MVN 15, 108. Silver deliveries to transferring agents were converted into butter oil (1 nun) at a rate of 10 slāl per shekel (thus a total of nearly 89 1/2 slāl of silver, x 10 = 895 52/60 slāl a nun).
responding to an i.dab₂ text)⁶³ or whether the receiving agent was the ultimate destination of the goods who thus issued a sealed receipt, recorded in the accounts as kisib (corresponding to a šu ba.ti text).

The first two receiving agents (see figure 11) recorded in the credits section of MVN 15, 108, for instance, are qualified giri and so identified as officials who assumed responsibility for the products listed and who transferred them on to other economic units, in this case into the system of internal exchange known as bāla⁶⁴. The dairy products were delivered as probable contributions of the Umma province to this system for the years Amar-Suen 2, that is, the year preceding that of this account, and Amar-Suen 3, all deliveries however made during the latter year and into the hands of the same two officials Ur-Sakan and Kaš.

<table>
<thead>
<tr>
<th>1 nun</th>
<th>ga gazi</th>
<th>ga UDgunū</th>
<th>ga SIG₃,₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>0;3,0,4</td>
<td>0;0,2,9</td>
<td>0;2,4,4</td>
<td>1;3,2,8</td>
</tr>
<tr>
<td>0;2,3,8 20</td>
<td>0;0,4,6 20</td>
<td>0;1,1,2</td>
<td>1;3,0,8</td>
</tr>
<tr>
<td>2;4,5,5 52</td>
<td>0;0,1,4</td>
<td>0;0,2,2</td>
<td></td>
</tr>
<tr>
<td>0;0,0,3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0;1,1,8 30</td>
<td>0;3,0,5 40</td>
<td>0;0,0,7</td>
<td></td>
</tr>
<tr>
<td>3;1,3,3 2 ½₂</td>
<td>1;3,5,2 50</td>
<td>4;3,2,3 20</td>
<td>3;3,5</td>
</tr>
<tr>
<td>7;3,4,6 44 ½₂</td>
<td>2;0,0,8 10</td>
<td>6;1,1,9</td>
<td>7;1,5,5</td>
</tr>
<tr>
<td>ga UDgunū bi (x ½₂);</td>
<td>ga.günū₃.bi (x ½₂);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3;0,1,2 15</td>
<td>3;0,1,2 15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Totals:**

<table>
<thead>
<tr>
<th>1 nun</th>
<th>ga UDgunū</th>
<th>ga SIG₃,₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>7;3,4,6 44 ½₂</td>
<td>6;1,1,9</td>
<td></td>
</tr>
<tr>
<td>0;1,5 45</td>
<td>(ga SIG₃,₄)</td>
<td></td>
</tr>
<tr>
<td>8;0,3,7 29 ½₂</td>
<td>9;4,1,7 22 ½₂</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12: The credits section of MVN 15, 108, listed according to named products. Gazi cheese was converted into dried cheese (ga UDgunū), the postulated soured milk ga SIG₃,₄ into butter oil (1 nun) and dried cheese (ga UDgunū) at the rates noted.

⁶³ See, for example, the i.dab₂ text AnOr 1, 45, cited above, fn. 54, certifying receipt of oxen from Aru by Kaš, who in related accounts is qualified with giri.

⁶⁴ Most recently discussed in Ur III-Fischerei 57, with reference to P. Steinzelner, SAOC 46, 28; W. Sallaberger, Der kultische Kalender der Ur III-Zeit I (Berlin/New York 1993) 32-34.
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Amounts of silver were given the second group of receiving agents, also qualified as giri, by either the supervisor Atu or his herders or representatives (rev. iii 66-76). Since as a bookkeeping mechanism the running account was held in butter oil and cheese, these silver transfers were converted, using the equivalence rate of 10 sīla 1 nun per shekel silver, into the large sum of nearly 3 gur of butter oil. Any of a number of means will have been at the disposal of the cattle supervisor to come into the possession of silver. The most obvious is the dealing for silver of dairy products or of the cattle themselves through the exchange markets in the hands of private dealers or of the state agents known as dam.gār, but less obvious means may have played a substantial role in his liquidity, namely, collection of debts in the form of silver or silver equivalents from his individual herders. Certainly no less than the control mechanisms evident in the Ur text UET 3, 1215, discussed above, running accounts of the production of the supervisor’s herders will have been kept and their individual arrears calculated. Although it is not documented how higher management levels represented by such supervisors as Atu in Umma were able to enforce payment of obligations, this must have been so embedded in the administrative structure that no conflict arose which would have been found in legal documents, so that should the herder Lu-Zabala, for instance, have been unable to deliver in full his obligation of (83 milk cows \( \times 5 = \)) 415 sīla of butter oil and \( (83 \times 7\frac{1}{2}) = 622\frac{1}{2} \) sīla of cheese for the year Amar-Suen 3, he would have owed his supervisor this failing amount, and should the supervisor call in all debts, the herder might have been required to convert by default or sale any valuables in his possession, in the final analysis including members of his household and even himself, into silver to cover the debts involved. If the supervisor Atu — and not

65 The silver entries may be totaled as 21 gīn + 48\% gīn + 9 gīn + 9\% gīn + 1\% gīn \( \frac{3}{5} \) sē = 89\% gīn 15\% sē. This amount of silver is at 10 sīla per shekel very nearly equal to \( (895\% \times 52) = 2;4,5,5 \) 52 gīn of butter oil 1 nun (the assumed capacity notation for 52 gīn, \( \frac{1}{2} \) sīla) 12 gīn, would however be unusual, if not unlikely, for the expected \( \frac{3}{5} \) sīla 2 gīn. Note that the final individual entry of silver, rev. iii 75: sag.na.bi 1\% gīn 1\% sē 4 ku, “the stone ‘head’ involved: 1\% shekel, 1\% grain silver”, refers to a probable adjustment in the weights used to measure the silver. The quantity recorded bears no obvious ‘nice’ relationship with the preceding total of silver notations (very nearly 1:66), nor to partial combinations of the entries (ca. 1:52 for the Lukaiai silver, very nearly 1:14 for the Ur-Sara/Lu-Zabala silver, etc.). See K. Veenhof, *Fs. Birot* 294-95.

66 The text T. Gomi, *SNAT* 382, dated to Amar-Suen 7, is a clear example of how the accounting between Atu and one of his herders took place:

\[
\begin{align*}
0;1,0,7\frac{1}{2} & \text{ sīla } 1 \text{ gīn } 1 \text{ nun} \\
0;2,2,4 & \text{ sīla } 4\% \text{ gīn } \text{ ga } \text{ ungūnī} \\
\text{ si.l[tum] mu en.una₃[gal] 4[nanna] & 1 \text{ (barig) } 7\frac{1}{2} \text{ sīla } 1 \text{ shekel of dairy oil,} \\
0 & 2 \text{ (barig) } 2 \text{ (bān) } 4 \text{ sīla } 4\% \text{ shekels of cheese,} \\
\text{ arrears of the year ‘Enunugal(ana) of Inanna’ (=} \text{ Amar-Suen 5).}
\end{align*}
\]
his herders — were responsible for the arrears, he might himself have been in possession of silver, gained, for example, through personal business, which he could transfer to state ownership to, in effect, partially clear his books.  

The third group of entries in the credits of MVN 15, 108, involves confirmed deliveries of dairy products by the office of Atu to various state agencies. In each case, the account records the receiving agents, all well-known high officials in the Umma administration close to the level of the ensi, and the existence of sealed documents which certify the correctness of the amounts received.

Four dairy products are registered among the credits in this account: beyond the two ‘accounting products’ i nun and ga unguni found also in the debits of the account, two further products designated ga gazi and ga sigi, a. We find in the attestations of these latter products in Ur III accounts the same consistency as with zi7/6tu0.unguni in account debits: they are only found in credits sections and so represent real and not at least potentially artificial dairy products. Quantities of the products ga gazi and ga sigi, a are, moreover, converted into i nun and ga unguni in MVN 15, 108, as well as in other accounts using the same or comparable equivalence values.

Therefrom:
3 shekels of silver,  
1 gur of grain,  
the corresponding dairy fat: 4 (ban),  
did Atu receive.

Deficit: 2 (ban) 7½ sim 1 shekel of dairy oil,  
2 (barig) 4 (ban) 4½ shekels of cheese.

Account of dairy oil  
concerning Budu, the cow herder,  
via Dadaga,  
year: ‘HuHuuri was destroyed’ (Amar-Suen 7).

According to MVN 15, 108, obv. i 31-33, Budu was in Amar-Suen 3 responsible for deliveries from 10 milk cows; SNAT 382 records arrears — amounting to the yearly norm of more than 13 cows — of this herder from Amar-Suen 5, that is, just two years later, which were partially covered with the delivery of grain and silver. That Dadaga acted as transferring agent in the transaction suggests that the grain and silver actually went to repay some of Atu’s debts, since Dadaga is otherwise known as the official who, prior to Gududu, received silver payments, qualified as LA+NI su ga, directly from Atu (see above, § 4.2.1 and fn. 52 and 54; Lukala, who was chiefly responsible for silver transfers in the years Amar-Suen 2 through Sh-Sin 6, was replaced in this function by his cousin Gududu, whose father Dadaga had himself been chief silver agent before Lukala. Dadaga was named ensi of Umma in Sh-Sin 7).

This use of silver is, by the way, known from accounts concerning other economic activities of state households; see, for example, Ur III-Fischerel 127-129, for the transfer of silver in credit sections of fisheries accounts.
Four such conversions are known to me of the product ga gazi into ga udgunu, all from Umma and all at the rate of three units of ga udgunu per two of ga gazi:

\[ \text{SET 130 (Amar-Suen 4) in "credits"} \]
\[ \text{rev. ix 399-400} 0;0,2 \text{ ga gazi} \]
\[ ga.udgunu.bi (20 \times \frac{2}{3} = 30) = 0;0,3 \]
\[ \text{rev. ix 415-16} 0;1,2,5 \text{ sila ga gazi} \]
\[ ga.udgunu.bi (85 \times \frac{2}{3} = 127) = 0;2,0,7 \text{ sila} \]

\[ \text{TCL 5, 6040 (date lost) in "credits"} \]
\[ \text{rev. ix 399-400} 0;0,2 \text{ ga gazi} \]
\[ ga.uogunu.bi (20 \times \frac{2}{3} = 30) = 0;0,3 \]
\[ \text{rev. ix 415-16} 0;1,2,5 \text{ sila ga gazi} \]
\[ ga.uogunu.bi (85 \times \frac{2}{3} = 127) = 0;2,0,7 \text{ sila} \]

\[ \text{SET 130 (Amar-Suen 4) in "credits"} \]
\[ \text{rev. ix 399-400} 0;0,2 \text{ ga gazi} \]
\[ ga.udgunu.bi (20 \times \frac{2}{3} = 30) = 0;0,3 \]
\[ \text{rev. ix 415-16} 0;1,2,5 \text{ sila ga gazi} \]
\[ ga.udgunu.bi (85 \times \frac{2}{3} = 127) = 0;2,0,7 \text{ sila} \]

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\[ \text{rev. ix 415-16} 0;1,2,5 \text{ sila ga gazi} \]
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\[ \text{rev. ix 415-16} 0;1,2,5 \text{ sila ga gazi} \]
\[ ga.uogunu.bi (85 \times \frac{2}{3} = 127) = 0;2,0,7 \text{ sila} \]

The sign combination ga gazi is certainly an abbreviation of ga har(uudgunu)99 gazi and represented a cheese processed with the condiment gazi; one attestation from Girsu suggests salt could also be

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99 See the references for ga har gazi listed by M. Stol, RLA 8, 200 (note that SET 188 derives from Umma and add W. Hallo, JCS 14, 111, no. 15 obv. 7), and BSA 7, 108.

The sign gazi is originally a combination of laoaβ and, inscribed within laoβ, a sign representing a basic unit in the numerical system B* (designated N6, see P. Damerow and R. Englund, "Die Zahlzeichenysteme der archaischen Texte aus Urkak", in: M. Green and H. Nissen, ATU 2, 134-135), attested in Urkak IV and III levels of Urkak (Damerow and Englund, loc. cit.), in Jemdet Nasr (see Englund, MSVO 4, 16 [= ATU 1, 646] obv. iii 1: '2N5) and rev. iii 4: '2N5; MSVO 4, 14 (= ATU 1, 654) obv. i 2). The so-called bisexagesimal system from which B* was derived seems to have been used to qualify amounts of products used as rations (specific measures of grain and dry grain products, fish, cheese); we may suspect this is also the case with B*, characterized by the use of gumified variants of the basic bisexagesimal signs. Unfortunately, notations in this system are, with one or two unclear exceptions, not qualified with ideograms and so remain undeciphered. Nonetheless, the fact that such notations must represent foodstuffs probably widely available in southern Babylonia suggests that the early form of gazi represented a product similar to if not the same as that of later third millennium tradition. The sign itself following the Late Urkak period mutated to a combination ga+zis, but at least in the extended lexical history of the list 'Tribute' (see R. Englund and H. Nissen, ATU 3, 25-29 and 112-120, li. 4/32) its association with the possible condiments munu and galaun remained stable; indeed, the Old Babylonian witness of the list, SLT 42 (+ Ni 1597), registers the corresponding entries with numerical notations which seem to derive from the Babylonian capacity system used in the Ur III period to qualify the product gazi. The product itself remains unidentified despite a long history of research and discussion, possibly made more difficult by a semantic transfer in sign and references in the second millennium. The Akkadian kasā/kasū was in early glossaries (cf. W. Muss-Arnolt, Assyrisch-englisch-deutsches Handwörterbuch 1 [Berlin 1905] 411) equated with cassia; in 1948, A. L. Oppenheim, AOS 32, 7-8 (and, following him, D. Snell, Ledger and Prices 219), after a review of lexical attestations, presumed the Sumerian gazi found in Ur III administrative texts had the same referent as its Akkadian counterpart. At the same
added to the cheese. The relationship of 2:3 between this flavored cheese and ga ḫa-ra/udquna must be an exchange constant and not an indication of the amount of ga ḫa-ra/udquna which could be processed from a liquid product ga gazi, since it is improbable that the resulting cheese would have grown by 50% during processing. A recently published text with silver equivalencies of dairy products, moreover, tends to support an exchange mechanism evidenced by the conversions in dairy accounts, for which see below, § 5. That herders should have delivered this product is not surprising, since gazi must have been freely accessible through normal exchange mechanisms, for example, directly from harvesters from Umma.

The product ga siq. a seems on the other hand to have been converted into dairy oil and cheese both as a value constant and a constant resulting from actual processing. The first to recognize the importance of the time, R. Campbell Thompson proposed in A Dictionary of Assyrian Botany (London 1949) 192-194 to identify late Babylonian katsa with the husks of the carob (Ceratonia siliqua), Akk. harību. B. Landsberger and O. Gurney in AFO 18 (1957-58) 337-338, and an unusually irresolute Landsberger in JCS 21 (1967) 151-152, ventured instead the translation 'mustard', later doubted, among other reasons because it formed a large component in some beer recipes of the first millennium; see M. Civil, Studies Presented to A. Leo Oppenheim (Chicago 1964) 77, and the discussion in CAD, vol. K s.v. (for the associated plant za. ẖi.11/sabī, s. M. Stol, "Cress and its Mustard", JESOL 28 [1983-1984] 24-32). Following the discussion at the 1981 meeting of the RAI in Vienna by M. Geller of the kasi used in beer, and his identification of the condiment with a type of beet ("A Recipe against Bu̇dēm", AFO Beiheft 19 [1982] 192-197), P. Steinkeller presented an as yet unpublished paper at the 1983 meeting in Baltimore of the American Oriental Society entitled "The Mesopotamian Spice Plant gazi/ kasi: A New Interpretation" (referred to in his article "The Foresters of Umma: Toward a Definition of Ur III Labor," in: M. Powell, ed., Labor in the Ancient Near East [AOS 68; New Haven/London 1987] 92) in which he proposed an identification of the spice with wild licorice (his identification has been hesitantly accepted by the PISD group, see volume B, 153, s.x. bi.1, gazi). I have no access to this paper and so cannot judge its merits; note that, since Campbell Thompson, DAB 133 (cf. AHw 290), and as W. Lambert noted in Quaderni di Semitistica 18 (1992) 59, with reference to Eblaic ẖuṣ.š(es-nām), ᵃ-si/tu-su-t, licorice is believed to be Akanadian ᵃ-sū, later Sumerian ᵃ-u.i₃ (gš.mu₃.gš₃.s₃), and see the suggestions of M. Civil, in: P. Rochberg-Halton, ed., Festschrift Reitner (AOS 67; New Haven 1987) 45, that ᵃ-su-na₃/mu₃₃/₃₅ may be the older form of this 'licorice', and of M. Stol, RIA 8, 200, that gazi is a dodder (already refuted by Landsberger and Gurney, AFO 18, 337). Note that according to literature cited by M. Abdalla, JAAS 6/2, 26, the sumac Rhhus hirta is used in the Near East as a seasoning in dried cheese. For a discussion of the common Sumerian designation of spices, mun gazi, s. K. Mieckawa, "Cultivation of Legumes and mun-gazi Plants in Ur III Girum", BSï 2 (1985) 97-118.

²⁰ MVN 2, 130 obv. 1-3: 4:0,0 ga še.a gurugal / kl Ur*qigir šuk.ta / ga mun gazi.bē, "4 gur of soured milk (measured with the) royal (measure), from the cattle supervisor Urqigir, for sal-gazi cheese". The qualification mun gazi might, however, represent a general designation 'spiced', 'seasoned'; see the preceding fn.

²¹ See P. Steinkeller, AOS 68, 94, with reference to Nik. 2, 401. Steinkeller's discussion AOS 68, 96, of the 'sale' of gazi to 'private entrepreneurs' dam.gar is, however, based on an illogical representation of kū gazi (cf. Ur III-Fischeire 162-164) and of the accounting formats used in his forestry texts, in particular his no. 19, MVN 1, 106, pp. 104-105 ('aseta' = debits, 'expenditures' = credits, 'positive/negative balance' = deficit/surplus; note that the 150 šila of gazi recorded in the debits section of the account, obv. 14, and in BIN 5, 8, p.asi₃₃, represent the partial expected yearly performance of each of the named workers).
latter fact was M. Stol, who also noted the likelihood that ga șe a was a variant writing of ga șe e. a attested mainly in Umma.79 An examination of extant references to both products makes the interchangeability of the two certain and so supports the proposed reading of ga șe , a = ga șe, a 74. Although the exact meaning of the phrase remains elusive, technical considerations make Stol’s ad sensum translation ‘sour milk’ preferable. In the first place, ga șe a is in accounts from Umma and Ur found only in the credits sections and so represents a real dairy product. Secondly, it is converted into i n u n and into ga țar/udgunâ at rates entirely consonant with those expected to result from the processing of soured milk into butter oil and cheese 76. These conversions would further be very difficult to

70 BSA 7, 100-101; RIA 8, 193 (appeared in 1994, manuscript submitted in March 1991 [see BSA 7, 99]; the point was missed by T. Gomi, who following A. L. Oppenheim [see fn. 41 above] refers in JSJ 23, 1-32, to an impossible ga șe a, a cheese). A reading ga șe (s țe), a was suggested to Stol by Th. Krispijn, based on the identification of the variant reading sțe, a = s e , a 74 by P. Steinkeller in ASJ 7 (1985) 195 (s e, a is possibly a typographical error in Steinkeller’s article, meaning s țe, a = s e , a = s țe, a), but certainly not s e, a as proposed by Stol, RIA 8, 193, which is a reading of the sign țoska; the sign readings in both articles should be corrected to s e, a, t e, a. Stol may be thinking of a nominalized intransitive “which has sat out” with his translation of sour milk; however, this interpretation would not be in accord with Steinkeller’s understanding of the verb as a plural stem of ti, “to live” (but note the OBGT 1 entries 647-655 with the apparent singular stem s e, a cited by M. Yoshikawa, ASJ 3 [1981] 117). For a possible meaning “to cause to cream” of the verb see fn. 76 below.

71 Compare, for example, the pertinent references in the Umma texts ȘET 130, TCL 5, 6040 and MVN 15, 108, cited below.

72 The likelihood that s e, a represents a verbal adjective of a transitive verb /s e / is supported by a literary reference offered by S. Kramer, PAS 3 107 (1963) 505, to ga șe (s țe), a made of ga u d a, goat’s milk, and to the imperative form s e a (s țe, a), a.m.a. b, “let (the milk) cream” (IŠET 2, 15-16, Ni. 9602 lii 18; see the following fn.).

73 See the discussion above, fnn. 7-10. Conversions in accounts from the two cities Umma and Ur are based on a fat content of ga șe a, a of between 5 and 6% %, respectively. These figures would be too high for fresh milk (since the milk itself only appears in credits sections of accounts, a manipulation by state bookkeepers of expected fat content to a higher figure is out of the question), and even though soured milk will have lost some percentage of its water content, dependent on whether and how long it had been heated in initial processing, this seems unlikely to account for a fat content twice that expected of modern cows. For this reason, M. Teuber has suggested to me that the designation ga șe a, a might represent the top half of fresh milk kept in containers over-night, into which the cream had separated and which had thus ‘yellowed’. This interpretation would return the designation s țe/șe to a possible translation “to cause to cream”, literally “to cause to be yellow” (Akkadian warrum), with, however, two complications. In the first place, the amount of casein in the creamed milk would have been proportionately reduced according to the amount of milk considered ga șe a, a, making our hypothetical calculation of the amount of dried cheese which can be processed from 100 liters of sour milk less stable. Textual evidence, in the second, suggests that (warrum) corresponded only to Sumarian s e a(g) in the Ur III, as it did in the Old Babylonian period (both hamtu and marâli; cf. G. Gragg, TCS 2, 177-178; H. Stieble, FAOS 1, 47; S. Cohen, ELA 473; P. Michalowski, Fr. & E. Kutscher 124-125v; Gudea Cyls. A xxx 10 and B xvi 20). Note that receipts recording the delivery of amounts of ga șe a, a in Umma are on the whole dated, if at all, to the final and first months of the year (for example, MVN 16, 725 [Amar-Suen 6/11]; Umma 3, 1651 [Sî-Sîn 4/v] and N. Ferde, Nebraska 20 [Sulig 4/iv]); however, the scattered dates of comparable texts from Drehem (for example, S. Langdon, TAD 7 [Ibbi-Sîn 2/x], BIN 3, 586 [Sî-Sîn 9/vi/21], and TCL 2, 5482 [Ibbi-Sîn 1/vii/13; rev. ii 5: 3 sîla ga șe a u.d u a ur.gl., ra/]) would seem to exclude the assumption that
explain as value equivalents, since such bookkeeping acrobatics would unnecessarily complicate accounts and since we know for example with silver and with ga gazi that as a rule one or the other of the 'accounting products' was chosen in value conversions. Finally, the two known ga $e_{\text{v}}$, a : butter oil conversion rates of 20:1 and 15:1 were consistently used in Umma and in Ur, respectively; in both cities, to the amount of butter oil expected to derive from a delivered amount of ga $e_{\text{v}}$, a a fixed measure of cheese is added, at exactly the same ratio of 2:3 as that recorded in the debits sections of dairy accounts in the yearly delivery norms of milk cows (5 and 7½ sila)\(^17\) and nanny goats (½ and ½ or ½ and ¾ sila)\(^18\) in the cities Umma, Drehem and Ur.

\[ \text{ga } e_{\text{v}}, \text{ a : } \text{lunun } = 20 : 1 \text{ in Umma} \]

\[ \text{SET 130 (Amar-Suen 4) in "credits" (from cows and/or nanny goats?; see figure 6 above)} \]

\[ \text{rev. ix 401-5} \]

\[ \text{0;1,2,6 sila ga } \text{s}e_a \]

\[ \text{i.nun.bi (86 + 20 = ) 4% sila} \]

\[ \text{ga.udgun\u0107.bi (4\% \times \frac{1}{2} = ) 6\% sila} \]

\[ \text{rev. ix 419-23} \]

\[ \text{0;0,0,7 sila ga } \text{s}e_a \]

\[ \text{i.nun.bi (7 + 20 = ) \% sila} \]

\[ \text{ga.udgun\u0107.bi (\% \times \frac{1}{2} = ) \% sila} \]

\[ \text{TCL 5, 6040 (date lost) in "credits" (from cows)} \]

\[ \text{rev. ix 9-11} \]

\[ \text{SU+NIGIN 0;0,0,2 sila ga } \text{s}e_{(sro7)}a \]

\[ \text{i.nun.bi (2 + 20 = ) \% sila} \]

\[ \text{ga.udgun\u0107.bi (\% \times \frac{1}{2} = ) \% sila} \]

such deliveries might be used to determine the real period of lactation in Ur III Babylonia.

See A. Poyck, Farm Studies in Iraq (Wageningen 1962) 53, for modern data.

\(^17\)The conversion rates on which the Ur texts were based were noted (as 1:15 for ghee and 1:10 for cheese) but incorrectly analyzed by T. Gomi, JESHO 23, 1-42. M. Stol noted these rates in BSA 7, 101, and added the rates of 1:20 and 1:13, respectively, for the Umma text SET 130, but did not calculate correctly (RIA 8, 193) the rates in the texts MVN 15, 108, and TCL 5, 6040; all three are 1:20 for butter oil : soured milk and (1:20) \times \frac{1}{2} for cheese. It needs to be emphasized that book-keepers used 'nice numbers' in administrative texts and never exhibited the playful weakness of Old Babylonian scribes for calculations in mathematical exercises with such sexagesimally irreducible numbers as 7, 11, and 13, discussed by J. Hoyrup, "Remarkable Numbers" in Old Babylonian Mathematical Texts: A Note on the Psychology of Numbers, JNES 52 (1993) 281-286 (Hoyrup speculated p. 286 that Ur III accountants may have been using these numbers, given the fact that at least the number 7 had already been singled out for mathematical exercises in the Parah period; however, none of the ca. 35,000 published Ur III texts is known to substantiate this belief). Certainly the amount of butter oil derived from the soured milk was calculated first, and this result increased by \frac{1}{2} to find the amount of processed cheese. Thus also 1:10 for cheese in Ur is really (1:15) \times \frac{1}{2}.

\(^18\)See above, fn. 45, the texts cited by M. Stol, RIA 8, 194, § 6.2, and, for a rate of \frac{1}{5} and \frac{1}{5} in Girsu, TCTT 1, 878 (cited above, fn. 12; PAOS 16, 947, is, as Gomi suspected, almost certainly a Girsu text).
Regulating Dairy Productivity in the Ur III Period

MVN 15, 108 (Amar-Suen 3) in “credits” (from cows; see figure 12)
rev. iv 102-104  8U+NIGIN 7;1,5,5 sila ga še₄(sig₄)a
i.nun.bi (2215 + 20 = 110 ¼ =) 0;1,5,½ sila
gu.udgum. bi (110 ¼ × 3 = 166 ¼ =) 0;2,4,6 ¼ sila

ga še₄(sig₄).a : i nun = 15 : 1 in Ur

UET 3, 1214 (Ibbi-Sin 6) in “credits” (from cows)
i 13’ – ii 1 0;0,4,5 sila ga še₄(sig₄).a
i.bi (45 + 15 =) 3 sila
[ga.(ulbar).bi (3 × ½ =) 4 ½ sila]
ii 6’-8’ 0;0,2 ga še₄(sig₄).a
i.bi (20 + 15 =) 1½ sila
gu.bi (1½ × ½ =) 2 sila

rev. iii 3-5 0;0,5,5 sila ga še₄(sig₄).a
i.bi (35 + 15 =) 2 ½ sila
gu.bi (2½ × ½ =) 3 ½ sila

UET 3, 1215 (Ibbi-Sin 8/i) in “credits” (from cows)
rev. vi 2-4 0;0,2 ga še₄(sig₄).a
i.bi (20 + 15 =) 1½ sila
gu.bi (1½ × ½ =) 2 sila

rev. vii 16’-18’ 0;0,5,5 gīn ga še₄(sig₄).a
i.bi (15½ + 15 =) 1 sila
gu.ulbar.bi (1 x ½ =) ½ sila

UET 3, 1216 (Ibbi-Sin 8/i-vi) in “credits” (from cows)
rev. ili 13-15 0;0,3 ga še₄(sig₄).a
i.bi (30 + 15 =) 2 sila
gu.bi (2 × ½ =) 3 sila

rev. iv 4-6 8U+NIGIN 0;2,3,5 sila ga še₄(sig₄).a
i.bi (155 + 15 =) 0;0,1½ sila
gu.ulbar.bi (10½ × ½ =) 0;0,1½ sila

UET 9, 894 (Ibbi-Sin 8/i-vi; consolidated in 1216) in “credits” (from cows)
i 21-23 [0;0,1,5,5 sila ga še₄(sig₄).a]
[i.bi] (15 + 15 =) 1 [sila]
[ga.bi] (1 × ½ =) ½ [sila]

rev. iv 7-9 [8U+NIGIN 0;2,3,5 sila ga še₄(sig₄).a
[8U+NIGIN ]i.nun.bi (155 + 15 =) 0;0,1½ sila
[8U+NIGIN gu.ulbar.bi (10½ × ½ =) 0;0,1½ sila

The purpose of these conversions is the same as that of converting into silver goods dealt for and delivered to the state by dam.gār agents: the mechanism of exchange equivalencies reduced various goods and service to internally common and comparable artificial accounting units and so facilitated record keeping of an increasingly complex administration. It is obvious that the summations of the delivered goods in MVN 15, 108 (rev. iv 106-107; see figure 13), as quantities of i nun and gu udgumü represent artificial accounting units, since the actually delivered gazi cheese...
| Sū+NIGIN 7;3,4,6 1/2 sül 4 1/2 gin 1 nun gur | Total: 2326 49/120 sül butter oil. |
| Sū+NIGIN 2;0,0,8 sül 10 gin ga gazi gur | Total: 608 1/4 sül gazi-cheese, |
| ga UDgunā bi 3;0,1,2 sül 15 gin | (× 3/2) = 912 1/4 sül its cheese. |
| Sū+NIGIN 6;1,1,9 sül ga UDgunā gur | Total: 1879 sül cheese. |
| Sū+NIGIN 7;1,5,5 sül ga SIGa a gur | Total: 2215 sül soured milk, |
| Nun.bi 0;1,5 7/9 sül 5 gin | (+ 20 =) 110 3/4 sül its butter oil, |
| ga UDgunā bi 0;2,4,6 sül 7 1/2 gin | (110 3/4 sül × 3/2 =) 166 1/4 sül its cheese. |
| Sū+NIGIN 8;0,3,7 1/5 sül 9 1/2 gin 1 nun gur | |
| Sū+NIGIN 9;4,1,7 1/5 sül 2 1/2 gin ga UDgunā gur | zi ga âm |

Figure 13: Real dairy products delivered according to the credits section of the account MVN 15, 108, lines 98-108: 1 nun, ga UDgunā, ga gazi, ga SIGa a. Shaded areas indicate the products converted into butter oil and cheese.

and the soured milk ga še₅₄ a were lost in the preceding conversion. These equivalence conversions, found in any number of Ur III accounts, are at the heart of the bookkeeping system of that period.

§ 4.2.3. Balance of MVN 15, 108 (figure 14)

Once the products registered in the credits section of MVN 15, 108, have been converted and consolidated as quantities of butter oil and cheese, these totals are subtracted from the original debits, resulting in the balance of the account. It is not difficult to imagine that the herders under the supervisor Atu might have had a particularly productive year; that Atu in his private affairs might have been very successful and so have transferred to the account of the Umma administrator Lukala more silver than would have been necessary to fulfill his dairy product quotas; that indeed the scribe of this account might have made a calculation error in favor of the dairy supervisor, so that the total of deliveries might have exceeded that of his debits. In this case, seldom found in Ur III accounts, the difference between the debits and the credits totals would have been qualified as diri and either included in the following account as such in the cred-

79 The level of bookkeeping represented by MVN 15, 108, SET 130, UET 3, 1215, and other accounts is presented in figure 15. The cattle recorded in these texts is essentially to be considered property of the state represented in Umma, for instance, by the ēn.si; tended by individual herders, the supervisor Atu was responsible for managing the books of the 13 herds registered in the debits section of our account, for collecting and transferring the dairy products to the household of the ēn.si. Should Atu have remitted silver or dairy products to the high officials Lukala or Ur-Sulpa’ē, such transactions are nonetheless to be understood as having gone through the office of the ēn.si, since they are then dealt with in the books of these latter officials as property of his household, of course not of Atu.
its section — thus in exact correspondence to performed services or delivered goods of the supervisor or foreman involved — or possibly simply ‘cashed in’ by the supervisor in the form of silver, labor or realia. The great majority of Ur III accounts, including MVN 15, 108, however, show credit totals smaller than debits. In these cases the difference is qualified LA+NI and will either have been transferred to the following account as the first entry in the debits section (qualified s.i.i.tum), as we have seen, or will have been called in by central authorities; such clearings of debits are contained in receipts characterized by the term LA+NI s.u.ga, “replaced/repaid deficit”80.

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80 BIN 5, 333, dated to Šulgi 46/vii, states explicitly that Atu made such payments in an amount of silver corresponding to 162½ slīla of the butter oil: l nun:

16 slīla gīl.4.4.dīl kō.bābbar LĀ+NI su.ga l nun

16¼ shekels of silver, repaid deficit for the butter oil,
Although according to MVN 15, 108, the supervisor Atu was able to substantially reduce his initial arrears (from about 6 to less than 4 gur butter oil and from 13 to less than 10 gur cheese), the fact that he still shows very heavy debts in the balance of the account and the fact that such arrears are the rule in Ur III accounting suggest that the delivery norms and the standardized equivalencies, both established by the state, may have been unrealistic and thus that accounting might have been ex-

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Figure 15: The level of bookkeeping attested in such accounts as MVN 15, 108.

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See further the text P. Watson, CRB 2, 84, with, presumably, obv. 4: ½ mana kū 'Aš,ītu (following similar entries representing amounts of silver paid by the Umma officials Ur-e'ē and Kāš) and rev. 2-4: qa-NIGIN 6½ mana 2% gin 'kāš babbar / LA-NN kū, a gāl, la / giri Ur-Sara ša₄, dub-ba₄, "Together: 6½ mana 2% shekels of silver, arrears payment on account, via the chief accountant Ur-Sara" (to kū, a gāl, la; compare NATN 107 rev. iv 19 [copy apparently incorrect] and T. Fish, Iraq 5 [1938] 169, no. 2 [correct transliteration, incorrectly interpreted as 'in fragments']).
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exploited by state officials to insure the highest possible return on what they considered state property\(^\text{81}\).

§ 5. Possible relationships of silver values to equivalencies from dairy texts

The comparison of equivalent measures of the dairy products treated here in dairy accounts can be based either on the concrete derivation of one product from another, for example, of butter oil from soured milk or of flour from barley, or on the artificial equivalence of quantities of two products or services based on standardized accounting units of value, of which silver is the best known, but including gold and other precious metals, barley, fish, oil, and even, well documented beginning in the Ur III period but probably derived from earlier practice\(^\text{82}\), labor. A small number of accounts offer some information about the system of silver equivalencies employed in Ur III bookkeeping to price dairy products. Not in all cases consistent for the entire Ur III state, the silver equivalencies seem just the same standardized within, and at least comparable among provinces, and so reflect bookkeeping mechanisms which were probably generally known to state accountants. Currently available texts present us with the following data (the products from goat’s and cow’s milk were of approximately equal value):

<table>
<thead>
<tr>
<th>Product</th>
<th>Amount per shekel</th>
<th>Reference texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>i nun.HA</td>
<td>8 sila</td>
<td>Goats: UET 3, 1198 obv. 3 and passim; 1514 obv. 9; UET 9, 916 obv. 7’ (all references Ur)</td>
</tr>
<tr>
<td>i nun.HA</td>
<td>10 sila</td>
<td>Goats: SNA T 302 obv. i 1-2 (Umma)</td>
</tr>
<tr>
<td>i nun</td>
<td>10 sila</td>
<td>Cows: TCL 2, 5499 rev. vi 4 and 6 (Drehem); MVN 15, 108 rev. iii 66-76; VDI 1976/3, 110-111.37 (both Umma)</td>
</tr>
</tbody>
</table>

\(^{81}\) The household of the cow herder Ur-kA.nara, who according to MVN 10, 155, was responsible for butter oil and cheese arrears corresponding to ca. 15 shekels of silver at the time of his death, bore the burden of these debts: children and slaves of the herder were transferred to state property (see Ur III-Fischerei 42-48). Equally disagreeable fates suffered by the families of herders or foremen of similar status in the Ur III administration, who were unable or unwilling to cover debts owed the state, are documented in the texts TIM 6, 55 ii 9-12 (= rev. iii 17-20 [cited by H. Watzoldt, AOS 68, 139ff]); i ša mu.3 / l gu, giš / su.su Lugal-gigir.re mu.su / mu.bi.ki NIn-abb龛 da.mIn.ni Ama-gi.na dumu.ni us.bar.de ba.ab.dab, “i three-year-old heifer, i plow ox, to be replaced, Lugal-gigir did not replace them, as a result of which Nin-abbana, his wife, and Ama-gina, his daughter, have been transferred to the [state-owned] weavers\(^\text{a}\)”), CT 7, pl. 32, BM 18395, and CT 10, pl. 25, BM 14313 rev. iv 22-24. See fn. 56 above and compare the payment of two-year-old cattle to partially cancel the deficit of the cow herder Ses-ani, received by Kāšī, in the text BIN 5, 335.\(^\text{82}\) See Ur III-Fischerei 96-100.
This table suggests the following distribution of values in the Ur III administrative centers Umma, Drehem and Ur (reckoned in amount of products per shekel silver):

<table>
<thead>
<tr>
<th>Product</th>
<th>Amount per shekel</th>
<th>Reference texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>ga †Jar</td>
<td>150 sila</td>
<td>Cows: TCL 2, 5499 rev. vi 5 and 7 (Drehem); Goats: UET 3, 1198 obv. 5 and passim; 1514 rev. 1; UET 9, 916 obv. 9' (Ur)</td>
</tr>
<tr>
<td>ga †Jar</td>
<td>180 sila</td>
<td>Cows: SNAT 302 obv. ii 10-11 (Umma)</td>
</tr>
<tr>
<td>ga udgunū</td>
<td>180 sila</td>
<td>Cows: VDI 1976/3, 110-111:39 (?) (Umma)</td>
</tr>
<tr>
<td>ga gazi</td>
<td>120 sila</td>
<td>Cows: SNAT 302 obv. i 2-3 (Umma)</td>
</tr>
<tr>
<td>gazi</td>
<td>300/360 sila</td>
<td>TCL 5, 6051 obv. i 5-6; HUCA 30, 113 rev. 5-6 (both Umma)</td>
</tr>
<tr>
<td>ga še.a</td>
<td>180 sila</td>
<td>Cows: SNAT 302 obv. ii 4-5 (Umma)</td>
</tr>
</tbody>
</table>

We may use these data as soft and as hard evidence for speculation about the relationship between arbitrary value equivalencies and conversion rates used in Ur III bookkeeping to control ingredients in processed dairy goods. In the first case, ga gazi with a silver equivalence of 120 sila per shekel may be compared with the silver equivalence of ga udgunū of 180 sila in Umma. Since 120 × ½ = 180 sila ga udgunū and since the silver equivalence of gazi is 300 or 360 sila per shekel, the conversion of ga gazi may have resulted from a processing of 180 sila ga udgunū together with 180 sila ga gazi without volume increase in the original cheese. Employing the gazi/silver equivalence of 360 sila per shekel, the silver value equivalent of the two products together would be 1½ shekels ((180 + 180) + (180 + 360)), and 180 + 1½ shekels would correspond to an equivalence of 120 sila per shekel ga gazi. In the second

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83 Available accounts from Ur document only silver equivalents of dairy products derived from goat's milk, which, as stated above, may also in Ur have been valued the same as those from cow milk. The rate of 180 sila ga ševoa per shekel silver from Umma is attested in just one text, SNAT 302, and its applicability to this province is thus debatable. Since the text remains an indication of the value equivalence between equal measures of soured milk and cheese (each 180 sila per shekel silver) in Umma, however, the same may be speculated of Drehem and Ur, namely, that outside of Umma soured milk could be exchanged at a rate of 150 sila per shekel.

84 This is, as I stated, the 'soft' case and must be considered cum grano salis. Correspondingly, cheese in Drehem and Ur, with a rate of 150 sila ga †Jar per shekel silver, could be processed with an amount of gazi manipulated to result in comparable figures.
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case, we can, beginning with the attested silver equivalence of 180 sīla ga šē₅₄ₐ per shekel in Umma and assuming this refers to cow's milk₈₅, calculate the products derived from this volume of soured milk in the same city as \(180 + 20 = 9\) sīla i nūn and \(9 \times \frac{7}{8} = 13\frac{1}{2}\) sīla ga ḫār/udgunī. Using the conversion rates attested in Umma, the amounts of these two products have together the following value:

\[
\frac{9}{10} + \frac{2}{750} \times (180 \text{ sīla } ga \text{ udgunī per shekel}) = \frac{1}{2}\text{ shekel silver.}
\]

The same procedure applied to products and equivalencies attested in Drehem (and possibly Ur) results in:

\[
\frac{9}{10} + \frac{2}{750} \times (150 \text{ sīla } ga \text{ udgunī per shekel}) = \frac{1}{2}\text{ shekel silver,}
\]

and thus in both cases\(^{86}\) in equivalent values which support the contention that the sign combination ga šē₅₄ₐ, a found in the credits section of accounts designated a real delivered dairy product and that this product was equivalent to the quantities of processed products to which it corresponded both as the source of these products and as an exchange value.

One consequence of the likelihood that the delivery norms per milk cow in the Ur III period were 5 sīla i nūn and 7\(\frac{1}{2}\) sīla ga ḫār/udgunī in Ur and Umma and that at least in Umma precisely these quantities were processed from 100 sīla of the soured milk ga šē₅₄ₐ, a is that we can re-examine what the delivery norms really mean, namely, approximately one to two hundred liters of soured milk per adult cow per year. Since we know that reasonably well-fed and well-cared for cows in comparable climates will produce for the herder from seven to eight hundred or, after the nursing of their calves, between three and four hundred liters of milk, it seems most reasonable to assume that these hundred liters of ga šē₅₄ₐ, a represented a partial return on production for the owners of the cattle, that is, the state, and that the remaining milk was kept by the

\(^{85}\) Even if it does not, milk from cows and that from goats, which according to SET 130 were of equal value, were probably interchangeable in silver transactions (cf. also the equivalence of 10 sīla of the goat's butter oil i nūn ha and 1 shekel of silver in the same text SNAT 302).

\(^{86}\) Comparable calculations for Ur based on a value equivalence of i nūn from cows and i nūn ha from goats are more speculative, considering the fact that goat's cheese from Ur was valued the same as cheese made from cow milk in Drehem. Note that in both cases of hypothetical conversions of soured milk into its constituent dairy fat and cheese, it is difficult to decide whether labor costs were included in the calculations \(\frac{7}{100}\) shekel or \(4\frac{1}{2}\) grains of silver in Umma might represent from less than 1 to as many as \(4\frac{1}{2}\) labor days of the simple workers gurub lārin and gēme; see Ur III-Fischerei [93-197] [2 sē silver per day], and, for example, SNAT 259 ii 6-8 [3 sē per day; collated]. TCL 5, 6166 passim [4 sē per day] and the Girsu text TUT 137, obv. i 9'-11' [4\(\frac{1}{2}\) sē per day]). The same difficulty is met in analyses of other Ur III labor texts, in particular of accounts from Umma flour mills.
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herders as compensation for feed and care of the animals. If we take, based on the debits section of the account MVN 15, 108, an average size of individual milk cow herds of \((308 + 13 =) 25\) and multiply this by an average \(\text{ga} \ \text{še₃₃₃₃}₅\), a surplus of 200 \(\text{si₃₃₃₃a}₉\) — that is, basing our calculation on suckling cows —, the resulting 5000 \(\text{si₃₃₃₃a}₉\) would correspond to approximately 28 shekels of silver or, more generally, 28 \(\text{gur}₉\) of barley, from which all costs of the dairy operation involved, including feed, rations of helpers, personal compensation, and so on, had to be covered. Since there remain many unknown variables, for instance, the number and value of calves which the herder may have kept, and the number of juvenile cattle and bulls he will have been expected to care for together with the milk cows, these figures must be understood as merely indications of the order of valuables dairy herders at a lower level probably dealt with.

The manager Atu as a high official of the Umma administration was responsible for the production of 308 cows in the year Amar-Suen 3 and thus operated at an order of 10 times the value levels of the dairy herders whom he supervised. Texts which offer an idea of the total size of cattle holdings based on recorded milk cows imply that Atu will have administered altogether some three times as many, or probably close to 1000, animals. Remembering that Atu was one of perhaps several such supervisors — although he may well have managed the largest herds —, the size of dairy operations alone in the province Umma becomes more apparent and so also, for example, the capacity of this and other Ur III provinces, above all Lagash, to plow and tend the very large fields used in the cultivation of grain. The

\(^{87}\) See the discussion above, § 1.

\(^{88}\) See, for example, the treatment above of the pre-Sargonic Girsu text DP 93 and the Ur III Drehem text TCL 2, 5499; receipts such as those cited above, fn. 54, furthermore, state explicitly that Atu was also responsible for oxen.

\(^{89}\) Several Girsu accounts give us an idea of the total area of fields in that province farmed for grain in the Ur III period. The best known is RTC 407, which recorded field totals ranging in size from 4134\(\frac{1}{2}\) to 4261 \(\text{būr}₉\) for the years Sulgi 28, 30 and 32 (see H. Nissen et al., Archatic Bookkeeping 140-142). These figures are supported by the accounts TUT 5, CT 10, pls. 18-19, BM 12922, C. Walker, AJD 24, 122-123 + pls. XVII-XVIII, Truro no. 1, G. Pettinato, Rendiconti 33/1-2, 63-71, and K. Maekawa, ASJ 8, 18, no. 33 (BM 25055), cited variously by K. Maekawa, "The Development of the \(\text{ē-mû}₃₃₃₃\) in Lagash During Early Dynastic III", Mesopotamia 8-9 (1973-1974) 140-143 (see also Maekawa, Zinbun 1974 11-14), and I. J. Gelb, "Ebla and Lagash: Environmental Contrast", in: H. Weiss, ed., The Origins of Cities in Dry-Farming Syria and Mesopotamia in the Third Millennium B.C. (Guilford 1986) 159. Support is found further in such harvest accounts as D. Charpin and J.-M. Durand, DCS 63 (date broken), with reverse ii 2 + 4: 34.30.42;1,0 grain harvested in Lagash; this total divided by 30 \((\text{gur}₉ \text{per būr}₃)\) equals ca. 418\(\frac{1}{2}\) \(\text{būr}₉\) (compare CT 7, pl. 8, BM 12926 [cited K. Maekawa, ASJ 15, 117] with a total for the year Amar-Suen 2 of 27.39.55;0,5,2 [obv. i 12; see rev.
oxen pulling the plows on these fields were reared by the milk cows recorded in our dairy accounts. 

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The plowing and seeding of these tracts required, according to figures presented by J. Renger, "Überlegungen zur räumlichen Ausdehnung des Staates von Ebla an Hand der agrarischen und viehwirtschaftlichen Gegebenheiten", in: L. Cagni, ed., Ebla 1975-1985 — Dieci anni di studi linguistici e filologici (Naples 1987) 293-311 (see in particular his table 1, pp. 303-307, with notes 5-6 on p. 305), and "Report on the Implications of Employing Draught Animals", BSA 5 (1990) 267-279 (see further K. Maekawa, "Cultivation Methods in the Ur III Period", BSA 5, 115-145), a minimum of ca. 8000 plow animals, of which relative to equids oxen always formed the large majority. This number could have been still higher, assuming that at least half of such quantities as 12,354 and 11,652 būr in the Girsu texts BM 28673 and 23837 (K. Maekawa, ASJ 9 [1987] 122-124, nos. 52-53, first text dated to Ibi-Sin 5), respectively, reflect land that was really under plow, the other half being fallow (see B. Ebeling, RAI 3, 36; A. L. Oppenheim, AOS 32, 75; J. J. Gelb, "Ebla and Lagash," 159; K. Maekawa, ASJ 4, 90-91, and Zinbun 22, 52-55, to a.ākuru bītu). The estimates of the numbers of plow oxen — in Sumerian usually qualified gu₄ apin (more specifically qualified according to the type of plowing done) — requisite for working these fields are on the whole based on recent literature concerning agriculture in sub-Saharan Africa published above all by the Food and Agriculture Organization of the United Nations (reckoning with a mean of 3,75 ha per animal and season), and on information culled from Ur III administrative documents which record the amount per būr a given team of oxen was to plow, namely, ca. 1 būr per plowing season consisting of three types of plowing: deep plowing (with the so-called Near Eastern ard, Sumerian ap₄ un), harrowing (gīš.ūr₂₃₄) and seed plowing (numun). Depending on the work life of plow oxen, keeping these numbers available for farm operations in the area surrounding Girsu would require between two and four thousand adult cows and one hundred or more bulls, reckoning roughly with a service ratio of 20:1. Old Babylonian accounts from Ur which certify the existence of up to 20,400 cattle belonging to the Nanna temple (UET 5, 849; the total of 16,803 given by K. Butz, WZKM 65-66, 30, and repeated by M. van de Mieroop, BBVO 12 [Berlin 1992] 87, seems incorrect given the notation rev. 3: [su+NIN₃₄₅]₅₇.₄₀.₃₃ [the basis of van de Mieroop's objection to reconstructing 'Nanna in the colophon of the account is unclear to me] are in accordance with the relative sizes postulated for the Ur III period.

This breeding model will remain our primary working hypothesis as long as the ultimate destination of the cattle sent to Drehem from the eastern provinces of the Ur III empire, most importantly from Elam (see above, fn. 43), is unclear.
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