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ANNEXES : SUPPLEMENTAL INFORMATION IN THE DEVELOPMENT OF PARAMETERS

Annex 10A.1 Data underlying methane default emission factors for Enteric Fermentation

This annex presents the data used to develop the default emission factors for methane emissions from Enteric Fermentation. The Tier 2 method was implemented with these data to estimate the default emission factors for cattle and buffalo.

This annex also presents the data used to develop the default emission factors for methane emissions from manure management methane and for nitrogen excretion rate for cattle and buffaloes. The Tier 2 method was implemented with these data.

The sources of the values are presented in Tables in Annex.10B.1.

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TABLE 10A.1-1
DATA FOR ESTIMATING TIER 1A ENTERIC FERMENTATION EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR DAIRY CATTLE IN TABLE 10.11A

Regions	Weight kg	Weight Gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk, %	Protein content of milk, %	Work hrs/day	% Pregnant	Digestibility of Feed, %	CP in diet, %	CH_4 Conversion %[2]
North America	635	0	Stall Fed	28.0	3.7	3.2	0	90	71	16.7	5.7
Western Europe	600	0	Stall Fed	19.0	4.0	3.2	0	90	73	16.1	6.3
Eastern Europe	550	0	Stall Fed	10.2	3.9	3.2	0	85	70	15.1	6.5
Oceania [3]	488	0	Pasture/Range	12.1	4.8	3.7	0	92	77	22.3	6.5
Latin America	508	0	Pasture/Range	5.6	4.0	3.2	0	70	65	12.7	6.5
Asia[4]	386	0	Stall Fed	8.9	3.9	3.2	0	70	66	13.5	6.5
Africa	260	0	Stall Fed	3.5	3.5	3.6	0	54	51	8.2	6.5
Middle East	438	0	Stall Fed	8.5	3.7	3.4	0	54	64	14.8	6.5
Indian Subcontinent	285	0	Pasture/Range	5.5	4.2	3.7	0	42	57	14.3	6.5

[1] The value represent milk yield in kg per day during the whole year.

[2] Ym values are consist with those reported in Table 10.12

[3] All data are weighted values, representative of Australia and New Zealand. For Pacific Island nations, refer to Asia values.

[4] Data of Latin America, Asia, Africa, Middle East and Indian subcontinent were estimated as weighted average by taken into account parameter values related to low- and high production systems and livestock population structure of low and high productivity systems. The values were estimated based on the data reported in Table 10.A.1-2.

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TABLE 10A.1-2

DATA FOR ESTIMATING TIER 1B ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR DAIRY CATTLE IN TABLE 10.11B

Regions	Weight kg	Weight gain kg/day	Feeding situation	Milk yield[1], kg/day	Fat content of milk %	Protein content, of milk %	Work hrs/day	% Pregnant	Digestibility of Feed, %	CP in diet, %	CH_4 Conversion %[2]	Day weighted population mix,%
Latin America												
High productivity systems	520		Pasture/Range	9.3	4.0	3.1	0	72	65	17.0	6.5	38
Low productivity systems	500		Pasture/Range	3.4	4.0	3.2	0	68	65	10.0	6.5	62
Asia												
High productivity systems	485		Stall Fed	13.8	4.1	3.1	0	80	70	16.5	6.5	24
Low productivity systems	355		Stall Fed	7.3	3.9	3.2	0	67	65	12.6	6.5	76
Africa												
High productivity systems	250		Stall Fed	5.8	3.4	3.3		57	50	7.8	6.5	49
Low productivity systems	270		Pasture/Range	1.2	3.6	3.9		52	51	8.6	6.5	51
Middle East												
High productivity systems	510		Stall Fed	10.6	3.4	3.2		55	65	15.8	6.5	33
Low productivity systems	270		Pasture/Range	3.6	4.5	3.7		50	60	12.5	6.5	67
Indian subcontinent												
High productivity systems	350		Stall Fed	8.4	4.0	3.6		50	65	15.5	6.5	23
Low productivity systems	265		Pasture/Range	4.6	4.2	3.7		40	55	14.0	6.5	77

[1] The value represent milk yield in kg per day during the whole year

[2] Ym values are consist with those reported in Table 10.12

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TABLE 10A.1-3
DATA FOR ESTIMATING TIER 1A ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR OTHER CATTLE IN TABLE 10.11.A

Type	Weight kg	Weight Gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk %	Protein content of milk %	Work hrs/day	Pregnant %	Digestibility of Feed, %	CP in diet %	CH_4 Conversion %[2]	Day Weighted Population Mix %	Emission Factors kg/head/yr
North America													
Mature Females	580		Pasture/Range	3	4.0	3.5		80	62	12.0	7.0	35	98
Mature Males	820		Pasture/Range						62	12.0	7.0	2	98
Calves on milk	125	1.0	Pasture/Range						95	13.0	0.0	16	0
Calves on forage	215	1.0	Pasture/Range						65	13.0	6.3	8	50
Growing heifers/steers	300	0.9	Pasture/Range						65	13.0	6.3	17	61
Replacement/growing	400	0.5	Pasture/Range						62	12.0	7.0	11	73
Feedlot cattle	500	1.4	Stall Fed						75	14.0	3.0	11	37
Western Europe													
Mature Males	600		Pasture/Range						60	14.7	7.0	22	85
Replacement/growing	400	0.4	Pasture/Range						65	16.5	6.3	55	57
Calves on milk	230	0.3	Stall fed						95	17.1	0.0	15	0
Calves on forage	230	0.3	Pasture/Range						73	16.5	6.3	8	32
Eastern Europe													
Mature Females	500		Pasture/Range	3.0	4.2	3.7		80	70	15.1	6.3	39	67
Mature Males	600		Pasture/Range						65	14.2	6.3	9	65
Replacement/growing	350	0.4	Pasture/Range						65	14.2	6.3	27	53
Calves on forage	180	0.7	Pasture/Range						65	14.3	6.3	25	46
Oceania[3]													
Mature Females	416		Pasture/ Range	1.72	4.8	3.7		81	61	14.0	7.0	45	76
Mature Males	467		Pasture/ Range						62	14.0	7.0	25	64
Young	185	0.41	Pasture/ Range						61	14.0	7.0	30	43

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TABLE 10A.1-3
DATA FOR ESTIMATING TIER 1A ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR OTHER CATTLE IN TABLE 10.11.A

Type	Weight kg	Weight Gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk %	Protein content of milk %	Work hrs/day	Pregnant %	Digestibility of Feed, %	CP in diet %	CH_4 Conversion %[2]	Day Weighted Population Mix %	Emission Factors kg/head/yr
Latin America[4]													
Mature Females	435		Pasture/Range	2.0	4.9	3.0		63	59	9.5	7.0	36	82
Mature Males	582		Pasture/Range						59	9.8	7.0	2	81
Growing heifers/steers	240	0.35	Pasture/Range						61	9.8	7.0	22	47
Replacement/growing	302	0.34	Pasture/Range						60	9.6	7.0	18	57
Calves on milk	66	0.35	Pasture/Range						95	3.5	0.0	10	0
Calves on forage	160	0.35	Pasture/Range						61	10.0	7.0	10	39
Feedlot cattle	460	0.90	Stall Fed						74	14.0	3.5	1	34
Asia													
Mature Females	376		Stall Fed	1.5	4.7	3.3	1.1	50	61	10.6	7.0	27	65
Mature Females - grazing	305		Pasture/Range	1.4	4.7	3.3		65	59	10.0	7.0	9	54
Mature Males	501		Stall Fed				1.1		57	10.1	7.0	15	72
Mature Males - grazing	430		Pasture/Range						57	10.0	7.0	6	68
Growing/Replacement	207	0.28	Pasture/Range						61	10.5	7.0	25	45
Calves on forage	90	0.36	Pasture/Range						62	10.7	7.0	18	30
Africa													
Mature Females	356		Pasture/Range	2.4	4.0	3.5	0.55	62	60	11.3	7.0	17	71
Mature Females-Grazing	275		Large Areas	1.2	4.1	3.6		54	58	10.0	7.0	11	57
Mature Males	540		Pasture/Range						58	11.2	7.0	2	79
Draft Bullocks	340		Stall Fed				1.1		58	10.0	7.0	4	53
Bulls - Grazing	340		Large Areas						58	10.0	7.0	8	57
Growing/Replacement	204	0.24	Pasture/Range						59	10.4	7.0	42	46

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TABLE 10A.1-3
DATA FOR ESTIMATING TIER 1A ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR OTHER CATTLE IN TABLE 10.11.A

Type	Weight kg	Weight Gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk %	Protein content of milk %	Work hrs/day	Pregnant %	Digestibility of Feed, %	CP in diet %	CH_4 Conversion %[2]	Day Weighted Population Mix %	Emission Factors kg/head/yr
Calves on forage	82	0.33	Pasture/Range						59	10.3	7.0	18	31
Middle East													
Mature Females	386		Pasture/Range	2.7	4.0	3.2		54	64	14.9	7.0	10	73
Mature Males	483		Pasture/Range				0.55		60	14.7	7.0	9	75
Replacement/growing	250	0.43	Pasture/Range						61	14.9	7.0	42	57
Calves on forage	144	0.62	Pasture/Range						61	15.0	7.0	40	46
Indian subcontinent													
Mature Females	253		Pasture/Range	1.7	4.6	3.2		41	55	10.2	7.0	22	62
Mature Males	291		Pasture/Range						57	10.1	7.0	3	51
Draft bullocks	290		Stall Fed				1.7		55	10.0	7.0	43	47
Replacement/growing	158	0.21	Pasture/Range						57	10.9	7.0	16	41
Calves on forage	72	0.26	Pasture/Range						57	11.2	7.0	16	28

[1] The value represent milk yield in kg per day during the whole year

[2] Ym values are consist with those reported in Table 10.12

[3] All data are weighted values, representative of Australia and New Zealand. For Pacific Island nations, refer to Asia values

[4] Data of Latin America, Asia, Africa, Middle East and Indian subcontinent were estimated as weighted average by taken into account parameter values related to low- and high production systems and livestock population structure of low and high productivity systems. The values were estimated based on the data reported in Table 10.A.1-4.

TABLE 10A.1-4
DATA FOR ESTIMATING TIER 1B ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR OTHER CATTLE IN TABLE 10.11B

Type	Weight kg	Weight gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk %	Protein content of milk %	Work hrs/day	Pregnant %	Digestibility of Feed, %	CP in diet, %	CH_4 Conversion %[2]	Day weighted population mix %[3]	Emission Factors kg/head/yr
Latin America													
High productivity systems												23[3]	
Mature Females	490		Pasture/Range	2.7	4.2	3.2		78	61	11.2	7.0	33	89
Mature Males	595		Pasture/Range						61	11.2	7.0	1	79
Growing heifers/steers	240	0.5	Pasture/Range						63	11.8	6.3	22	48
Replacement/growing	350	0.5	Pasture/Range						61	11.0	7.0	16	74
Calves on milk	82	0.5	Pasture/Range						95	3.5	0.0	12	0
Calves on forage	200	0.5	Pasture/Range						63	12.3	7.0	12	51
Feedlot cattle	460	0.9	Stall Fed						74	14.0	3.5	4	36
Low productivity systems												77[3]	
Mature Females	420		Pasture/Range	1.8	4.3	3.2		59	59	9.1	7.0	37	79
Mature Males	580		Pasture/Range						59	9.6	7.0	2	81
Growing heifers/steers	240	0.3	Pasture/Range						60	9.2	7.0	22	47
Replacement/growing	290	0.3	Pasture/Range						60	9.3	7.0	19	54
Calves on milk	60	0.3	Pasture/Range						95	3.5	0.0	10	0
Calves on forage	145	0.3	Pasture/Range						60	9.2	7.0	10	35
Asia													
High productivity systems												17[3]	
Mature Females	450		Stall Fed	1.9	4.7	3.3		80	68	12.5	6.3	41	55
Mature Males	550		Stall Fed						68	12.5	6.3	2	49
Growing/Replacement	285	0.40	Stall Fed						68	12.5	6.3	27	41
Calves on forage	125	0.50	Stall Fed						68	12.5	6.3	30	28

TABLE 10A.1-4
DATA FOR ESTIMATING TIER 1B ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR OTHER CATTLE IN TABLE 10.11B

Type	Weight kg	Weight gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk %	Protein content of milk %	Work hrs/day	Pregnant %	Digestibility of Feed, %	CP in diet, %	CH_4 Conversion %[2]	Day weighted population mix %[3]	Emission Factors kg/head/yr
Low productivity systems												83	
Mature Females-Farming	350		Stall Fed	1.4	4.7	3.3	1.1	40	59	10.0	7.0	25	64
Mature Females-Grazing	305		Pasture/Range	1.4	4.7	3.3		65	59	10.0	7.0	11	54
Mature Males-Farming	500		Stall Fed				1.1		57	10.0	7.0	18	73
Mature Males-Grazing	430		Pasture/Range						57	10.0	7.0	8	68
Growing/Replacement	190	0.25	Pasture/Range						59	10.0	7.0	25	44
Calves on forage	75	0.30	Pasture/Range						59	10.0	7.0	15	28
Africa													
High productivity systems												30	
Mature Females	390		Pasture/Range	2.9	3.9	3.5		65	61	11.8	7.0	39	76
Mature Males	540		Pasture/Range						58	11.2	7.0	6	79
Growing/Replacement	250	0.34	Pasture/Range						60	11.2	7.0	41	50
Calves on forage	105	0.43	Pasture/Range						61	11.4	7.0	14	36
Low productivity systems												70	
Mature Females	275		Pasture/Range	1.2	4.1	3.6	0.55	54	58	10.0	7.0	7	60
Mature Females-Grazing	275		Large Areas	1.2	4.1	3.6		54	58	10.0	7.0	15	57
Draft Bullocks	340		Stall Fed				1.1		58	10.0	7.0	5	53
Bulls - Grazing	340		Large Areas						58	10.0	7.0	11	65
Growing/Replacement	185	0.20	Pasture/Range						58	10.0	7.0	42	42
Calves on forage	75	0.30	Pasture/Range						58	10.0	7.0	20	30
Middle East													
High productivity systems												33	

TABLE 10A.1-4 DATA FOR ESTIMATING TIER 1B ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR OTHER CATTLE IN TABLE 10.11B													
Type	**Weight kg**	**Weight gain kg/day**	**Feeding Situation**	**Milk yield[1], kg/day**	**Fat content of milk %**	**Protein content of milk %**	**Work hrs/day**	**Pregnant %**	**Digestibility of Feed, %**	**CP in diet, %**	**CH_4 Conversion %[2]**	**Day weighted population mix %[3]**	**Emission Factors kg/head/yr**
Mature Females	500		Pasture/Range	2.8	3.5	3.3%		55	65	15.5	6.3	10	72
Mature Males	600		Pasture/Range						63	15.5	6.3	7	68
Replacement/growing	350	0.50	Pasture/Range						63	15.5	6.3	42	61
Calves on forage	165	0.70	Pasture/Range						63	15.5	6.3	41	47
Low productivity systems												67	
Mature Females	330		Pasture/Range	2.3	5.0	4.0	0	50	60	13.5	7.0	10	69
Mature Males	450		Pasture/Range				0.55		55	13.5	7.0	12	79
Replacement/growing	200	0.25	Pasture/Range						55	13.5	7.0	42	50
Calves on forage	85	0.40	Pasture/Range						55	13.5	7.0	36	40
Indian subcontinent													
High productivity systems												14	
Mature Females	300		Pasture/Range	2.5	4.0	3.6		40	60	13.0	7.0	9	64
Mature Males	330		Pasture/Range						60	13.0	7.0	11	52
Replacement/growing	200	0.33	Pasture/Range						60	13.0	7.0	35	49
Calves on forage	90	0.33	Pasture/Range						60	13.0	7.0	45	31
Low productivity systems												86	
Mature Females	250		Pasture/Range	1.7	4.6	3.7		40	55	10.0	7.0	24	62
Mature Males	290		Pasture/Range						55	10.0	7.0	2	54
Draft bullocks	290		Stall Fed				1.7		55	10.0	7.0	50	47
Replacement/growing	140	0.15	Pasture/Range						55	10.0	7.0	13	37
Calves on forage	60	0.22	Pasture/Range						55	10.0	7.0	11	26

TABLE 10A.1-4
DATA FOR ESTIMATING TIER 1B ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR OTHER CATTLE IN TABLE 10.11B

Type	Weight kg	Weight gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk %	Protein content of milk %	Work hrs/day	Pregnant %	Digestibility of Feed, %	CP in diet, %	CH_4 Conversion %[2]	Day weighted population mix %[3]	Emission Factors kg/head/yr

[1] The value represent milk yield in kg per day during the whole year

[2] Ym values are consist with those reported in Table 10.12

[3] A share of low and high productivity animals from the total livestock population of a region

TABLE 10A.1-5
DATA FOR ESTIMATING TIER 1A ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR BUFFALOES IN TABLE 10.11A

Type	Weight kg	Weight Gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk, %	Protein content of milk, %	Work hrs/day	% Pregnant	Digestibility of Feed, %	CP in diet %	CH_4 Conversion, %[2]	Day Weighted Population mix , %	Emission factor, CH_4 kg/head/yr
Western Europe													
Mature Males	700		Pasture/Paddock				0		65	14.0	6.3	3	73
Mature Females	615		Pasture/Paddock	2.8	8.0	4.6	0	87	65	15.0	6.3	59	91
Growing/Replacement	420	0.53	Pasture/Paddock						65	14.0	6.3	25	62
Calves	170	0.68	Pasture/Paddock						65	14.0	6.3	13	43
Eastern Europe													
Mature Males	650		Pasture/Paddock						71	13.0	6.3	8	61
Mature Females	550		Pasture/Paddock	4.0	7.5	4.3	0	85	71	13.0	6.3	62	80
Growing/Replacement	350	0.55	Pasture/Paddock						71	13.0	6.3	14	52
Calves	155	0.66	Pasture/Paddock						71	13.0	6.3	16	37
Latin America													
Adult Males	650		Pasture/Range						60	12.0	7.0	4	86
Adult Females	500		Pasture/Range	3.0	7.1	4.3		62	60	12.0	7.0	40	112
Growing/Replacement	200	0.40	Pasture/Range						60	12.0	7.0	26	54
Calves	90	0.28	Pasture/Range						60	12.0	7.0	30	26
Asia													
Mature Males	490		Pasture/Paddock				1.1		55	10.0	7.0	20	88
Mature Females	420		Pasture/Paddock	1.6	9.1	5.2	1.1	45	55	10.0	7.0	40	99
Growing/Replacement	225	0.26	Pasture/Paddock						55	10.0	7.0	25	56
Calves	90	0.32	Pasture/Paddock						55	10.0	7.0	15	37
Africa													
Mature Males	590		Pasture/Paddock				1.37		58	10.0	7.0	6	94

TABLE 10A.1-5
DATA FOR ESTIMATING TIER 1A ENTERIC FERMENTATION CH4 EMISSION FACTORS AND NITROGEN EXCRETION FACTOR FOR BUFFALOES IN TABLE 10.11A

Type	Weight kg	Weight Gain kg/day	Feeding Situation	Milk yield[1], kg/day	Fat content of milk, %	Protein content of milk, %	Work hrs/day	% Pregnant	Digestibility of Feed, %	CP in diet %	CH_4 Conversion, %[2]	Day Weighted Population mix , %	Emission factor, CH_4 kg/head/yr
Mature Females	440		Pasture/Paddock	4.3	7.2	3.5	0.55	44	58	10.0	7.0	42	107
Growing/Replacement	300	0.40	Pasture/Paddock						58	10.0	7.0	32	71
Calves	115	0.45	Pasture/Paddock						58	10.0	7.0	20	43
Middle East													
Mature Males	650		Pasture/Paddock				1.37		60	11.0	7.0	5	96
Mature Females	520		Pasture/Paddock	3.0	7.0	4.2	0.55	65	65	11.0	6.3	52	83
Growing/Replacement	255	0.39	Pasture/Paddock						61	11.0	7.0	22	54
Calves	105	0.41	Pasture/Paddock						61	11.0	7.0	21	36
Indian subcontinent													
Breeding males	560		Pasture/Paddock						55	12.0	7.0	1	88
Working males	560		Pasture/Paddock				5.3		55	12.0	7.0	4	129
Mature Females	480		Pasture/Paddock	4.8	7.3	3.5	0.55	50	55	12.0	7.0	48	127
Growing/Replacement	195	0.31	Pasture/Paddock						59	12.0	7.0	21	45
Calves	85	0.31	Pasture/Paddock						56	12.0	7.0	26	35

[1] The value represent milk yield in kg per day during the whole year

[2] Ym values are consist with those reported in Table 10.12

Annex 10A.2 Additional data and information for the calculation of methane and nitrous oxide from Manure Management

This annex presents the data required for the calculation of average VS per animal category presented in Table10.14A as well as AWMS system information for regions around the country. The information has been compiled by the FAO for use in their modelling system GLEAM (FAO 2017; MacLeod *et al.* 2017). More specific information can be found, sometimes at the country level at http://www.fao.org/gleam/resources/en/.

Also included in this Annex is the information used Furthermore, information is supplied on IPCC climate zones and finally an approach is presented to calculate MCFs when country-specific climate information and manure management storage duration is known by the compiler.

TABLE 10A.2-1A
INFORMATION USED IN THE CALCULATION OF VOLATILE SOLIDS FROM DAIRY CATTLE

Region	Weight, kg	GE, MJ/day	DC, %	UE*GE	ASH	Calculated VS values, kg/hd/d	kg VS (1000 kg animal mass-1) day-1
North America	635	360	71	14	0.08	5.9	9.3
Western Europe	600	279	73	11	0.08	4.3	7.2
Eastern Europe	550	212	70	8	0.08	3.6	6.5
Oceania	488	218	77	9	0.08	2.9	6.0
Latin America	508	205	65	9	0.08	4.0	7.9
low productivity system	500	183	65	7	0.08	3.5	10.1
high productivity system	520	242	65	10	0.08	4.7	6.7
Asia	386	184	66	7	0.08	3.5	9.0
low productivity system	355	167	65	7	0.08	3.2	9.2
high productivity system	485	232	70	9	0.08	3.9	8.1
Africa	260	154	51	6	0.08	4.1	15.8
low productivity system	270	146	51	6	0.08	3.9	14.3
high productivity system	250	181	50	7	0.08	4.9	19.5
Middle East	349	183	62	7	0.08	3.9	11.1
low productivity system	270	145	60	6	0.08	3.2	11.8
high productivity system	510	221	65	9	0.08	4.3	8.4
Indian Subcontinent	285	179	57	7	0.08	4.2	14.7
low productivity system	265	175	55	7	0.08	4.3	16.1
high productivity system	350	175	65	7	0.08	3.4	9.7

TABLE 10A.2-1B
CALCULATIONS IN THE DEVELOPMENT OF VOLATILE SOLID ESTIMATES FOR NON NON-DAIRY CATTLE

Region	GE, MJ/day	Weight, kg	DC,%	UE	ASH	GE*(1-DE/100)	UE*GE	(1-ASH)/ 18.45	VS, kg/hd/day	Day Weighted Population Mix %	VS per 1000 kg animal mass^{-1}

North America									3.0		7.1
Mature Females	212	580	62	0.04	0.08	81	8	0.05	4.4	35%	7.7
Mature Males	213	820	62	0.04	0.08	81	9	0.05	4.5	2%	5.4
Calves on milk	47	125	95	0.04	0.08	2	2	0.05	0.2	16%	1.7
Calves on forage	122	215	65	0.04	0.08	43	5	0.05	2.4	8%	11.0
Growing heifers/steers	148	300	65	0.04	0.08	52	6	0.05	2.9	17%	9.6
Replacement/growing	159	400	62	0.04	0.08	60	6	0.05	3.3	11%	8.3
Feedlot cattle	187	500	75	0.04	0.08	47	7	0.05	2.7	11%	5.4
Western Europe									2.5		5.7
Mature Males	184	600	60	0.04	0.08	74	7	0.05	4.0	22%	6.7
Replacement/growing	138	400	65	0.04	0.08	48	6	0.05	2.7	55%	6.7
Calves on milk	48	230	95	0.04	0.08	2	2	0.05	0.2	15%	0.9
Calves on forage	77	230	73	0.04	0.08	21	3	0.05	1.2	8%	5.2
Eastern Europe									2.6		7.6
Mature Females	163	500	70	0.04	0.08	49	7	0.05	2.8	39%	5.5
Mature Males	157	600	65	0.04	0.08	55	6	0.05	3.1	9%	5.1
Replacement/growing	129	350	65	0.04	0.08	45	5	0.05	2.5	27%	7.2
Calves on forage	112	180	65	0.04	0.08	39	4	0.05	2.2	25%	12.1
Oceania									2.9		8.7
Mature Females	165	416	61	0.04	0.08	64	7	0.05	3.5	45%	8.5
Mature Males	139	467	62	0.04	0.08	53	6	0.05	2.9	25%	6.3
Young	94	185	61	0.04	0.08	37	4	0.05	2.0	30%	10.9
Latin America									3.3		11.0
Mature Females	198	431	59	0.04	0.08	82	8	0.05	4.5	39%	10.4
Mature Males	184	600	58	0.04	0.08	77	7	0.05	4.2	2%	7.0
Growing heifers/steers	127	260	59	0.04	0.08	52	5	0.05	2.9	19%	11.0

Replacement/growing	141	309	59	0.04	0.08	58	6	0.05	3.2	18%	10.3
Calves on milk	40	56	59	0.04	0.08	16	2	0.05	0.9	10%	15.9
Calves on forage	81	161	59	0.04	0.08	33	3	0.05	1.8	10%	11.4
Feedlot cattle	187	500	75	0.04	0.08	47	7	0.05	2.7	1%	5.4
Latin America: high production system									3.4		10.3
Mature Females	214	480	62	0.04	0.08	81	9	0.05	4.5	35%	9.4
Mature Males	168	600	62	0.04	0.08	64	7	0.05	3.5	1%	5.9
Growing heifers/steers	158	300	62	0.04	0.08	60	6	0.05	3.3	20%	11.0
Replacement/growing	182	350	62	0.04	0.08	69	7	0.05	3.8	16%	10.9
Calves on milk	50	80	62	0.04	0.08	19	2	0.05	1.0	11%	13.1
Calves on forage	108	200	62	0.04	0.08	41	4	0.05	2.3	11%	11.3
Feedlot cattle	197	500	75	0.04	0.08	49	8	0.05	2.9	6%	5.7
Latin America: low production system									3.2		11.3
Mature Females	194	420	58	0.04	0.08	81	8	0.05	4.4	40%	10.6
Mature Males	186	600	58	0.04	0.08	78	7	0.05	4.3	2%	7.1
Growing heifers/steers	119	250	58	0.04	0.08	50	5	0.05	2.7	19%	11.0
Replacement/growing	133	300	58	0.04	0.08	56	5	0.05	3.1	19%	10.2
Calves on milk	38	50	58	0.04	0.08	16	2	0.05	0.9	10%	17.4
Calves on forage	75	150	58	0.04	0.08	31	3	0.05	1.7	10%	11.4
Asia									2.6		9.9
Mature Females	141	376	61	0.04	0.08	55	6	0.05	3.0	27%	8.0
Mature Females - grazing	117	305	59	0.04	0.08	48	5	0.05	2.6	9%	8.6
Mature Males	158	501	57	0.04	0.08	67	6	0.05	3.7	15%	7.3
Mature Males - grazing	149	430	57	0.04	0.08	64	6	0.05	3.5	6%	8.1
Growing/Replacement	99	207	61	0.04	0.08	39	4	0.05	2.1	25%	10.3

Calves on forage	65	90	62	0.04	0.08	25	3	0.05	1.4	18%	15.5
Asia: low production system									2.7		10.6
Mature Females-Farming	140	350	59	0.04	0.08	58	6	0.05	3.2	25%	9.0
Mature Females-Grazing	117	305	59	0.04	0.08	48	5	0.05	2.6	11%	8.6
Mature Males-Farming	158	500	57	0.04	0.08	68	6	0.05	3.7	18%	7.4
Mature Males-Grazing	149	430	57	0.04	0.08	64	6	0.05	3.5	8%	8.1
Growing/Replacement	96	190	59	0.04	0.08	39	4	0.05	2.1	25%	11.3
Calves on forage	62	75	59	0.04	0.08	25	2	0.05	1.4	15%	18.5
Asia: high production system									1.9		6.8
Mature Females	132	450	68	0.04	0.08	42	5	0.05	2.4	41%	5.3
Mature Males	118	550	68	0.04	0.08	38	5	0.05	2.1	2%	3.9
Growing/Replacement	100	285	68	0.04	0.08	32	4	0.05	1.8	27%	6.3
Calves on forage	67	125	68	0.04	0.08	21	3	0.05	1.2	30%	9.6
Africa									2.5		11.8
Mature Females	156	356	60	0.04	0.08	62	6	0.05	3.4	17%	9.6
Mature Females-Grazing	123	275	58	0.04	0.08	52	5	0.05	2.8	11%	10.3
Mature Males	172	540	58	0.04	0.08	72	7	0.05	3.9	2%	7.3
Draft Bullocks	115	340	58	0.04	0.08	48	5	0.05	2.6	4%	7.8
Bulls - Grazing	124	340	58	0.04	0.08	52	5	0.05	2.8	8%	8.4
Growing/Replacement	100	204	59	0.04	0.08	41	4	0.05	2.3	42%	11.0
Calves on forage	68	82	59	0.04	0.08	28	3	0.05	1.5	18%	18.9
Africa: Low production system									2.3		12.5
Mature Females	132	275	58	0.04	0.08	55	5	0.05	3.0	7%	11.0
Mature Females-Grazing	123	275	58	0.04	0.08	52	5	0.05	2.8	15%	10.3

Draft Bullocks	115	340	58	0.04	0.08	48	5	0.05	2.6	5%	7.8
Bulls - Grazing	142	340	58	0.04	0.08	60	6	0.05	3.3	11%	9.6
Growing/Replacement	91	185	58	0.04	0.08	38	4	0.05	2.1	42%	11.2
Calves on forage	65	75	58	0.04	0.08	27	3	0.05	1.5	20%	19.9
Africa: High production system									2.8		10.2
Mature Females	166	390	61	0.04	0.08	65	7	0.05	3.6	39%	9.1
Mature Males	172	540	58	0.04	0.08	72	7	0.05	3.9	6%	7.3
Growing/Replacement	109	250	60	0.04	0.08	44	4	0.05	2.4	41%	9.6
Calves on forage	79	105	61	0.04	0.08	31	3	0.05	1.7	14%	16.1
Indian Subcontinent									2.4		12.2
Mature Females	135	253	55	0.04	0.08	61	5	0.05	3.3	22%	13.0
Mature Males	110	291	57	0.04	0.08	47	4	0.05	2.6	3%	8.8
Draft bullocks	102	290	55	0.04	0.08	46	4	0.05	2.5	43%	8.6
Replacement/growing	89	158	57	0.04	0.08	39	4	0.05	2.1	16%	13.3
Calves on forage	62	72	57	0.04	0.08	27	2	0.05	1.5	16%	20.3
Indian subcontinent: Low production system									2.5		12.0
Mature Females	135	250	55	0.04	0.08	61	5	0.05	3.3	24%	13.2
Mature Males	118	290	55	0.04	0.08	53	5	0.05	2.9	2%	9.9
Draft bullocks	102	290	55	0.04	0.08	46	4	0.05	2.5	50%	8.6
Replacement/growing	80	140	55	0.04	0.08	36	3	0.05	1.9	13%	13.9
Calves on forage	57	60	55	0.04	0.08	26	2	0.05	1.4	11%	23.2
Indian subcontinent: High production system									2.0		13.4
Mature Females	139	300	60	0.04	0.08	56	6	0.05	3.1	9%	10.2
Mature Males	113	330	60	0.04	0.08	45	5	0.05	2.5	11%	7.5

Replacement/growing	107	200	60	0.04	0.08	43	4	0.05	2.3	35%	11.7
Calves on forage	69	90	60	0.04	0.08	27	3	0.05	1.5	45%	16.7
Middle East									2.8		14.1
Mature Females	159	386	62	0.04	0.08	61	6	0.05	3.4	10%	8.7
Mature Males	164	483	57	0.04	0.08	71	7	0.05	3.9	10%	8.0
Replacement/growing	124	250	58	0.04	0.08	53	5	0.05	2.9	42%	11.5
Calves on forage	99	114	58	0.04	0.08	42	4	0.05	2.3	38%	20.1
Midle East: Low production system									2.7		16.8
Mature Females	150	330	60	0.04	0.08	60	6	0.05	3.3	10%	10.0
Mature Males	171	450	55	0.04	0.08	77	7	0.05	4.2	12%	9.3
Replacement/growing	109	200	55	0.04	0.08	49	4	0.05	2.7	42%	13.4
Calves on forage	88	85	55	0.04	0.08	40	4	0.05	2.1	36%	25.3
Midle East: high production system									2.8		10.5
Mature Females	174	500	65	0.04	0.08	61	7	0.05	3.4	10%	6.8
Mature Males	164	600	63	0.04	0.08	61	7	0.05	3.4	7%	5.6
Replacement/growing	148	350	63	0.04	0.08	55	6	0.05	3.0	42%	8.6
Calves on forage	114	165	63	0.04	0.08	42	5	0.05	2.3	41%	14.2

TABLE 10A.2-1C
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR DAIRY CATTLE

Region	Weigh, kg	Nintake, kg N/hd/d	CP of diet,%	Nintake, kg N/hd/yr	Milk yield, kg/hd/d	Protein content of milk, %	N retention, kgN/hd/day	N retention, kg N/yr/hd	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}	N retention fraction
North America	635	0.52	16.7	190	28	3.2	0.14	51	139	0.60	0.27

Western Europe	600	0.39	16.1	142	19	3.2	0.10	35	108	0.49	0.24
Eastern Europe	550	0.28	15.1	101	10.2	3.2	0.05	19	83	0.41	0.18
Oceania	488	0.42	22.3	154	12.1	3.7	0.07	26	129	0.72	0.17
Latin America	508	0.23	12.7	82	5.7	3.2	0.03	10	72	0.39	0.12
...low production system	500	0.16	10.0	58	3.4	3.2	0.02	6	52	0.28	0.11
...high production system	520	0.36	17.0	130	9.3	3.1	0.05	16	114	0.60	0.13
Asia	387	0.22	13.5	79	8.9	3.2	0.04	16	63	0.44	0.20
...low production system	355	0.18	12.6	67	7.3	3.2	0.04	13	53	0.41	0.20
...high production system	485	0.33	16.5	121	13.8	3.1	0.07	24	97	0.55	0.20
Africa & Middle East	260	0.11	8.2	40	3.5	3.6	0.02	7	33	0.35	0.18
...low production system	270	0.11	8.6	40	1.2	3.9	0.01	3	37	0.38	0.07
...high production system	250	0.12	7.8	45	5.8	3.3	0.03	11	34	0.37	0.25
Middle East	350	0.22	13.6	79	5.9	3.5	0.03	12	67	0.52	0.15
...low production system	270	0.16	12.5	58	3.6	3.7	0.02	8	50	0.51	0.13
...high production system	510	0.30	15.8	110	10.6	3.2	0.05	19	91	0.49	0.18
Indian Subcontinent	285	0.22	14.3	81	5.5	3.7	0.03	12	70	0.67	0.14
...low production system	265	0.21	14.0	77	4.6	3.7	0.03	10	68	0.70	0.13
...high production system	350	0.24	15.5	86	8.4	3.6	0.05	17	69	0.54	0.20

TABLE 10A.2-1C
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR NON-DAIRY CATTLE

Region	Weight, kg	CP of diet, %	N intake, Kg/hd/d	N intake, Kg/hd/yr	N retention due to milk production, kg/hd/d	N retention due to weight gain, kg/hd/d	N retention, kg/hd/d	N retention fraction	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}
North America				63				0.19	55	0.36
Mature Females	580	12.0%	0.22	81	0.02		6	0.07	75	0.35
Mature Males	820	12.0%	0.22	81	0.00		0	0.00	81	0.27

TABLE 10A.2-1C CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR NON-DAIRY CATTLE										
Region	**Weight, kg**	**CP of diet, %**	**N intake, Kg/hd/d**	**N intake, Kg/hd/yr**	**N retention due to milk production, kg/hd/d**	**N retention due to weight gain, kg/hd/d**	**N retention, kg/hd/d**	**N retention fraction**	**N excretion, kg/hd/yr**	**kg N(1000 kg animal mass^{-1}) day^{-1}**
Calves on milk	125	13.0%	0.05	19	0.00	0.03	12	0.65	7	0.15
Calves on forage	215	13.0%	0.14	50	0.00	0.03	11	0.22	39	0.50
Growing heifers/steers	300	13.0%	0.17	61	0.00	0.02	9	0.14	53	0.48
Replacement/growing	400	12.0%	0.17	60	0.00	0.01	4	0.07	60	0.39
Feedlot cattle	500	14.0%	0.23	83	0.00	0.03	11	0.13	72	0.39
Western Europe				66				0.04	63	0.42
Mature Males	600	14.7%	0.24	86	0.00		0	0.00	86	0.39
Replacement/growing	400	16.5%	0.20	72	0.00	0.01	3	0.04	69	0.47
Calves on milk	230	17.1%	0.07	26	0.00	0.01	3	0.10	23	0.28
Calves on forage	230	16.5%	0.11	40	0.00	0.01	3	0.06	38	0.45
Eastern Europe				65				0.08	60	0.47
Mature Females	500	15.1%	0.21	78	0.02	0.00	6	0.08	72	0.39
Mature Males	600	14.2%	0.19	71	0.00	0.00	0	0.00	71	0.32
Replacement/growing	350	14.2%	0.16	58	0.00	0.01	3	0.05	55	0.43
Calves on forage	180	14.3%	0.14	51	0.00	0.02	6	0.12	45	0.68
Oceania				61				0.00	58	0.46
Mature Females	416	14.0%	0.20	73	0.01	0.00	4	0.05	70	0.46
Mature Males	467	14.0%	0.17	62	0.00	0.00	0	0.00	62	0.36
Young	185	14.0%	0.11	42	0.00	0.01	4	0.10	37	0.55
Latin America				38				0.02	37	0.33
Mature Females	435	9.5%	0.15	54	0.01	0.00	3	0.06	50	0.32
Mature Males	582	9.8%	0.15	55	0.00	0.00	0	0.00	55	0.26

TABLE 10A.2-1C
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR NON-DAIRY CATTLE

Region	Weight, kg	CP of diet, %	N intake, Kg/hd/d	N intake, Kg/hd/yr	N retention due to milk production, kg/hd/d	N retention due to weight gain, kg/hd/d	N retention, kg/hd/d	N retention fraction	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}
Growing heifers/steers	240	9.8%	0.09	32	0.00	0.00	0	0.00	32	0.37
Replacement/growing	302	9.6%	0.10	38	0.00	0.00	0	0.00	38	0.34
Calves on milk	66	3.5%	0.01	3	0.00	0.00	0	0.00	3	0.12
Calves on forage	160	10.0%	0.07	27	0.00	0.00	0	0.00	27	0.46
Feedlot cattle	460	14.0%	0.18	66	0.00	0.00	0	0.00	66	0.39
Latin America: high productivity system				50				0.02	46	0.36
Mature Females	490	11.2%	0.19	68	0.01	0.00	5	0.07	63	0.35
Mature Males	595	11.2%	0.17	61	0.00	0.00	0	0.00	61	0.28
Growing heifers/steers	240	11.8%	0.12	43	0.00	0.01	5	0.12	38	0.43
Replacement/growing	350	11.0%	0.15	56	0.00	0.01	4	0.07	52	0.41
Calves on milk	82	3.5%	0.01	4	0.00	0.01	3	0.72	1	0.04
Calves on forage	200	12.3%	0.12	44	0.00	0.01	5	0.10	39	0.53
Feedlot cattle	460	14.0%	0.19	70	0.00	0.02	7	0.10	63	0.37
Latin America: low productivity system				35				0.15	32	0.28
Mature Females	420	9.1%	0.14	50	0.01	0.00	3	0.07	46	0.30
Mature Males	580	9.6%	0.15	54	0.00	0.00	0	0.00	54	0.25
Growing heifers/steers	240	9.2%	0.08	30	0.00	0.01	3	0.10	27	0.30
Replacement/growing	290	9.3%	0.09	35	0.00	0.01	3	0.08	32	0.30
Calves on milk	60	3.5%	0.01	3	0.00	0.01	2	0.78	1	0.03
Calves on forage	145	9.2%	0.06	22	0.00	0.01	3	0.14	19	0.37

TABLE 10A.2-1C
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR NON-DAIRY CATTLE

Region	Weight, kg	CP of diet, %	N intake, Kg/hd/d	N intake, Kg/hd/yr	N retention due to milk production, kg/hd/d	N retention due to weight gain, kg/hd/d	N retention, kg/hd/d	N retention fraction	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}
Asia				39				0.07	37	0.38
Mature Females	376	10.6%	0.13	48	0.01	0.00	3	0.06	45	0.33
Mature Females - grazing	305	10.0%	0.10	37	0.01	0.00	3	0.07	34	0.31
Mature Males	501	10.1%	0.14	50	0.00	0.00	0	0.00	50	0.27
Mature Males - grazing	430	10.0%	0.13	47	0.00	0.00	0	0.00	47	0.30
Growing/Replacement	207	10.5%	0.09	33	0.00	0.01	2	0.07	31	0.40
Calves on forage	90	10.7%	0.06	22	0.00	0.01	3	0.15	19	0.58
Asia: low productivity system				38				0.06	36	0.38
Mature Females-Farming	350	10.0%	0.12	44	0.01	0.00	3	0.06	42	0.33
Mature Females-Grazing	305	10.0%	0.10	37	0.01	0.00	3	0.07	34	0.31
Mature Males-Farming	500	10.0%	0.14	50	0.00	0.00	0	0.00	50	0.27
Mature Males-Grazing	430	10.0%	0.13	47	0.00	0.00	0	0.00	47	0.30
Growing/Replacement	190	10.0%	0.08	30	0.00	0.01	2	0.07	28	0.41
Calves on forage	75	10.0%	0.05	20	0.00	0.01	3	0.14	17	0.61
Asia: high productivity system				41				0.10	37	0.36
Mature Females	450	12.5%	0.14	52	0.01	0.00	4	0.07	49	0.30
Mature Males	550	12.5%	0.13	47	0.00	0.00	0	0.00	47	0.23
Growing/Replacement	285	12.5%	0.11	40	0.00	0.01	3	0.07	37	0.35
Calves on forage	125	12.5%	0.07	26	0.00	0.01	5	0.18	22	0.47
Africa				36				0.07	34	0.43

TABLE 10A.2-1C
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR NON-DAIRY CATTLE

Region	Weight, kg	CP of diet, %	N intake, Kg/hd/d	N intake, Kg/hd/yr	N retention due to milk production, kg/hd/d	N retention due to weight gain, kg/hd/d	N retention, kg/hd/d	N retention fraction	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}
Mature Females	356	11.3%	0.15	55	0.01	0.00	5	0.09	51	0.39
Mature Females-Grazing	275	10.0%	0.11	39	0.01	0.00	2	0.06	37	0.36
Mature Males	540	11.2%	0.17	61	0.00	0.00	0	0.00	61	0.31
Draft Bullocks	340	10.0%	0.10	37	0.00	0.00	0	0.00	37	0.29
Bulls - Grazing	340	10.0%	0.11	39	0.00	0.00	0	0.00	39	0.32
Growing/Replacement	204	10.4%	0.09	33	0.00	0.01	2	0.06	31	0.41
Calves on forage	82	10.3%	0.06	22	0.00	0.01	3	0.14	19	0.65
Africa: low productivity system				32				0.06	30	0.44
Mature Females	275	10.0%	0.11	42	0.01	0.00	2	0.06	39	0.39
Mature Females-Grazing	275	10.0%	0.11	39	0.01	0.00	2	0.06	37	0.36
Draft Bullocks	340	10.0%	0.10	37	0.00	0.00	0	0.00	37	0.29
Bulls - Grazing	340	10.0%	0.12	45	0.00	0.00	0	0.00	45	0.36
Growing/Replacement	185	10.0%	0.08	29	0.00	0.00	2	0.06	27	0.40
Calves on forage	75	10.0%	0.06	21	0.00	0.01	3	0.13	18	0.65
Africa: high productivity system				48				0.09	44	0.42
Mature Females	390	11.8%	0.17	62	0.02	0.00	6	0.09	56	0.40
Mature Males	540	11.2%	0.17	61	0.00	0.00	0	0.00	61	0.31
Growing/Replacement	250	11.2%	0.11	39	0.00	0.01	3	0.09	35	0.39
Calves on forage	105	11.4%	0.08	28	0.00	0.01	4	0.14	24	0.64
Indian Subcontinent				33				0.04	32	0.44

TABLE 10A.2-1C CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR NON-DAIRY CATTLE										
Region	**Weight, kg**	**CP of diet, %**	**N intake, Kg/hd/d**	**N intake, Kg/hd/yr**	**N retention due to milk production, kg/hd/d**	**N retention due to weight gain, kg/hd/d**	**N retention, kg/hd/d**	**N retention fraction**	**N excretion, kg/hd/yr**	**kg N(1000 kg animal mass^{-1}) day^{-1}**
Mature Females	253	10.2%	0.12	44	0.01	0.00	3	0.07	40	0.44
Mature Males	291	10.1%	0.10	35	0.00	0.00	0	0.00	35	0.33
Draft bullocks	290	10.0%	0.09	32	0.00	0.00	0	0.00	32	0.31
Replacement/growing	158	10.9%	0.08	31	0.00	0.00	2	0.05	29	0.50
Calves on forage	72	11.2%	0.06	22	0.00	0.01	2	0.11	20	0.74
Indian subcontinent: low productivity system				32				0.04	31	0.40
Mature Females	250	10.0%	0.12	43	0.01	0.00	4	0.08	39	0.43
Mature Males	290	10.0%	0.10	37	0.00	0.00	0	0.00	37	0.35
Draft bullocks	290	10.0%	0.09	32	0.00	0.00	0	0.00	32	0.31
Replacement/growing	140	10.0%	0.07	25	0.00	0.00	1	0.05	24	0.47
Calves on forage	60	10.0%	0.05	18	0.00	0.01	2	0.11	16	0.73
Indian subcontinent: high productivity system				38				0.08	36	0.63
Mature Females	300	13.0%	0.16	57	0.01	0.00	5	0.09	52	0.48
Mature Males	330	13.0%	0.13	46	0.00	0.00	0	0.00	46	0.39
Replacement/growing	200	13.0%	0.12	44	0.00	0.01	2	0.06	41	0.57
Calves on forage	90	13.0%	0.08	28	0.00	0.01	3	0.11	25	0.77
Middle East				55				0.07	51	0.70
Mature Females	386	14.2%	0.20	71	0.01	0.00	5	0.06	67	0.47
Mature Males	483	13.9%	0.20	72	0.00	0.00	0	0.00	72	0.41
Replacement/growing	250	14.2%	0.15	56	0.00	0.01	3	0.05	53	0.58

TABLE 10A.2-1C
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR NON-DAIRY CATTLE

Region	Weight, kg	CP of diet, %	N intake, Kg/hd/d	N intake, Kg/hd/yr	N retention due to milk production, kg/hd/d	N retention due to weight gain, kg/hd/d	N retention, kg/hd/d	N retention fraction	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}
Calves on forage	114	14.2%	0.12	45	0.00	0.01	5	0.10	40	0.96
Midle East: low productivity system				48				0.06	46	0.75
Mature Females	330	13.5%	0.18	64	0.01	0.00	5	0.08	59	0.49
Mature Males	450	13.5%	0.20	73	0.00	0.00	0	0.00	73	0.45
Replacement/growing	200	13.5%	0.13	47	0.00	0.01	2	0.05	45	0.61
Calves on forage	85	13.5%	0.10	38	0.00	0.01	4	0.10	34	1.09
Midle East: high productivity system				68				0.07	63	0.63
Mature Females	500	15.5%	0.23	85	0.01	0.00	5	0.06	80	0.44
Mature Males	600	15.5%	0.22	81	0.00	0.00	0	0.00	81	0.37
Replacement/growing	350	15.5%	0.20	72	0.00	0.01	4	0.05	69	0.54
Calves on forage	165	15.5%	0.15	56	0.00	0.02	6	0.11	50	0.83

TABLE 10A.2-1D
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR BUFFALO

Region	Weight, kg	CP of diet, %	N intake, kg/hd/d	N intake, Kg/hd/yr	N retention due to milk production, kg/hd/d	N retention due to weight gain, kg/hd/d	N retention, kg/hd/yr	N retention fraction	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}
Indian Subcontinent								0.13	60	0.57
Breeding males	560	12%	0.20	73			0	0.00	73	0.36
Working males	560	12%	0.29	106			0	0.00	106	0.52
Mature Females	480	12%	0.29	105	0.05		20	0.19	85	0.49
Growing	195	12%	0.10	37		0.01	3	0.08	34	0.48
Calves	85	12%	0.08	29		0.01	3	0.10	26	0.83
Asia								0.08	48	0.44
Mature Males	490	10%	0.17	60			0	0.00	60	0.34
Mature Females	420	10%	0.19	68	0.02		8	0.12	60	0.39
Growing	225	10%	0.10	38		0.01	2	0.05	36	0.44
Calves	90	10%	0.07	26		0.01	3	0.11	23	0.69
Latin America								0.10	58	0.40
Mature Males	650	12%	0.20	71			0	0.00	71	0.30
Mature Females	550	12%	0.25	92	0.05		17	0.18	75	0.37
Growing	240	12%	0.12	44		0.01	4	0.08	41	0.47
Calves	90	12%	0.06	22		0.01	3	0.14	19	0.56
Africa								0.16	47	0.46
Mature Males	590	10%	0.18	65			0	0.00	65	0.30
Mature Females	440	10%	0.20	74	0.05		18	0.24	56	0.35
Growing	300	10%	0.13	49		0.01	3	0.07	46	0.42
Calves	115	10%	0.08	30		0.01	4	0.14	26	0.61

TABLE 10A.2-1D
CALCULATIONS IN THE DEVELOPMENT OF N EXCRETION AND N RETENTION ESTIMATES FOR BUFFALO

Region	Weight, kg	CP of diet, %	N intake, kg/hd/d	N intake, Kg/hd/yr	N retention due to milk production, kg/hd/d	N retention due to weight gain, kg/hd/d	N retention, kg/hd/yr	N retention fraction	N excretion, kg/hd/yr	kg N(1000 kg animal mass^{-1}) day^{-1}
Middle East								0.13	44	0.42
Mature Males	650	11%	0.20	73			0	0.00	73	0.31
Mature Females	520	11%	0.19	70	0.03		12	0.17	58	0.30
Growing	255	11%	0.11	41		0.01	3	0.08	38	0.40
Calves	105	11%	0.07	27		0.01	4	0.14	23	0.61
Western Europe								0.12	82	0.42
Mature Males	700	14%	0.21	78			0	0.00	78	0.31
Mature Females	615	15%	0.29	105	0.04		14	0.13	91	0.41
Growing	420	14%	0.18	66		0.01	4	0.06	62	0.41
Calves	170	14%	0.13	46		0.02	6	0.13	40	0.65
Eastern Europe								0.17	55	0.35
Mature Males	650	13%	0.17	61			0	0.00	61	0.26
Mature Females	550	13%	0.22	79	0.05		17	0.22	62	0.31
Growing	340	13%	0.14	51		0.01	4	0.08	47	0.38
Calves	155	13%	0.10	37		0.02	6	0.16	31	0.54

TABLE 10A.2-2
SUGGESTED ANIMAL WASTE MANAGEMENT SYSTEM (AWMS) BREAKDOWNS FOR DIFFERENT WORLD REGIONS AND CORRESPONDING PRODUCTION SYSTEMS FOR CATTLE. IN THE CASE OF CATTLE, AWMS DO NOT DIFFER BY PRODUCTIVITY SYSTENS (HIGH OR LOW PRODUCTIVY) FOR TIER 1B CALCULATIONS.

Animal Category	Region[1]	Climate and System Based Category[2]	AWMS (%)								
			Lagoon	Liquid /Slurry	Solid storage	Drylot	Pasture/ Range/ Paddock	Daily spread	Digester	Burned for fuel	Other
Dairy Cows	North America	GRASSland based Arid	48	24	14	0	7	7	0	0	0
		GRASSland based Humid	26	15	12	0	33	14	0	0	0
		GRASSland based Temperate	13	26	29	0	17	15	0	0	0
		Mixed Arid	50	24	15	0	3	8	0	0	0
		Mixed Humid	33	18	12	0	23	13	0	0	0
		Mixed Temperate	15	27	35	0	13	11	0	0	0
		Average	**30.9**	**22.3**	**19.4**	**0.0**	**16.0**	**11.3**	**0.0**	**0.0**	**0.0**
	Western Europe	GRASSland based Arid	0.1	24.2	46.9	0.0	24.2	4.6	0.0	0.0	0.0
		GRASSland based Humid	0.1	32.8	19.7	0.0	40.2	7.1	0.0	0.0	0.0
		GRASSland based Temperate	0.0	45.4	26.3	0.0	25.8	2.5	0.0	0.0	0.0
		Mixed Arid	0.1	18.3	49.2	0.0	29.2	3.2	0.0	0.0	0.0
		Mixed Humid	0.0	20.7	33.3	0.0	44.1	1.8	0.0	0.0	0.0
		Mixed Temperate	0.0	50.8	24.4	0.0	23.6	1.1	0.0	0.0	0.0
		Average	**0.1**	**32.0**	**33.3**	**0.0**	**31.2**	**3.4**	**0.0**	**0.0**	**0.0**
	Eastern Europe	GRASSland based Humid or Arid	0.0	18.8	67.2	0.0	13.0	1.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	14.4	67.0	0.0	16.0	2.6	0.0	0.0	0.0
		Mixed Arid	0.0	18.8	67.2	0.0	13.0	1.0	0.0	0.0	0.0
		Mixed Temperate	0.0	9.3	72.7	0.0	16.8	1.2	0.0	0.0	0.0
		Russia	0.0	0.0	77.5	0.0	22.5	0.0	0.0	0.0	0.0
		Average (excluding Russia)	**0.0**	**15.3**	**68.5**	**0.0**	**14.7**	**1.4**	**0.0**	**0.0**	**0.0**

	Oceania	GRASSland based Arid	4.3	0.1	0.0	0.0	93.8	1.8	0.0	0.0	0.0
		GRASSland based Humid	4.6	0.1	0.0	0.0	94.4	0.9	0.0	0.0	0.0
		GRASSland based Temperate	4.9	0.0	0.0	0.0	94.8	0.3	0.0	0.0	0.0
		Mixed Arid	3.9	0.1	0.0	0.0	93.4	2.5	0.0	0.0	0.0
		Mixed Humid	4.8	0.0	0.0	0.0	94.7	0.5	0.0	0.0	0.0
		Mixed Temperate	4.0	0.1	0.0	0.0	93.3	2.6	0.0	0.0	0.0
		Average	**4.4**	**0.1**	**0.0**	**0.0**	**94.1**	**1.4**	**0.0**	**0.0**	**0.0**
	East Asia and South-East Asia (Asia)	GRASSland based Arid	0.0	0.1	0.0	4.1	77.7	0.0	0.0	18.2	0.0
		GRASSland based Humid	0.0	1.9	0.2	4.1	80.5	0.0	0.0	13.4	0.0
		GRASSland based Temperate	0.0	4.0	36.2	0.0	42.2	0.0	0.0	17.6	0.0
		Mixed Arid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		Mixed Humid	0.0	0.7	0.1	73.7	25.6	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	1.9	71.3	0.0	26.8	0.0	0.0	0.0	0.0
		Average	**0.0**	**1.4**	**17.9**	**26.1**	**46.3**	**0.0**	**0.0**	**8.2**	**0.0**
	South Asia (Indian subcontinent)	GRASSland based Arid	0.0	0.0	0.0	4.0	76.0	0.0	0.0	20.0	0.0
		GRASSland based Humid	0.0	0.0	0.0	4.0	76.0	0.0	0.0	20.0	0.0
		GRASSland based Temperate	0.0	0.0	40.0	0.0	40.0	0.0	0.0	20.0	0.0
		Mixed Arid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		Mixed Humid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		Mixed Temperate	0.0	0.0	60.0	0.0	20.0	0.0	0.0	20.0	0.0
		Average	**0.0**	**0.0**	**16.7**	**21.3**	**42.0**	**0.0**	**0.0**	**20.0**	**0.0**
	Latin America and the Caribbean	GRASSland based Arid	0.0	0.0	0.0	24.7	74.1	0.0	0.0	1.3	0.0
		GRASSland based Humid	0.0	0.0	0.0	25.0	74.9	0.0	0.0	0.1	0.0
		GRASSland based Temperate	0.0	0.0	64.2	0.0	31.5	0.0	0.0	4.2	0.0
		Mixed Arid	0.0	0.0	0.0	49.8	49.8	0.0	0.0	0.3	0.0

		Mixed Humid	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	65.9	0.0	32.4	0.0	0.0	1.7	0.0
		Average	**0.0**	**0.0**	**21.7**	**24.9**	**52.1**	**0.0**	**0.0**	**1.3**	**0.0**
	Near East (Middle East) and North Africa	GRASSland based Arid	0.0	0.0	0.0	19.8	75.2	0.0	0.0	4.9	0.0
		GRASSland based Humid	0.0	0.0	0.0	23.5	75.1	0.0	0.0	1.4	0.0
		GRASSland based Temperate	0.0	0.0	40.3	0.0	39.9	0.0	0.0	19.8	0.0
		Mixed Arid	0.0	0.0	0.0	64.1	35.5	0.0	0.0	0.4	0.0
		Mixed Humid	0.0	0.0	0.0	67.4	32.6	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	70.2	0.0	23.8	0.0	0.0	6.1	0.0
		Average	**0.0**	**0.0**	**18.4**	**29.1**	**47.0**	**0.0**	**0.0**	**5.4**	**0.0**
	Sub-Saharan Africa	GRASSland based Arid	0.0	0.0	0.0	21.6	64.7	0.0	0.0	13.7	0.0
		GRASSland based Humid	0.0	0.0	0.0	25.0	75.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	67.0	0.0	33.0	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	0.0	0.0	53.9	36.0	0.0	0.0	10.1	0.0
		Mixed Humid	0.0	0.0	0.0	60.0	40.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	75.0	0.0	25.0	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.0**	**23.7**	**26.8**	**45.6**	**0.0**	**0.0**	**4.0**	**0.0**
Non Dairy Cattle	North America	GRASSland based Arid	0.0	0.2	42.7	14.4	42.7	0.0	0.0	0.0	0.0
		GRASSland based Humid	0.0	0.0	42.5	15.0	42.5	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	1.3	43.8	10.7	44.2	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	0.0	42.5	15.0	42.5	0.0	0.0	0.0	0.0
		Mixed Humid	0.0	0.0	42.5	15.0	42.5	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.4	42.9	13.8	43.0	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.3**	**42.8**	**14.0**	**42.9**	**0.0**	**0.0**	**0.0**	**0.0**
	Western Europe	GRASSland based Arid	0.0	16.3	30.2	0.0	52.5	1.1	0.0	0.0	0.0

		GRASSland based Humid	0.0	13.0	21.2	0.0	63.4	2.5	0.0	0.0	0.0
		GRASSland based Temperate	0.0	19.2	24.9	0.6	46.0	9.2	0.0	0.0	0.0
		Mixed Arid	0.0	22.7	29.1	0.0	48.0	0.2	0.0	0.0	0.0
		Mixed Humid	0.0	26.1	20.0	0.0	51.6	2.3	0.0	0.0	0.0
		Mixed Temperate	0.0	26.1	26.4	0.0	41.1	6.4	0.0	0.0	0.0
		Average	**0.0**	**20.6**	**25.3**	**0.1**	**50.4**	**3.6**	**0.0**	**0.0**	**0.0**
	Eastern Europe	GRASSland based Arid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	63.6	5.3	0.0	31.2	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	63.9	4.5	0.0	31.6	0.0	0.0	0.0	0.0
		Average	**0.0**	**63.8**	**4.9**	**0.0**	**31.4**	**0.0**	**0.0**	**0.0**	**0.0**
	Oceania		0.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0
	East Asia and South-East Asia	GRASSland based Arid	0.0	0.0	0.0	4.1	77.4	0.0	0.0	18.5	0.0
		GRASSland based Humid	0.0	0.0	0.0	4.3	82.2	0.0	0.0	13.5	0.0
		GRASSland based Temperate	0.0	0.1	39.1	0.0	41.9	0.0	0.0	18.9	0.0
		Mixed Arid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		Mixed Humid	0.0	0.0	0.0	74.8	25.2	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	74.3	0.0	25.6	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.0**	**18.9**	**26.4**	**46.2**	**0.0**	**0.0**	**8.5**	**0.0**
	South Asia (Indian subcontinent)	GRASSland based Arid	0.0	0.0	0.0	4.0	76.0	0.0	0.0	20.0	0.0
		GRASSland based Humid	0.0	0.0	0.0	4.0	76.0	0.0	0.0	20.0	0.0
		GRASSland based Temperate	0.0	0.0	40.0	0.0	40.0	0.0	0.0	20.0	0.0
		Mixed Arid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		Mixed Humid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		Mixed Temperate	0.0	0.0	60.0	0.0	20.0	0.0	0.0	20.0	0.0
		Average	**0.0**	**0.0**	**16.7**	**21.3**	**42.0**	**0.0**	**0.0**	**20.0**	**0.0**

	Latin America and the Caribbean	GRASSland based Arid	0.0	0.0	0.0	5.0	94.4	0.0	0.0	0.6	0.0
		GRASSland based Humid	0.0	0.0	0.0	5.0	94.9	0.0	0.0	0.1	0.0
		GRASSland based Temperate	0.0	0.0	64.4	0.0	31.6	0.0	0.0	4.0	0.0
		Mixed Arid	0.0	0.0	0.0	5.0	94.8	0.0	0.0	0.2	0.0
		Mixed Humid	0.0	0.0	0.0	5.0	95.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	65.6	0.0	32.3	0.0	0.0	2.1	0.0
		Average	**0.0**	**0.0**	**21.7**	**3.3**	**73.8**	**0.0**	**0.0**	**1.2**	**0.0**
	Near East (Middle East) and North Africa	GRASSland based Arid	0.0	0.0	0.0	4.8	76.0	0.0	0.0	19.2	0.0
		GRASSland based Humid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	40.0	0.0	40.0	0.0	0.0	20.0	0.0
		Mixed Arid	0.0	0.0	0.0	74.8	25.2	0.0	0.0	0.0	0.0
		Mixed Humid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	75.0	0.0	25.0	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.0**	**28.8**	**19.9**	**41.5**	**0.0**	**0.0**	**9.8**	**0.0**
	Sub-Saharan Africa	GRASSland based Arid	0.0	0.0	0.0	22.8	68.3	0.0	0.0	8.9	0.0
		GRASSland based Humid	0.0	0.0	0.0	25.0	75.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	67.0	0.0	33.0	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	0.0	0.0	57.2	38.2	0.0	0.0	4.6	0.0
		Mixed Humid	0.0	0.0	0.0	60.0	40.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	75.0	0.0	25.0	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.0**	**23.7**	**27.5**	**46.6**	**0.0**	**0.0**	**2.3**	**0.0**

[1] Corresponding name to enteric fermentation definitions provided in brackets

[2] For Tier 1, unless specific knowledge of production systems is known, countries should use average AWMS distributions for the regions from which they come.

TABLE 10A.2-3
SUGGESTED ANIMAL WASTE MANAGEMENT SYSTEM (AWMS) BREAKDOWNS FOR DIFFERENT WORLD REGIONS AND CORRESPONDING PRODUCTION SYSTEMS FOR BUFFALO.

Animal Category	Region[1]	Climate and System Based Category[2]	AWMS (%)								
			Lagoon	Liquid /Slurry	Solid storage	Drylot	Pasture/ Range/ Paddock	Daily spread	Digester	Burned for fuel	Other
Buffalo-meat	Russia		**0.0**	**5.6**	**66.6**	**0.0**	**27.8**	**0.0**	**0.0**	**0.0**	**0.0**
	Eastern Europe	GRASSland based Arid	0.0	5.6	66.6	0.0	27.8	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	5.6	66.6	0.0	27.8	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	5.6	66.6	0.0	27.8	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	11.6	62.8	0.0	25.6	0.0	0.0	0.0	0.0
		Average	**0.0**	**7.1**	**65.6**	**0.0**	**27.3**	**0.0**	**0.0**	**0.0**	**0.0**
	Near East (Middle East) and North Africa	GRASSland based Arid	0.0	0.0	17.9	3.0	63.9	0.0	0.0	15.2	0.0
		GRASSland based Humid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	40.0	0.0	40.0	0.0	0.0	20.0	0.0
		Mixed Arid	0.0	0.0	0.0	31.0	56.1	0.0	0.0	12.9	0.0
		Mixed Humid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	12.3	55.6	23.2	0.0	0.0	8.8	0.0
		Average	**0.0**	**0.0**	**11.7**	**40.0**	**38.9**	**0.0**	**0.0**	**9.5**	**0.0**
	East Asia and South-East Asia (Asia)	GRASSland based Arid	0.0	0.0	16.1	3.2	68.5	0.0	0.0	12.1	0.0
		GRASSland based Humid	0.0	0.0	0.0	73.9	26.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.2	38.2	0.0	45.7	0.0	0.0	15.9	0.0
		Mixed Arid	0.0	0.0	0.1	29.2	62.8	0.0	0.0	7.9	0.0
		Mixed Humid	0.0	0.0	0.0	74.7	25.3	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.1	43.3	28.8	27.8	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.1**	**16.3**	**35.0**	**42.7**	**0.0**	**0.0**	**6.0**	**0.0**
	South Asia	GRASSland based Arid	0.0	0.0	0.6	4.0	75.4	0.0	0.0	20.0	0.0
		GRASSland based Humid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		GRASSland based Temperate	0.0	0.0	40.0	0.0	40.0	0.0	0.0	20.0	0.0
		Mixed Arid	0.0	0.0	0.0	42.8	37.2	0.0	0.0	20.0	0.0

		Mixed Humid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		Mixed Temperate	0.0	0.0	58.6	1.4	20.0	0.0	0.0	20.0	0.0
		Average	**0.0**	**0.0**	**16.5**	**28.0**	**35.4**	**0.0**	**0.0**	**20.0**	**0.0**
	Latin America and the Caribbean	GRASSland based Arid	0.0	0.0	31.9	2.6	65.4	0.0	0.0	0.0	0.0
		GRASSland based Humid	0.0	0.0	0.0	5.0	95.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	67.0	0.0	33.0	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	0.0	0.0	5.0	95.0	0.0	0.0	0.0	0.0
		Mixed Humid	0.0	0.0	0.0	5.0	95.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	66.2	0.1	33.7	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.0**	**27.5**	**2.9**	**69.5**	**0.0**	**0.0**	**0.0**	**0.0**
Buffalo-dairy	North America	GRASSland based Arid	0.0	42.4	40.2	0.0	17.4	0.0	0.0	0.0	0.0
		GRASSland based Humid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	42.4	40.2	0.0	17.4	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Mixed Humid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	42.4	40.2	0.0	17.4	0.0	0.0	0.0	0.0
		Average	**0.0**	**21.2**	**20.1**	**0.0**	**8.7**	**0.0**	**0.0**	**0.0**	**0.0**
	Western Europe		**0.0**	**34.0**	**63.0**	**0.0**	**3.0**	**0.0**	**0.0**	**0.0**	**0.0**
	Eastern Europe	GRASSland based Arid	0.0	19.0	67.0	0.0	13.0	1.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	18.1	67.9	0.0	13.0	1.0	0.0	0.0	0.0
		Mixed Arid	0.0	19.0	67.0	0.0	13.0	1.0	0.0	0.0	0.0
		Mixed Temperate	0.0	18.3	67.7	0.0	13.0	1.0	0.0	0.0	0.0
		Average	**0.0**	**18.6**	**67.4**	**0.0**	**13.0**	**1.0**	**0.0**	**0.0**	**0.0**
	Near East (Middle East) and North Africa	GRASSland based Arid	0.0	0.0	47.4	8.3	43.5	0.0	0.0	0.8	0.0
		GRASSland based Humid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	40.0	0.0	40.0	0.0	0.0	20.0	0.0
		Mixed Arid	0.0	0.0	0.0	49.3	49.9	0.0	0.0	0.7	0.0
		Mixed Humid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	15.9	59.1	25.0	0.0	0.0	0.0	0.0

		Average	**0.0**	**0.0**	**17.2**	**44.5**	**34.7**	**0.0**	**0.0**	**3.6**	**0.0**
	East Asia and South-East Asia	GRASSland based Arid	0.0	0.0	1.6	4.0	75.8	0.0	0.0	18.6	0.0
		GRASSland based Humid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	40.2	0.0	40.2	0.0	0.0	19.6	0.0
		Mixed Arid	0.0	0.0	0.0	29.1	59.4	0.0	0.0	11.5	0.0
		Mixed Humid	0.0	0.0	0.0	75.0	25.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	43.3	31.7	25.0	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.0**	**14.2**	**35.8**	**41.7**	**0.0**	**0.0**	**8.3**	**0.0**
	South Asia (Indian subcontinent)	GRASSland based Arid	0.0	0.0	0.5	4.0	75.5	0.0	0.0	20.0	0.0
		GRASSland based Humid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		GRASSland based Temperate	0.0	0.0	40.0	0.0	40.0	0.0	0.0	20.0	0.0
		Mixed Arid	0.0	0.0	0.0	45.1	34.9	0.0	0.0	20.0	0.0
		Mixed Humid	0.0	0.0	0.0	60.0	20.0	0.0	0.0	20.0	0.0
		Mixed Temperate	0.0	0.0	58.7	1.3	20.0	0.0	0.0	20.0	0.0
		Average	**0.0**	**0.0**	**16.5**	**28.4**	**35.1**	**0.0**	**0.0**	**20.0**	**0.0**
	Latin America and the Caribbean	GRASSland based Arid	0.0	0.0	30.2	13.7	56.0	0.0	0.0	0.0	0.0
		GRASSland based Humid	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0
		GRASSland based Temperate	0.0	0.0	67.0	0.0	33.0	0.0	0.0	0.0	0.0
		Mixed Arid	0.0	0.0	0.0	26.0	74.0	0.0	0.0	0.0	0.0
		Mixed Humid	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0
		Mixed Temperate	0.0	0.0	66.2	0.6	33.2	0.0	0.0	0.0	0.0
		Average	**0.0**	**0.0**	**27.2**	**23.4**	**49.4**	**0.0**	**0.0**	**0.0**	**0.0**

[1] Corresponding name to enteric fermentation definitions provided in brackets

[2] For Tier 1, unless specific knowledge of production systems is known, countries should use average AWMS distributions for the regions from which they come.

TABLE 10A.2-4
SUGGESTED ANIMAL WASTE MANAGEMENT SYSTEM (AWMS) BREAKDOWNS FOR DIFFERENT WORLD REGIONS AND CORRESPONDING PRODUCTION SYSTEMS FOR SWINE.

Animal Category	Productivity Class	Region	Manure Management System Usage (MS%)								
			Lagoon	Liquid/ Slurry	Solid storage	Drylot	Pit <1 month	Pit >1 month	Daily spread	Digester	Pasture/ Range/ Paddock

Growing Swine	High Productivity (Industiral)	North America	28.0	31.0	4.0	3.0	0.0	34.0	0.0	0.0	0.0
		Western Europe	6.0	52.0	14.0	0.0	2.0	25.0	1.0	0.0	0.0
		Eastern Europe	6.0	36.0	53.0	1.0	2.0	2.0	0.0	0.0	0.0
		Russia	0.0	24.0	76.0	0.0	0.0	0.0	0.0	0.0	0.0
		Oceania	92.0	0.0	1.0	7.0	0.0	0.0	0.0	0.0	0.0
		East Asia and South East Asia	38.0	22.0	1.0	2.0	30.0	0.0	0.0	7.0	0.0
		South Asia (Indian subcontinent)	12.0	28.0	5.0	46.0	1.0	0.0	3.0	7.0	0.0
		Latin America and the Caribean	11.0	34.0	12.0	41.0	0.0	0.0	2.0	0.0	0.0
		Near East (Middle East) and North Africa	10.0	29.0	0.0	54.0	0.0	0.0	0.0	7.0	0.0
		Sub-saharan Afirca	0.0	9.0	6.0	84.0	1.0	0.0	0.0	0.0	0.0
	Low Productivity	East Asia and South East Asia	31.0	10.0	1.0	2.0	38.0	0.0	1.0	10.0	7
		South Asia (Indian subcontinent)	12.0	11.0	16.0	30.0	3.0	0.0	9.0	11.0	8
		Latin America and the Caribean	12.0	16.0	13.0	41.0	0.0	0.0	2.0	16.0	0.0
		Near East (Middle East) and North Africa	7.5	22.5	7.5	34.0	7.5	2.5	2.5	10.0	6.0
		Sub-saharan Afirca	0.0	3.0	6.0	87.0	1.0	0.0	0.0	3.0	0.0
Breeding Swine	High Productivity (Industiral)	North America	28.0	31.0	4.0	3.0	0.0	34.0	0.0	0.0	0.0
		Western Europe	6.0	52.0	14.0	0.0	2.0	25.0	1.0	0.0	0.0
		Eastern Europe	6.0	36.0	53.0	1.0	2.0	2.0	0.0	0.0	0.0
		Russia	0.0	24.0	76.0	0.0	0.0	0.0	0.0	0.0	0.0
		Oceania	92.0	0.0	1.0	7.0	0.0	0.0	0.0	0.0	0.0
		East Asia and South East Asia	38.0	22.0	1.0	2.0	30.0	0.0	0.0	7.0	0.0
		South Asia (Indian subcontinent)	12.0	28.0	5.0	46.0	1.0	0.0	3.0	7.0	0.0
		Latin America and the Caribean	11.0	34.0	12.0	41.0	0.0	0.0	2.0	0.0	0.0
		Near East (Middle East) and North Africa	10.0	29.0	0.0	54.0	0.0	0.0	0.0	7.0	0.0
		Sub-saharan Afirca	0.0	9.0	6.0	84.0	1.0	0.0	0.0	0.0	0.0
	Low Productivity	East Asia and South East Asia	31.0	10.0	1.0	2.0	38.0	0.0	1.0	10.0	7
		South Asia (Indian subcontinent)	12.0	11.0	16.0	30.0	3.0	0.0	9.0	11.0	8
		Latin America and the Caribean	12.0	16.0	13.0	41.0	0.0	0.0	2.0	16.0	0.0
		Near East (Middle East) and North Africa	10.0	15.0	0.0	53.0	0.0	0.0	0.0	15.0	7.0
		Sub-saharan Afirca	0.0	3.0	6.0	87.0	1.0	0.0	0.0	3.0	0.0

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Table 10A.2-5 Suggested Animal Waste Management System (AWMS) breakdowns for different world regions and corresponding production systems for Sheep.											
Animal Category	Region[1]	Climate and System Based Category[2]	AWMS(%)								
			Lagoon	Liquid/ Slurry	Solid storage	Drylot	Pasture/ Range/ Paddock	Daily spread	Digester	Burned for fuel	Other

		GRASSland based Arid	0	0	53	0	47	0	0	0	0
	North America	GRASSland based Humid	0	0	55	0	45	0	0	0	0
		GRASSland based Temperate	0	0	52	0	48	0	0	0	0
		Mixed Arid	0	0	55	0	45	0	0	0	0
		Mixed Humid	0	0	55	0	45	0	0	0	0
		Mixed Temperate	0	0	54	0	46	0	0	0	0
		Average	**0**	**0**	**54**	**0**	**46**	**0**	**0**	**0**	**0**
	Russia		**0**	**0**	**82**	**0**	**18**	**0**	**0**	**0**	**0**
	Western Europe	GRASSland based Arid	0	0	15	0	85	0	0	0	0
		GRASSland based Humid	0	0	9	0	91	0	0	0	0
		GRASSland based Temperate	0	0	12	0	87	0	0	0	0
		Mixed Arid	0	0	18	0	82	0	0	0	0
		Mixed Humid	0	0	10	0	90	0	0	0	0
		Mixed Temperate	0	0	14	0	86	0	0	0	0
		Average	**0**	**0**	**13**	**0**	**87**	**0**	**0**	**0**	**0**
	Eastern Europe	GRASSland based Arid	0	0	50	0	50	0	0	0	0
		GRASSland based Temperate	0	0	57	0	43	0	0	0	0
		Mixed Arid	0	0	50	0	50	0	0	0	0
		Mixed Temperate	0	0	59	0	41	0	0	0	0
		Average	**0**	**0**	**54**	**0**	**46**	**0**	**0**	**0**	**0**
	Near East (Middle East) and North Africa		**0**	**0**	**0**	**50**	**50**	**0**	**0**	**0**	**0**
	East Asia and	GRASSland based Arid	0	0	0	5	95	0	0	0	0
		GRASSland based Humid	0	0	0	5	95	0	0	0	0
		GRASSland based Temperate	0	0	50	0	50	0	0	0	0

[1] Corresponding name to enteric fermentation definitions provided in brackets

[2] For Tier 1, unless specific knowledge of production systems is known, countries should use average AWMS distributions for the regions from which they come.

Table 10A.2-6
Suggested Animal Waste Management System (AWMS) breakdowns for different world regions and corresponding production systems for Goat.

Animal Category	Region[1]	Climate and System Based Category[2]	AWMS(%)								
			Lagoon	Liquid/ Slurry	Solid storage	Drylot	Pasture/ Range/ Paddock	Daily spread	Digester	Burned for fuel	Other

	North America		**0**	**0**	**50**	**0**	**50**	**0**	**0**	**0**	**0**
	Russia		**0**	**0**	**82**	**0**	**18**	**0**	**0**	**0**	**0**
	Western Europe	GRASSland based Arid	0	0	25	0	75	0	0	0	0
		GRASSland based Humid	0	0	22	0	78	0	0	0	0
		GRASSland based Temperate	0	0	36	0	64	0	0	0	0
		Mixed Arid	0	0	27	0	73	0	0	0	0
		Mixed Humid	0	0	23	0	77	0	0	0	0
		Mixed Temperate	0	0	36	0	64	0	0	0	0
		Average	**0**	**0**	**28**	**0**	**72**	**0**	**0**	**0**	**0**
	Eastern Europe	GRASSland based Arid	0	0	0	0	0	0	0	0	0
		GRASSland based Temperate	0	0	9	0	91	0	0	0	0
		Mixed Arid	0	0	8	0	92	0	0	0	0
		Mixed Temperate	0	0	10	0	90	0	0	0	0
		Average	**0**	**0**	**7**	**0**	**68**	**0**	**0**	**0**	**0**
Goat	Near East (Middle East) and North Africa		**0**	**0**	**0**	**50**	**50**	**0**	**0**	**0**	**0**
	East Asia and South-East Asia		**0**	**0**	**50**	**0**	**50**	**0**	**0**	**0**	**0**
	Oceania		**0**	**0**	**0**	**0**	**100**	**0**	**0**	**0**	**0**
	South Asia (Indian subcontinent)		**0**	**0**	**50**	**0**	**50**	**0**	**0**	**0**	**0**
	Latin America and the Caribbean	GRASSland based Arid	0	0	0	5	95	0	0	0	0
		GRASSland based Humid	0	0	0	5	95	0	0	0	0
		GRASSland based Temperate	0	0	50	0	50	0	0	0	0
		Mixed Arid	0	0	0	5	95	0	0	0	0

[1] Corresponding name to enteric fermentation definitions provided in brackets

[2] For Tier 1, unless specific knowledge of production systems is known, countries should use average AWMS distributions for the regions from which they come.

TABLE 10A.2-7
SUGGESTED ANIMAL WASTE MANAGEMENT SYSTEM (AWMS) BREAKDOWNS FOR DIFFERENT WORLD REGIONS AND CORRESPONDING PRODUCTION SYSTEMS FOR POULTRY.

Animal Category	Region	AWMS(%)								
		Lagoon	Liquid/Slurry	Solid storage	Drylot	Pasture/Range/Paddock	Pit >1 month	Daily spread	Digester	Other (Poultry manure with litter)

Chicken-Layer	North America	1.0	29.0	70.0	0.0	0.0	0.0	0.0	0.0	0
	Russia	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0
	Western Europe	0.0	1.2	20.3	21.1	0.0	43.1	0.6	0.0	13.6
	Eastern Europe	0.0	0.0	0.0	47.3	0.0	33.7	0.0	0.0	19
	Near East (Middle East) and North Africa	10.8	6.5	10.9	0.0	0.0	68.2	0.0	0.0	3.5
	East Asia and South-East Asia	0.0	4.4	0.0	0.0	1.4	93.1	0.9	0.0	0
	Oceania	0.0	0.0	0.0	0.0	23.0	77.0	0.0	0.0	0
	South Asia (Indian subcontinent)	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0
	Latin America and the Caribbean	0.0	58.5	41.5	0.0	0.0	0.0	0.0	0.0	0
	Sub-Saharan Africa	0.0	0.0	0.0	0.0	0.0	90.0	0.0	0.0	10
Chicken-Broiler	North America	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	Western Europe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	Eastern Europe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	Near East (Middle East) and North Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	East Asia and South-East Asia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	Oceania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	South Asia (Indian subcontinent)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	Latin America and the Caribbean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
	Sub-Saharan Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Low productivity	North America	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100
	Russia	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100
	Western Europe	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100
	Eastern Europe	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100
	Near East (Middle East) and North Africa	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100
	East Asia and South-East Asia	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100
	Oceania	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100
	South Asia (Indian subcontinent)	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	100

TABLE 10A.2-8 MANURE MANAGEMENT METHANE EMISSION FACTOR DERIVATION FOR OTHER ANIMALS									
Animal	Animal Characteristics						Manure management system MCF	Emission factors	
	Mass (kg)		VS (kg VS day^{-1})		Bo (m^3 kg VS)			(kg CH_4 head^{-1} yr^{-1})	
	Range	mean±SD	Range	mean±SD	Range	mean±SD		Range	mean±SD
Deer	50.00~126.52	71.50±30.78	0.74~1.27	0.83±0.22	0.18~0.19	0.18±0.004	NR	0.005~4.162	0.53±0.99
Reindeer	70	70±0.00	0.39~0.54	0.45±0.08	0.19	0.19±0.00	2.00%	0.219~0.362	0.31±0.06
Rabbits	1.60~4.30	2.32±1.19	0.10~0.15	0.11±0.02	0.32	0.32±0.00	1.00%	0.078~0.252	0.09±0.04
Fur-bearing animals	2.00~4.62	3.31±1.86	0.10~0.14	0.12±0.02	0.25	0.25±0.00	8.00%	0.378~0.685	0.62±0.09
Ostrich	120	120±0.00	1.16~1.95	1.75±0.39	0.25	0.25	8.00%	0.002~5.677	3.74±1.90
Calculated based on country submisison of CRF table to UNFCCC									

TABLE 10A.2-9A PARAMETERS FOR CALCULATING N RETENTION FOR BREEDING SWINE				
	Gestation		Piglets	
Parity	Days	Weight gain during gestation (kg)	N at birth (kg)	N at weaning (kg)
0	114	56.7	1.19	1.98
1	114	52.2	1.30	2.16
2+	114	38.6	1.40	2.34

TABLE 10A.2-9B PARAMETERS FOR CALCULATING N RETENTION FOR BREEDING SWINE						
annual	gestation		lactation		dry	
	days	N intake, kg	days	N intake, kg	days	N intake, kg
Parity 0	114	6.284	25	1.9	7	0.355
parity 1	114	6.63	25	2.2	7	0.56
parity 2	73	3.547				
Total N intake, kg		21.476				
Total weight gain, kg		133.5	30 kg weight gain sow		0.765 kg N retain in weight gain sow	
piglets		23	103 kg for piglets		2.472 kg retained in piglet at birth	
					4.14 kg retain in piglet at weaning	

INFORMATION REQUIRED TO DETERMINE CLIMATE ZONES ACCORDING TO CHAPTER 3 OF VOLUME 5 CURRENT GUIDELINE

Outlined below are the conditions required to determine the climate zone required for the selection of a party's MCF factor, according to the IPCC climate zone determination as defined in Volume 4, Chapter 3, Annex 3A.5, Figure 3A.5.2. Where possible, if countries span multiple climate zones, efforst should be made to disaggregate animal populations into climate zones. If this is not possible, partys are advised to select the climate zone covering the greatest surface area of their country or regions of their country for which they have distinct animal populations.

Briefly, all data is drawn from "The Climate Reseach Unit (CRU) or the CGIAR-Consortium for Spatial Information (CSI) 1985-2015." Climate zones are differentiated based on the factors of mean annual temperature, elevation, mean annual precipitation and the ratio of mean annual precipitation to precipitation

Therefore as identified in Chapter 3 of these guidelines climate zones are defined where

- Tropical Montane: has >18ºC mean annual temperature and at an elevation greater than 1000m
- Tropical Wet: has >18ºC mean annual temperature and mean annual precipitation >2000mm
- Tropical Moist: has >18ºC mean annual temperature and mean annual precipitation >1000mm
- Tropical Dry: has >18ºC mean annual temperature and mean annual precipitation < 1000mm
- Tropical Moist: has >18ºC mean annual temperature and mean annual precipitation >1000mm
- Warm temperate moist: has >10 ºC mean annual temperature and a ratio of potential evapotranspiration to prescipitation > 1
- Warm temperate dry: has >10 ºC mean annual temperature and a ratio of potential evapotranspiration to precipitation < 1
- Cool temperate moist: has > 0 ºC mean annual temperature and a ratio of potential evapotranspiration to precipitation >1
- Cool temperate dry: has > 0 ºC mean annual temperature and a ratio of potential evapotranspiration to precipitation <1
- Boreal moist: has < 0 ºC mean annual temperature but some monthly temperatures > 10and a ratio of potential evapotranspiration >1
- Boreal dry: has < 0 ºC mean annual temperature but some monthly temperatures > 10 and a ratio of potential evapotranspiration to precipitation <1
- Polar moist: has < 0 ºC mean annual temperature but all monthly temperatures < 10and a ratio of potential evapotranspiration >1
- Polar dry: has < 0 ºC mean annual temperature but all monthly temperatures < 10 and a ratio of potential evapotranspiration to precipitation <1

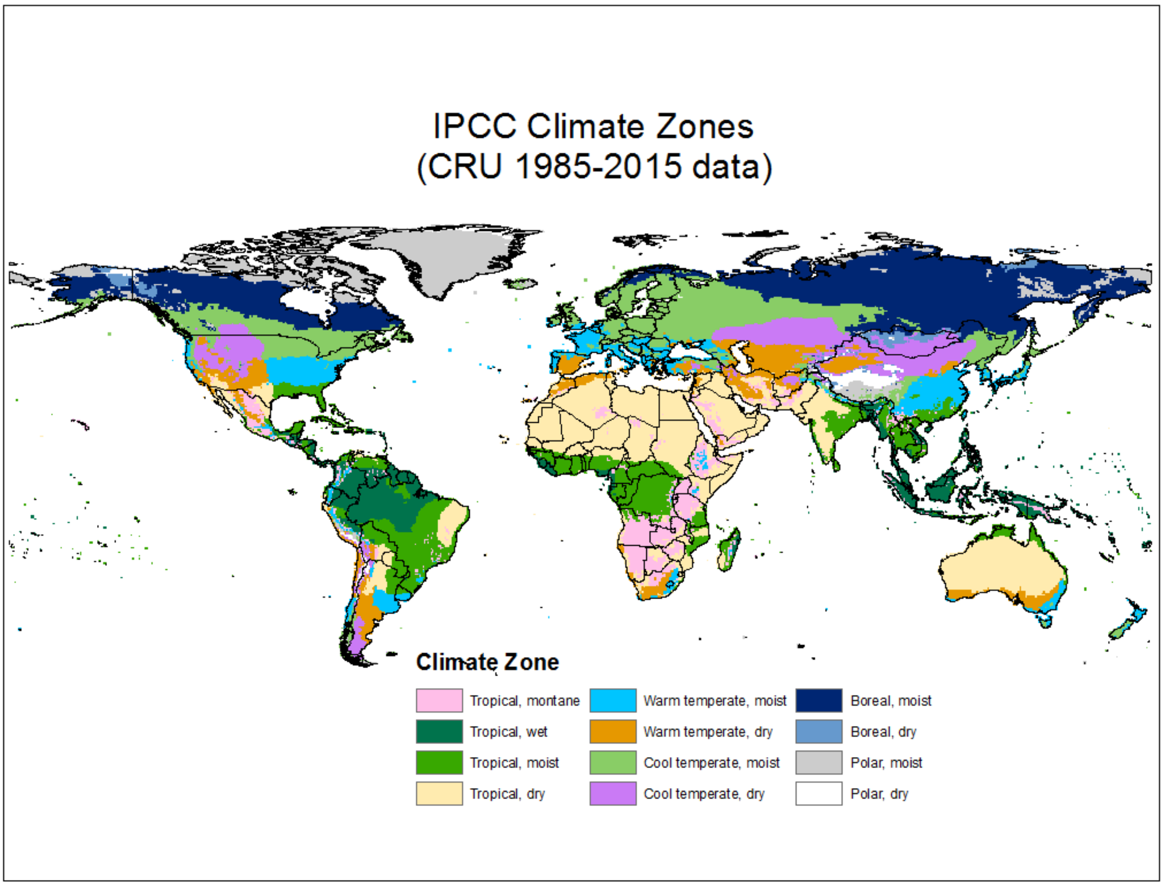
IPCC Climate Zones
(CRU 1985-2015 data)
Climate Zone
Tropical, montane
Tropical, wet
Tropical, moist
Tropical, dry
Warm temperate, moist
Warm temperate, dry
Cool temperate, moist
Cool temperate, dry
Boreal, moist
Boreal, dry
Polar, moist
Polar, dry

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Figure A.2-1. Mapping of IPCC climate zones. (taken from Volume 4, Chapter 3, Annex 3A.5)

TABLE 10A.2-10 COMPARISON OF MANURE STORAGE TYPE DEFINITIONS USED BY THE IPCC AND BY THE EMEP/EEA AIR POLLUTANT EMISSION INVENTORY GUIDEBOOK 2016 (HTTPS://WWW.EEA.EUROPA.EU/PUBLICATIONS/EMEP-EEA-GUIDEBOOK-2016)		
System IPCC	System EMEP / EEA	Definition

Pasture/Range/Paddock		grazing	The manure from pasture and range grazing animals is allowed to lie as deposited, and is not managed.
Daily spread		no definition given	Manure is routinely removed from a confinement facility and is applied to cropland or pasture within 24 hours of excretion.
Solid storage		Heaps	The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked because of the presence of a sufficient amount of bedding material or loss of moisture by evaporation
Dry lot		no definition given	A paved or unpaved open confinement area without any significant vegetative cover. Dry lots do not require the addition of bedding to control moisture. Manure may be removed periodically and spread on fields.
Liquid/Slurry [a]		tanks	Manure is stored as excreted or with some minimal addition of water in either tanks or earthen ponds outside the livestock building, usually for periods of less than 1 year; Storage with a low surface area to depth ratio; normally steel or concrete cylinders
Liquid/Slurry, With natural crust cover		crust	Natural or artificial layer on the surface of slurry which reduces the diffusion of gasses to the atmosphere
Liquid/Slurry, cover		cover	Rigid or flexible structure that covers the manure and is impermeable to water and gasses
Uncovered anaerobic lagoon		lagoons	Storage with a large surface area to depth ratio; normally shallow excavations in the soil
Pit storage below animal confinements		In-house slurry pit	Mixture of excreta and washing water, stored within the livestock building, usually below the confined animals
Anaerobic digester		Biogas treatment	Anaerobic fermentation of slurry and/or solid
Burned for fuel		no definition given	The dung and urine are excreted on fields. The sun dried dung cakes are burned for fuel.
Deep bedding		In-house deep litter	Mixture of excreta and bedding, accumulated on the floor of the livestock building
Composting	In-vessel[a]	Forced-aeration composting	Aerobic decomposition of manure with forced ventilation
	Static pile	Composting, passive windrow	Aerobic decomposition of manure without forced ventilation
	Intensive windrow[a]	No EMEP equivalent	
		No EMEP equivalent	

	Composting - Passive windrow[a]		
Poultry manure with litter		Laying hens – solid Broilers – litter Other poultry - litter	Similar to cattle and swine deep bedding except usually not combined with a dry lot or pasture. Typically used for all poultry breeder flocks, for alternative systems for layers and for the production of meat type chickens (broilers) and other fowl. Litter and manure are left in place with added bedding during the poultry production cycle and cleaned between poultry cycles, typically 5 to 9 weeks in productive systems and X amount of days in lower productivity systems.
Poultry manure without litter		Laying hens – slurry	May be similar to open pits in enclosed animal confinement facilities or may be designed and operated to dry the manure as it accumulates. The latter is known as a high-rise manure management system and is a form of passive windrow composting when designed and operated properly. Some intensive poultry farms installed the manure belt under the cage, where the manure is dried inside housing.
Aerobic treatment		No EMEP equivalent	The biological oxidation of manure collected as a liquid with either forced or natural aeration. Natural aeration is limited to aerobic and facultative ponds and wetland systems and is due primarily to photosynthesis. Hence, these systems typically become anoxic during periods without sunlight.
No definition given		Slurry separation	The separation of the solid and liquid components of slurry
No definition given		Acidification	The addition of strong acid to reduce manure pH

Annex 10A.3. MCF Spreadsheet example for the calculation of a country or regions specific MCF

MCF Calculations and Example Spreadsheet

This Annex was developed to explain how MCF factors in the guidelines have been derived and to provide a detailed step by step protocol for inventory compilers to calculate country or region specific MCFs.

Further, to support the IPCC Guidance Document, a spreadsheet was created to enable users to calculate a site-specific Methane Conversion Factor (MCF). The spreadsheet uses the same calculations that were used to calculated the MCF Table in the guidance document, but has been designed with a user in mind and can be provided from (To be supplied to reviewers)

The calculation procedure outlined in the spreadsheet contains three main sections:

- **Inputs** to the model
- **Model** calculations
- **Results** from the model

As an explanation of procedures, within each section, cells are colour coded. Compilers are required to develop input data for anything that is indicated by yellow highlighted cells, and have the option of editing the orange highlighted cells if needed, but only if country-specific information is available for those parameters. Other cells are not meant to be edited by the user.

COLOUR CODE:	REQUIRED USER INPUT	OPTIONAL USER INPUT	FIXED INPUT DON'T EDIT	CALCULATION DON'T EDIT

Figure A.3-1. Colour code for cells in the example spreadsheet.

MODEL INPUT

The Input required to recreate the spreadsheet is shown below (Figures 2 and 3). In this section, the compiler should input 12 months of temperature data (degrees C) in cells D9:D20, based on average monthly temperatures for the region for which they wish to develop the MCF.

If the compiler has <u>manure temperature</u> available, they should select "Manure" in cell D6. As a result, the spreadsheet will copy the user-input temperature into cells E9:E20, for further use in the analysis.

If the compiler has <u>air temperature</u> (not manure temperature), they should select "Air" in cell D6. As a result, the spreadsheet will generate an estimate for manure temperature in cells E9:E20. The estimates are based on the following logic:

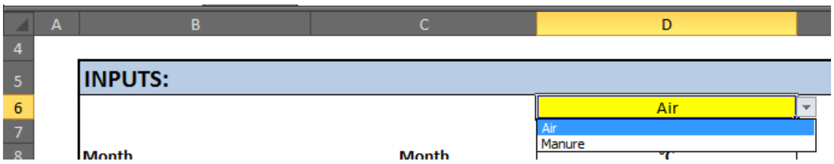
- Manure temperature lags 1-month behind air temperature.
    - e.g., Tmanure in June = Tair in May.
- The minimum manure temperature will be used (1 degree C by default; user adjustable)
    - e.g., for Tair = -9 C, Tman = 1 C
- If and only if the storage is emptied once per year, manure temperature will be reduced by a dampening factor (3 degrees C by default; user adjustable).
    - i.e. Tman = Tair – damping factor; e.g., 12 = 15 – 3
- The logic equation is implemented in Excel as follows, for example, in cell E9: =IF($D$6="Manure",D9,IF($F$21>1,MAX(D20,f_Tmin),MAX(D20-f_T2damping,f_Tmin)))
    - Broken into steps:
    - If $D$6="Manure" then the result in E9 will equal D9
    - If $D$6 is not "Manure" (i.e. it is "Air") then the second IF statement is operated

- IF $F$21>1 (i.e. multiple removals per year), then no damping is applied
  - Manure temperature is selected as air temperature from the previous month, and it is always greater or equal to the minimum temperature, i.e. E9 will equal MAX(D20,f_Tmin). In this case, D20 (-6.7) is less than the minimum, so the result in E9 is the minimum (1.0).
- IF $F$21=1 then damping is applied
  - Damping is applied by subtracting the damping factor: D20-f_T2damping
  - The temperature is always greater or equal to the minimum temperature, using the MAX() function.

The compiler should then identify the months when manure is removed from the storage in column F (F9:F20). This can be indicated by a "Y" indicating months when manure was removed, and an "N" for months when manure is not removed. The number of months when manure was removed is counted and displayed in cell F21.

INPUTS:

Month	Month	Air Temperature °C	Manure Temperature °C	Manure Removed (Y/N)
January	1	-9.0	1.0	N
February	2	-7.7	1.0	N
March	3	-2.3	1.0	N
April	4	4.7	1.0	N
May	5	10.7	4.7	Y
June	6	15.2	10.7	N
July	7	17.7	15.2	N
August	8	16.7	17.7	N
September	9	12.0	16.7	N
October	10	5.8	12.0	N
November	11	-1.4	5.8	Y
December	12	-6.7	1.0	N
		4.6	7.3	2
		Average	*Average*	*Count of "Y"*



INPUTS:

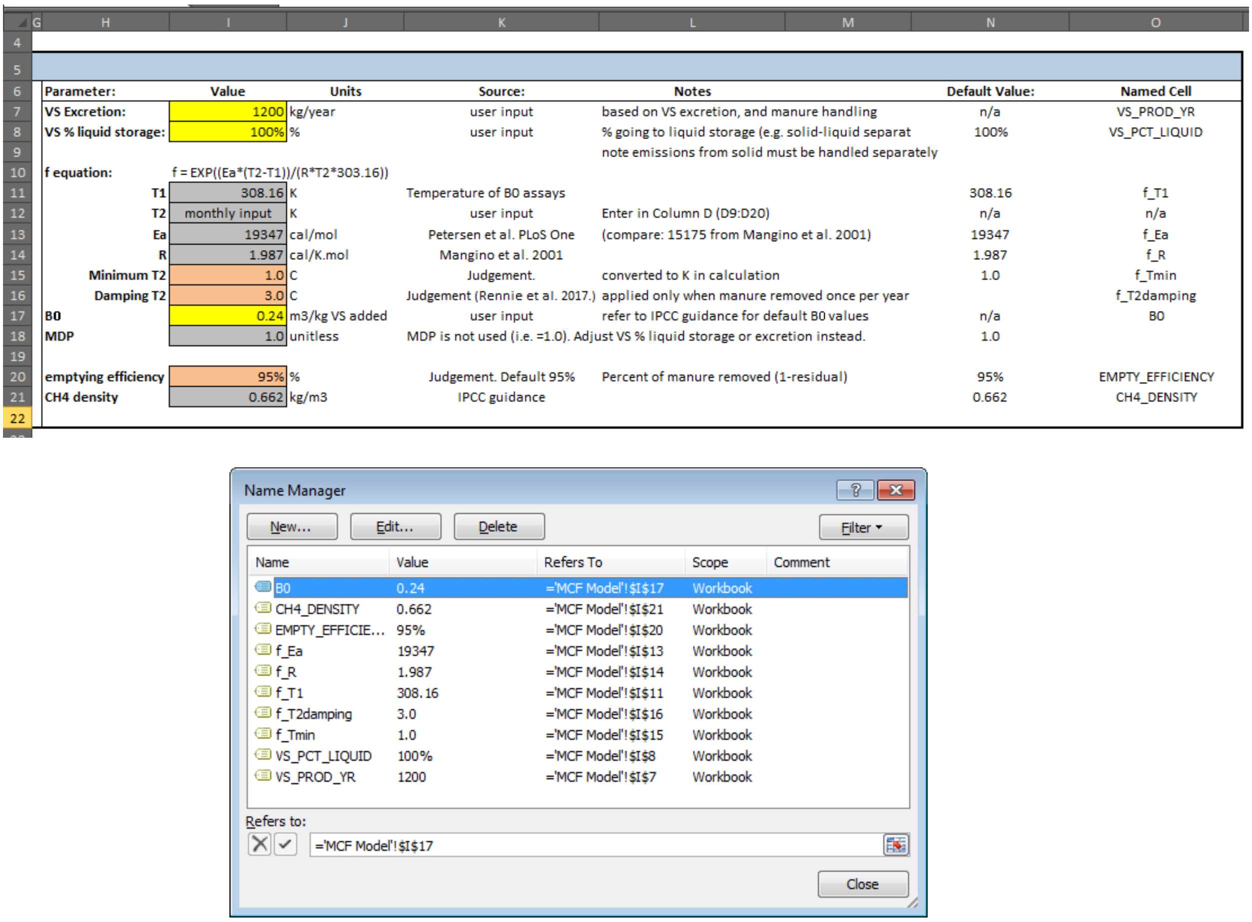
Month	Month	Air Temperature °C	Manure Temperature °C	Manure Removed (Y/N)
January	1	-9	=IF($D$6="Manure",D9,IF($F$21>1,MAX(D20,f_Tmin),MAX(D20-f_T2damping,f_Tmin)))	N
February	2	-7.7	=IF($D$6="Manure",D10,IF($F$21>1,MAX(D9,f_Tmin),MAX(D9-f_T2damping,f_Tmin)))	N
March	3	-2.3	=IF($D$6="Manure",D11,IF($F$21>1,MAX(D10,f_Tmin),MAX(D10-f_T2damping,f_Tmin)))	N
April	4	4.7	=IF($D$6="Manure",D12,IF($F$21>1,MAX(D11,f_Tmin),MAX(D11-f_T2damping,f_Tmin)))	N
May	5	10.7	=IF($D$6="Manure",D13,IF($F$21>1,MAX(D12,f_Tmin),MAX(D12-f_T2damping,f_Tmin)))	Y
June	6	15.2	=IF($D$6="Manure",D14,IF($F$21>1,MAX(D13,f_Tmin),MAX(D13-f_T2damping,f_Tmin)))	N
July	7	17.7	=IF($D$6="Manure",D15,IF($F$21>1,MAX(D14,f_Tmin),MAX(D14-f_T2damping,f_Tmin)))	N
August	8	16.7	=IF($D$6="Manure",D16,IF($F$21>1,MAX(D15,f_Tmin),MAX(D15-f_T2damping,f_Tmin)))	N
September	9	12	=IF($D$6="Manure",D17,IF($F$21>1,MAX(D16,f_Tmin),MAX(D16-f_T2damping,f_Tmin)))	N
October	10	5.8	=IF($D$6="Manure",D18,IF($F$21>1,MAX(D17,f_Tmin),MAX(D17-f_T2damping,f_Tmin)))	N
November	11	-1.4	=IF($D$6="Manure",D19,IF($F$21>1,MAX(D18,f_Tmin),MAX(D18-f_T2damping,f_Tmin)))	Y
December	12	-6.7	=IF($D$6="Manure",D20,IF($F$21>1,MAX(D19,f_Tmin),MAX(D19-f_T2damping,f_Tmin)))	N
		=AVERAGE(D9:D20)	=AVERAGE(E9:E20)	=COUNTIF(F9:F20,"Y")
		Average	*Average*	*Count of "Y"*

Figure A.3-2. Temperature and manure removal inputs to the model. Top panel: alphanumeric values in each cell. Middle panel: dropdown menu to select "Air" or "Manure". Bottom panel: all formulae are visible.

The inventory compiler is required to provide several other inputs in the section shown below (Fig. 3). The name of each parameter is provided in column H, the numeric value of the parameter is in column I, the units are in column J, the source each value are given in column K, additional notes are in columns L and M, default values are in column N. To make equations more easily understood, the Microsoft Excel feature of "Named Cells" has been used to name the cells in column I, and the name of each cell is shown in column O for convenience. For example, cell I7 is given the name "VS_PROD_YR". See Figure 3 for a full list of named cells.

Additional information about the input parameters:

- VS Excretion – based on IPCC guidance.
- VS % liquid storage – this indicates what percentage of excreted VS is handled as a liquid. For example,
  - 100% indicates that all excreted VS enters the liquid storage
  - A lower number (say, 75%) could indicate that a portion of the solids are separated by a screwpress and handled as a solid (25%) while the remaining 75% is handled as liquid.
- The compiler must provide a B_0 value for the manure. Refer to IPCC guidance.
- The compiler may, optionally, adjust the minimum temperature (and temperature damping factors.
- The compiler also has the option to adjust the emptying efficiency, which indicates the percentage of manure removed from storage at each removal. By default this is set to 95%, indicating that 5% of the VS remain in storage after emptying. Set this value to 100% for complete removal.



Parameter:	Value	Units	Source:	Notes	Default Value:	Named Cell
VS Excretion:	1200	kg/year	user input	based on VS excretion, and manure handling	n/a	VS_PROD_YR
VS % liquid storage:	100%	%	user input	% going to liquid storage (e.g. solid-liquid separat	100%	VS_PCT_LIQUID
				note emissions from solid must be handled separately		
f equation:	f = EXP((Ea*(T2-T1))/(R*T2*303.16))					
T1	308.16	K	Temperature of B0 assays		308.16	f_T1
T2	monthly input	K	user input	Enter in Column D (D9:D20)	n/a	n/a
Ea	19347	cal/mol	Petersen et al. PLoS One	(compare: 15175 from Mangino et al. 2001)	19347	f_Ea
R	1.987	cal/K.mol	Mangino et al. 2001		1.987	f_R
Minimum T2	1.0	C	Judgement.	converted to K in calculation	1.0	f_Tmin
Damping T2	3.0	C	Judgement (Rennie et al. 2017.)	applied only when manure removed once per year		f_T2damping
B0	0.24	m3/kg VS added	user input	refer to IPCC guidance for default B0 values	n/a	B0
MDP	1.0	unitless	MDP is not used (i.e. =1.0). Adjust VS % liquid storage or excretion instead.		1.0	
emptying efficiency	95%	%	Judgement. Default 95%	Percent of manure removed (1-residual)	95%	EMPTY_EFFICIENCY
CH4 density	0.662	kg/m3	IPCC guidance		0.662	CH4_DENSITY

Name	Value	Refers To	Scope	Comment
B0	0.24	='MCF Model'!$I$17	Workbook	
CH4_DENSITY	0.662	='MCF Model'!$I$21	Workbook	
EMPTY_EFFICIE...	95%	='MCF Model'!$I$20	Workbook	
f_Ea	19347	='MCF Model'!$I$13	Workbook	
f_R	1.987	='MCF Model'!$I$14	Workbook	
f_T1	308.16	='MCF Model'!$I$11	Workbook	
f_T2damping	3.0	='MCF Model'!$I$16	Workbook	
f_Tmin	1.0	='MCF Model'!$I$15	Workbook	
VS_PCT_LIQUID	100%	='MCF Model'!$I$8	Workbook	
VS_PROD_YR	1200	='MCF Model'!$I$7	Workbook	

Figure A.3-3. Constants and other input parameters for the model are shown in the top panel. Named Cells in column I are shown in column O, and in the Name Manager dialog box (bottom panel). No formulae exist in this part of the spreadsheet.

MODEL CALCULATIONS

The model calculations are run for three years, in order to ensure VS available has stabilized on an annual basis. For example, in Figure 4, we see that VS Available (column J) increases substantially from the first year to the second year (J64 vs J65), and then stabilizes in the third year (J66). This is because the first year begins from a perfectly empty storage, whereas the second year is emptied according to the Emptying Efficiency parameter (95% removed / 5% remaining; Figure 3).

The model approach is as follows:

- Column B: Month of year, over 3 years. These month numbers are used to extract input data shown in Figure 2.
- Column C: Average manure temperature in each month. This is extracted from cells E9:E20 (Fig. 2) using a VLOOKUP function (Figure 5).
- Column D: temperature is converted from Celsius to Kelvin, using Excel's CONVERT function (Fig. 5).
- Column E: the temperature-dependent *f* parameter is calculated using the van't Hoff-Arrhenius equation (Mangino et al. 2001; IPCC 2006), with updated input parameters shown in Figure 3.
- Column F: monthly VS excreted is calculated by dividing the annual VS input parameter by 12.
- Column G: monthly VS loaded is calculated by multiplying VS excreted by the percentage stored as liquid. In this example, the two are equal because VS_PCT_LIQUID is 100% (Fig. 3).
- Column H: monthly manure emptying is extracted from cells F9:F20 (Fig. 2) using a VLOOKUP function (Fig. 5).
- Column I: the quantity of VS emptied is calculated. The logic is as follows: if emptying occurred, then calculate the mass of VS available to be removed using the mass of VS available in the previous month minus the mass of VS consumed in the previous month. Then, multiply the result by the EMPTY_EFFICIENCY parameter (Fig. 3, 5).
- Column J: the mass of VS available for producing methane is calculated. In the first month of the first year this is equal to the mass of VS loaded. In all other months, this is calculated as the VS loaded in the current month + VS available in the previous month – VS consumed in the previous month – VS emptied in the current month.
- Column K: the mass of VS consumed is calculated by multiplying VS available by *f*.
- Column L: the volume of CH4 produced is calculated by multiplying VS consumed by B_0.

Using these values and equations, the compiler should be able to reproduce graphics such as the profile of manure temperature, volatile solids and methane production shown in Figure 6.

	B	C	D	E	F	G	H	I	J	K	L
23											
24	**MODEL:**										
25		*(lookup)*	*(converted)*	*(calculated)*	*VS Excreted*	*VS Loaded*	Emptying	VS Emptied	VS "Available"	VS "consumed"	CH4 Produced
26	Month	Tav_C	Tav_K	*f*	*kg/month*	*kg/month*	*Y/N*	*kg*	*kg*	*kg*	*m3*
27	1	1.0	274.15	0.02	100	100	N	n/a	100	2	0
28	2	1.0	274.15	0.02	100	100	N	-	198	4	1
29	3	1.0	274.15	0.02	100	100	N	-	294	6	1
30	4	1.0	274.15	0.02	100	100	N	-	388	8	2
31	5	4.7	277.85	0.03	100	100	Y	362	119	4	1
32	6	10.7	283.85	0.07	100	100	N	-	215	14	3
33	7	15.2	288.35	0.11	100	100	N	-	301	34	8
34	8	17.7	290.85	0.15	100	100	N	-	367	56	13
35	9	16.7	289.85	0.14	100	100	N	-	411	56	13
36	10	12.0	285.15	0.08	100	100	N	-	455	36	9
37	11	5.8	278.95	0.04	100	100	Y	398	121	4	1
38	12	1.0	274.15	0.02	100	100	N	-	217	4	1
39	1	1.0	274.15	0.02	100	100	N	-	312	6	1
40	2	1.0	274.15	0.02	100	100	N	-	406	8	2
41	3	1.0	274.15	0.02	100	100	N	-	498	10	2
42	4	1.0	274.15	0.02	100	100	N	-	588	12	3
43	5	4.7	277.85	0.03	100	100	Y	548	129	4	1
44	6	10.7	283.85	0.07	100	100	N	-	225	15	4
45	7	15.2	288.35	0.11	100	100	N	-	310	35	8
46	8	17.7	290.85	0.15	100	100	N	-	374	57	14
47	9	16.7	289.85	0.14	100	100	N	-	417	57	14
48	10	12.0	285.15	0.08	100	100	N	-	461	36	9
49	11	5.8	278.95	0.04	100	100	Y	403	121	4	1
50	12	1.0	274.15	0.02	100	100	N	-	217	4	1
51	1	1.0	274.15	0.02	100	100	N	-	312	6	1
52	2	1.0	274.15	0.02	100	100	N	-	406	8	2
53	3	1.0	274.15	0.02	100	100	N	-	498	10	2
54	4	1.0	274.15	0.02	100	100	N	-	588	12	3
55	5	4.7	277.85	0.03	100	100	Y	548	129	4	1
56	6	10.7	283.85	0.07	100	100	N	-	225	15	4
57	7	15.2	288.35	0.11	100	100	N	-	310	35	8
58	8	17.7	290.85	0.15	100	100	N	-	374	57	14
59	9	16.7	289.85	0.14	100	100	N	-	417	57	14
60	10	12.0	285.15	0.08	100	100	N	-	461	36	9
61	11	5.8	278.95	0.04	100	100	Y	403	121	4	1
62	12	1.0	274.15	0.02	100	100	N	-	217	4	1
63				**SUM:**							
64				**Year 1**	1,200	1,200		760	3,185	228	55
65				**Year 2**	1,200	1,200		951	4,058	249	60
66				**Year 3**	1,200	1,200		951	4,059	249	60

Figure A.3-4. Model inputs and outputs over a three year period.

	A	B	C	D	E	F	G
23							
24		**MODEL:**					
25			*(lookup)*	*(converted)*	*(calculated)*	*VS Excreted*	*VS Loaded*
26		**Month**	**Tav_C**	**Tav_K**	***f***	*kg/month*	*kg/month*
27		1	=VLOOKUP(B27,$C$9:$E$20,3,FALSE)	=CONVERT(C27,"C","K")	=EXP((f_Ea*(D27-f_T1))/(f_R*D27*f_T1))	=VS_PROD_YR/12	=F27*VS_PCT_LIQUID
28		2	=VLOOKUP(B28,$C$9:$E$20,3,FALSE)	=CONVERT(C28,"C","K")	=EXP((f_Ea*(D28-f_T1))/(f_R*D28*f_T1))	=VS_PROD_YR/12	=F28*VS_PCT_LIQUID
29		3	=VLOOKUP(B29,$C$9:$E$20,3,FALSE)	=CONVERT(C29,"C","K")	=EXP((f_Ea*(D29-f_T1))/(f_R*D29*f_T1))	=VS_PROD_YR/12	=F29*VS_PCT_LIQUID
30		4	=VLOOKUP(B30,$C$9:$E$20,3,FALSE)	=CONVERT(C30,"C","K")	=EXP((f_Ea*(D30-f_T1))/(f_R*D30*f_T1))	=VS_PROD_YR/12	=F30*VS_PCT_LIQUID
31		5	=VLOOKUP(B31,$C$9:$E$20,3,FALSE)	=CONVERT(C31,"C","K")	=EXP((f_Ea*(D31-f_T1))/(f_R*D31*f_T1))	=VS_PROD_YR/12	=F31*VS_PCT_LIQUID
32		6	=VLOOKUP(B32,$C$9:$E$20,3,FALSE)	=CONVERT(C32,"C","K")	=EXP((f_Ea*(D32-f_T1))/(f_R*D32*f_T1))	=VS_PROD_YR/12	=F32*VS_PCT_LIQUID
33		7	=VLOOKUP(B33,$C$9:$E$20,3,FALSE)	=CONVERT(C33,"C","K")	=EXP((f_Ea*(D33-f_T1))/(f_R*D33*f_T1))	=VS_PROD_YR/12	=F33*VS_PCT_LIQUID
34		8	=VLOOKUP(B34,$C$9:$E$20,3,FALSE)	=CONVERT(C34,"C","K")	=EXP((f_Ea*(D34-f_T1))/(f_R*D34*f_T1))	=VS_PROD_YR/12	=F34*VS_PCT_LIQUID
35		9	=VLOOKUP(B35,$C$9:$E$20,3,FALSE)	=CONVERT(C35,"C","K")	=EXP((f_Ea*(D35-f_T1))/(f_R*D35*f_T1))	=VS_PROD_YR/12	=F35*VS_PCT_LIQUID
36		10	=VLOOKUP(B36,$C$9:$E$20,3,FALSE)	=CONVERT(C36,"C","K")	=EXP((f_Ea*(D36-f_T1))/(f_R*D36*f_T1))	=VS_PROD_YR/12	=F36*VS_PCT_LIQUID
37		11	=VLOOKUP(B37,$C$9:$E$20,3,FALSE)	=CONVERT(C37,"C","K")	=EXP((f_Ea*(D37-f_T1))/(f_R*D37*f_T1))	=VS_PROD_YR/12	=F37*VS_PCT_LIQUID
38		12	=VLOOKUP(B38,$C$9:$E$20,3,FALSE)	=CONVERT(C38,"C","K")	=EXP((f_Ea*(D38-f_T1))/(f_R*D38*f_T1))	=VS_PROD_YR/12	=F38*VS_PCT_LIQUID

	A	B	H	I	J	K	L
23							
24		**MODEL:**					
25			**Emptying**	**VS Emptied**	**VS "Available"**	**VS "consumed"**	**CH4 Produced**
26		**Month**	***Y/N***	*kg*	*kg*	*kg*	*m3*
27		1	=VLOOKUP(B27,$C$9:$F$20,4,FALSE)	n/a	=G27	=J27*E27	=K27*B0
28		2	=VLOOKUP(B28,$C$9:$F$20,4,FALSE)	=IF(H28="N",0,(J27-K27)*EMPTY_EFFICIENCY)	=G28+J27-K27-I28	=J28*E28	=K28*B0
29		3	=VLOOKUP(B29,$C$9:$F$20,4,FALSE)	=IF(H29="N",0,(J28-K28)*EMPTY_EFFICIENCY)	=G29+J28-K28-I29	=J29*E29	=K29*B0
30		4	=VLOOKUP(B30,$C$9:$F$20,4,FALSE)	=IF(H30="N",0,(J29-K29)*EMPTY_EFFICIENCY)	=G30+J29-K29-I30	=J30*E30	=K30*B0
31		5	=VLOOKUP(B31,$C$9:$F$20,4,FALSE)	=IF(H31="N",0,(J30-K30)*EMPTY_EFFICIENCY)	=G31+J30-K30-I31	=J31*E31	=K31*B0
32		6	=VLOOKUP(B32,$C$9:$F$20,4,FALSE)	=IF(H32="N",0,(J31-K31)*EMPTY_EFFICIENCY)	=G32+J31-K31-I32	=J32*E32	=K32*B0
33		7	=VLOOKUP(B33,$C$9:$F$20,4,FALSE)	=IF(H33="N",0,(J32-K32)*EMPTY_EFFICIENCY)	=G33+J32-K32-I33	=J33*E33	=K33*B0
34		8	=VLOOKUP(B34,$C$9:$F$20,4,FALSE)	=IF(H34="N",0,(J33-K33)*EMPTY_EFFICIENCY)	=G34+J33-K33-I34	=J34*E34	=K34*B0
35		9	=VLOOKUP(B35,$C$9:$F$20,4,FALSE)	=IF(H35="N",0,(J34-K34)*EMPTY_EFFICIENCY)	=G35+J34-K34-I35	=J35*E35	=K35*B0
36		10	=VLOOKUP(B36,$C$9:$F$20,4,FALSE)	=IF(H36="N",0,(J35-K35)*EMPTY_EFFICIENCY)	=G36+J35-K35-I36	=J36*E36	=K36*B0
37		11	=VLOOKUP(B37,$C$9:$F$20,4,FALSE)	=IF(H37="N",0,(J36-K36)*EMPTY_EFFICIENCY)	=G37+J36-K36-I37	=J37*E37	=K37*B0
38		12	=VLOOKUP(B38,$C$9:$F$20,4,FALSE)	=IF(H38="N",0,(J37-K37)*EMPTY_EFFICIENCY)	=G38+J37-K37-I38	=J38*E38	=K38*B0

	A	B	F	G	I	J	K	L
23								
24		**MODEL:**						
25			***VS Excreted***	***VS Loaded***	**VS Emptied**	**VS "Available"**	**VS "consumed"**	**CH4 Produced**
26		**Month**	***kg/month***	***kg/month***	*kg*	*kg*	*kg*	*m3*
63								
64			=SUM(F27:F38)	=SUM(G27:G38)	=SUM(I27:I38)		=SUM(K27:K38)	=SUM(L27:L38)
65			=SUM(F39:F50)	=SUM(G39:G50)	=SUM(I39:I50)		=SUM(K39:K50)	=SUM(L39:L50)
66			=SUM(F51:F62)	=SUM(G51:G62)	=SUM(I51:I62)		=SUM(K51:K62)	=SUM(L51:L62)

A.3-5. Formulae used in the model. To conserve space, only 12 months are shown. Top panel: columns C:G. Middle panel: columns H:L. Bottom panel: sums in rows 64:66 for selected columns.

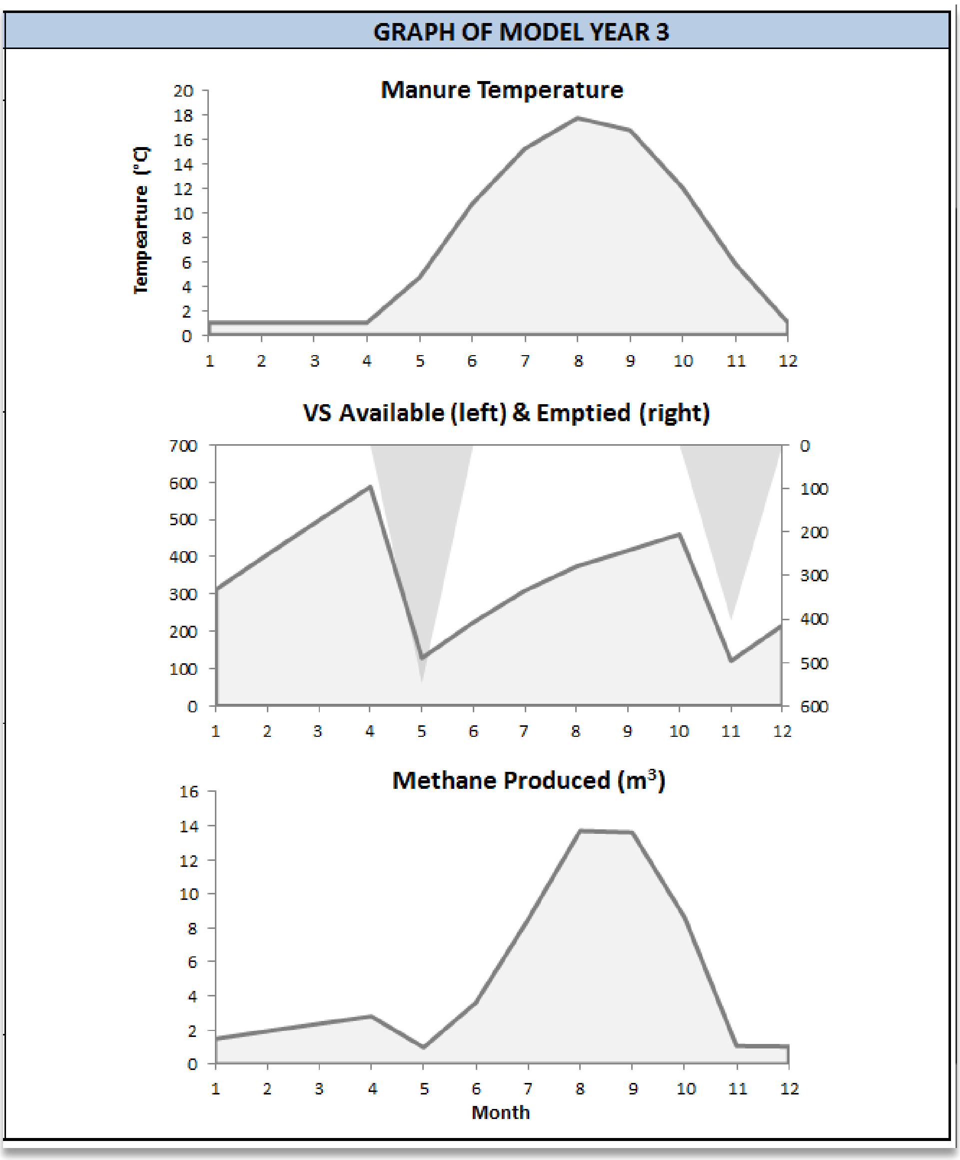


Figure A.3-6. Monthly patterns in Year 3: manure temperature, VS available, VS emptied, and methane production.

MODEL RESULTS

The MCF is calculated in the Results section. This is done using the third year outputs. In this particular example, the input air temperature is from the Cool Temperate Moist region and the retention time is 6-months. The resulting MCF (21%) is identical with the guidance document (21%).

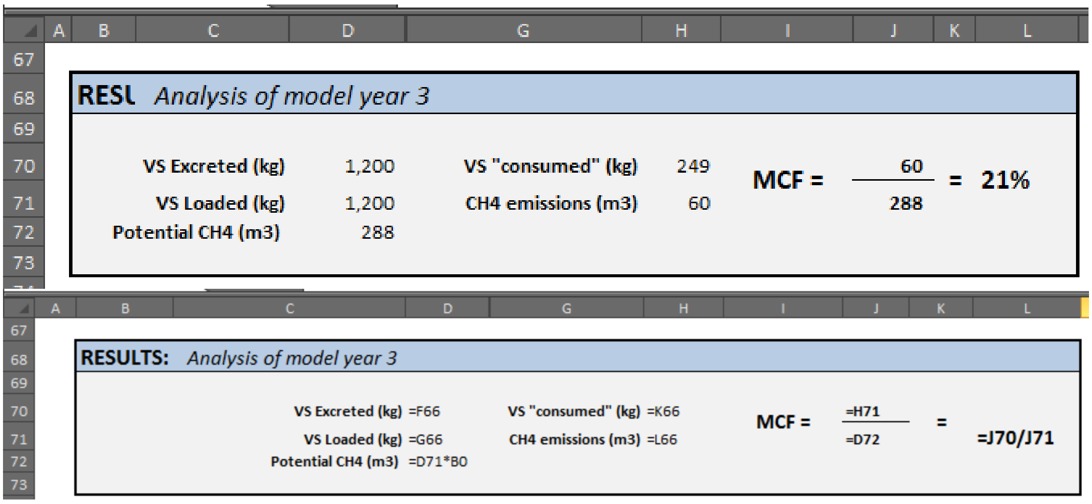


Figure A.3-7. Summary of Year 3 VS and methane production, and calculation of MCF. Top panel shows results, bottom panel shows equations.

NOTE ABOUT TERMINOLOGY:

The terms "VS Available" and "VS Consumed" are used here to be consistent with IPCC 2006 and Mangino et al. 2001 approach. However, these terms require some clarification to avoid misinterpretation. (1) The term "VS Consumed" does not represent the reality of VS degradation. To put it simply, VS consumed is not equivalent to VS destroyed. Rather, the term VS Consumed can be thought of as the quantity of VS conceptually removed from the liquid/slurry storage and placed into a (conceptual) biomethane potential at 35°C (i.e. to produce the B0). Therefore, just as B0 reports the quantity of CH4 produced per kg of VS (i.e. all fractions, degradable and non-degradable), the concept of "VS Consumed" removes all fractions of VS from storage. This approach is convenient because it uses the B0 as the integrator of all fractions of VS degradability, and reports the total methane produced from all fractions as if they were incubated for infinite time, while the f parameter introduces a temperature dependence. While this is convenient for modeling, and is consistent with the B0, this is not really what is happening in a liquid/slurry storage. (2) Since "VS Consumed" does not equate with the amount of VS degraded in the storage, the "VS available" does equate with the amount of VS that would actually be measured in a storage. Therefore, researchers should not attempt to compare measured VS with "VS available". (3) The strength of this approach is its simplicity and the fact that the maximum amount of methane that can be produced is equal to the total VS produced multiplied by the B0. In other words, the model cannot produce more methane than the B0. (4) The MCF is the ratio of predicted "VS Consumed" to the total VS that entered the storage over one year. The method does not address VS destruction. If the "VS Consumed" were multiplied by B' (m3 CH4/kg VS destroyed), the result be would be erroneous because "VS Consumed" is not VS Destroyed. This is not to say that B' cannot be used to model methane production, but simply that it is not compatible with the "VS Consumed" concept. (5) Although B0 does not need to enter the MCF calculation, the role of B0 is to be multiplied by the MCF, as stated in equation 10.23 of IPCC (2006)

Annex 10A.4. Equations relating all direct and indirect N_2O emissions from manure along all stages in agricultural production for livestock.

As explained in section 10.5.6, nitrogen excreted by animals contribute to serveral direct and indirect N2O emission as it cascades through livestock and crop cultivation systems. It is therefore crucial to accurately estimate nitrogen excretion coefficients. The total direct and indirect N_2O emissions associated with the excretion of nitrogen of an animal type is an important quantity to assess the benefit from improving the estimation of the N-excretion coefficient for that animal type. However, the total direct and indirect N_2O emissions from animal excretion cannot be easily estimated using the equations given in Chapter 10 and 11 of the Guidelines and their Refinements. This annex provides a set of equations, based on the equations given in Chapter 10 and 11, that allow the quantification of total direct and indirect N_2O emissions from nitrogen excretion of each animal type *T*. They are reported in Equations 10.A4-1 through 10.A4-20.

The definition of the symbols used in the set of equations is given below Equation 10.A4-20, grouped by symbols. Note that for internal consistency, the symbol *N* is used for all nitrogen flows in kg N animal^{-1} yr^{-1}; the symbol *F* is used for all animal-independent nitrogen flows or nitrogen flows for the total animal population in kg N yr^{-1}; the symbol *Frac* is used for all fractions in kg N (kg N)$^{-1}$ or %, the symbol *EF* is used for all N_2O emission factors in kg N_2O-N (kg N)$^{-1}$, and the symbol N_2O is used for all N_2O emissions in kg N_2O-N yr^{-1} . Not in all cases therefore, the symbols are identical to those used in the Equations given in Chapters 10 and 11.

EQUATION 10.A4-1.
TOTAL N_2O EMISSIONS FOR ANIMAL TYPE T

$$N_2O_{(T)} = N_2O_{mm(T)} + N_2O_{AM(T)} + N_2O_{PRP(T)}$$

EQUATIONS 10.A4-2 AND 10.A4-3.
TOTAL N2O EMISSIONS FROM MANURE MANAGEMENT FOR ANIMAL TYPE T

$$N_2O_{(mm,T)} = N_2O_{D(mm,T)} + N_2O_{G(mm,T)} + N_2O_{L(mm,T)}$$

$$N_2O_{mm(T)} = \left(\sum_S F_{mm(T,S)} \bullet \left[EF_{3(S)} + \left(\frac{Frac_{GasMS}}{100} \right)_{(T,S)} \bullet EF_4 + \left(\frac{Frac_{LeachMS}}{100} \right)_{(T,S)} \bullet EF_5 \right] \right) \bullet \frac{44}{28}$$

EQUATIONS 10.A4-4 THROUGH 10.A4-6.
TOTAL, DIRECT AND INDIRECT N2O EMISSIONS FROM THE APPLICATION OF MANURE TO MANAGED SOILS FOR ANIMAL TYPE T

$$N_2O_{AM(T)} = N_2O_{D,AM(T)} + N_2O_{I,AM(T)}$$

$$N_2O_{D,AM(T)} = F_{AM(T)} \bullet \left[\left(1 - Frac_{AM,Rice}\right) \bullet EF_1 + Frac_{AM,Rice} \bullet EF_{1FR}\right] \bullet \frac{44}{28}$$

$$N_2O_{I,AM(T)} = F_{AM(T)} \bullet \left[Frac_{GASM} \bullet EF_4 + Frac_{LEACH-(H)} \bullet EF_5\right] \bullet \frac{44}{28}$$

EQUATION 10.A4-7.
TOTAL AMOUNT OF ANIMAL MANURE N APPLIED TO SOILS OTHER THAN BY GRAZING ANIMALS FOR ANIMAL TYPE T

$$\mathrm{F_{AM(T)}} = \left\{ \left[\left(\sum_{S} \mathrm{F_{mm(T,S)}} \bullet \left(1 - \frac{\mathrm{Frac_{LossMS}}}{100} \right)_{(T,S)} \right) + \mathrm{F_{bedding(T,S)}} \right] + \mathrm{F_{codigestate}} \right\} \bullet \mathrm{Frac_{APPL(T)}}$$

EQUATION 10.A4-8.
FRACTION OF TOTAL ANIMAL MANURE N LOST IN MANURE MANAGEMENT SYSTEMS FOR ANIMAL TYPE T

$$\mathrm{Frac_{LossMS(T,S)}} = \mathrm{Frac_{GASMS(T,S)}} + \mathrm{Frac_{LEACHMS(T,S)}} + \mathrm{Frac_{N2MS(,S)}} + 100 \bullet \mathrm{EF_{3(,S)}}$$

EQUATION 10.A4-9.
FRACTION OF ANIMAL MANURE N AVAILABLE FOR APPLICATION TO MANAGED SOILS, APPLIED TO MANAGED SOILS FOR ANIMAL TYPE T

$$Frac_{APPL(T)} = 1 - \left(Frac_{FEED(T)} + Frac_{FUEL(T)} + Frac_{CNST(T)}\right)$$

EQUATION 10.A4-10
THROUGH EQUATION 10.A4-12.
TOTAL, DIRECT AND INDIRECT N2O EMISSIONS FROM N IN URINE AND DUNG DEPOSITED BY GRAZING ANIMALS ON PASTURE, RANGE AND PADDOCK (TIER 1) FOR ANIMAL TYPE T

$$N_2O_{PRP(T)} = N_2O_{D,PRP(T)} + N_2O_{I,PRP(T)}$$

$$N_2O_{D,PRP(T)} = \left[\left(F_{PRP,CPP(T)} \bullet EF_{3PRP,CPP}\right) + \left(F_{PRP,SO(T)} \bullet EF_{3PRP,SO}\right)\right] \bullet \frac{44}{28}$$

$$N_2O_{I,RPR(T)} = F_{RPR(T)} \bullet \left[Frac_{GASM} \bullet EF_4 + Frac_{LEACH-(H)} \bullet EF_5\right] \bullet \frac{44}{28}$$

EQUATION 10.A4-13.
RELATIONSHIP BETWEEN AVERAGE ANNUAL NITROGEN FLOWS ASSOCIATED WITH AN INDIVIDUAL ANIMAL [KG N ANIMAL^{-1} YR^{-1}] AND THE ANNUAL NITROGEN FLOW FOR THE ANIMAL POPULATION OF LIVESTOCK CATEGORY/SPECIES T IN A COUNTRY [KG N YR^{-1}]

$$F = POP_{(T)} \bullet N$$

EQUATION 10.A4-14.
TOTAL MANURE-N EXCRETED

$$N_{(T)} = N_{MMS(T)} + N_{PRP(T)}$$

EQUATION 10.A4-15 AND 10.A4.16.
NITROGEN EXCRETION CALCULATED EITHER USING A DEFAULT FRACTION OF RETENTION (TIER 1) OR DIRECTLY FROM RETENTION DATA

$$Nex_{(T)} = N_{intake(T)} \bullet \left(1 - Frac_{RET(T)}\right)$$

$$Nex_{(T)} = N_{intake(T)} - N_{RET(T)}$$

EQUATION 10.A4-17.
TOTAL MANURE-N IN MANURE MANAGEMENT AND STORAGE SYSTEMS

$$N_{MMS(T)} = \sum_S \left(POP_{(T)} \bullet Nex_{(T)} \bullet Frac_{S(T,S)}\right)$$

EQUATION 10.A4-18.
MANURE-N MANAGED IN SYSTEM S

$$N_{mm(T,S)} = POP_{(T)} \bullet Nex_{(T)} \bullet Frac_{S(T,S)}$$

EQUATION 10.A4-19.
MANURE-N DEPOSITED BY GRAZING ANIMALS, WITH X=CPP,SO

$$N_{PRP(X)} = POP_{(X)} \bullet Nex_{(X)} \bullet Frac_{S(X,G)}$$

EQUATION 10.A4-20.
N IN BEDDING MATERIAL ADDED TO MANAGED MANURE

$$N_{bedding(T,S)} = POP_{(T)} \bullet Nex_{(T)} \bullet N_{beddingMS,(T,S)}$$

Where

POP(T) = number of head of livestock species/category T in the country

Annual total nitrogen flows, F, and annual average nitrogen flows per head, N:

$F_{(T)}$ and $N_{(T)}$ = animal manure nitrogen excreted for livestock species/category *T* in the country, kg N yr^{-1} and kg N animal-1 yr-1

$F_{codigestates}$ = amount of nitrogen from co-digestates added to biogas plants , kg N yr^{-1}

$F_{MMS(T)}$ and $N_{MMS(T)}$ = animal manure nitrogen excreted for livestock species/category *T* in manure management and storage systems in the country, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{PRP(T)}$ and $N_{PRP(T)}$ = animal manure nitrogen excreted for livestock species/category *T* on pasture, range and paddock in the country, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{PRP,CPP(T)}$ and $N_{PRP,CPP(T)}$ = animal manure nitrogen excreted for cattle, pig and poultry species/category *T* on pasture, range and paddock in the country, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{PRP,SO(T)}$ and $N_{PRP,SO(T)}$ = total animal manure nitrogen excreted for sheep and other livestock species/category *T* on pasture, range and paddock in the country, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{mm(T,S)}$ and $N_{mm(T,S)}$ = animal manure nitrogen excreted for livestock species/category *T* in manure management and storage system *S* in the country, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{bedding(T,S)}$ and $N_{bedding(T,S)}$ = nitrogen in bedding material added for livestock species/category *T* in manure management and storage system *S* in the country, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{AM(T)}$ and $N_{AM(T)}$ = annual amount of animal manure N applied to soils for each livestock species/category *T*, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{intake(T)}$ and $N_{intake(T)}$ = annual intake of N in feed for each livestock species/category *T*, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{retention(T)}$ and $N_{retention(T)}$ = annual retention of N each livestock species/category *T*, kg N yr^{-1} and kg N $animal^{-1}$ yr^{-1}

$F_{ex(T)}$ and $N_{ex(T)}$ = annual average N excretion of species/category *T* in the country, kg N $animal^{-1}$ yr^{-1}

Annual N_2O emissions for the total population of each livestock species/category T

$N_2O_{\ (T)}$ = total annual N_2O emissions

$N_2O_{\ mm(T)}$ = total annual N2O emissions from Manure Management for each livestock species/category *T* in the country, kg N_2O yr^{-1}

$N_2O_{D,mm(T)}$ = direct annual N2O emissions from Manure Management for each livestock species/category *T* in the country, kg N_2O yr^{-1}

$N_2O_{G,mm(T)}$ = indirect annual N2O emissions from volatilization of NH_3+NO_x from Manure Management for each livestock species/category *T* in the country, kg N_2O yr^{-1}

$N_2O_{L,mm(T)}$ = indirect annual N2O emissions from leaching and run-off from Manure Management for each livestock species/category *T* in the country, kg N_2O yr^{-1}

$N_2O_{AM(T)}$ = total annual N_2O emissions from manure nitrogen applied to cultivated soils for each livestock species/category *T*, kg N_2O yr^{-1}

$N_2O_{PRP(T)}$ = total annual N_2O emissions from manure nitrogen deposited on pasture, range and paddock for each livestock species/category *T*, kg N_2O yr^{-1}

$N_2O_{D,AM(T)}$ = direct annual N_2O emissions from Manure Management for each livestock species/category *T* in the country, kg N_2O yr^{-1}

$N_2O_{I,AM(T)}$ = indirect annual N_2O emissions from Manure Management for each livestock species/category *T* in the country, kg N2O yr^{-1}

$N_2O_{D,PRP(T)}$ = direct annual N_2O emissions from pasture, range and paddock for each livestock species/category *T* in the country, kg N_2O yr^{-1}

$N2O_{I,PRP(T)}$ = indirect annual N2O emissions from pasture, range and paddock for each livestock species/category *T* in the country, kg N_2O yr^{-1}

N_2O emission factors

EF_1 = emission factor for direct N_2O emissions from N inputs to cultivated soils, kg N_2O –N (kg N input)$^{-1}$

EF_{1FR} = emission factor for direct N_2O emissions from N inputs to flooded rice, kg N_2O –N (kg N input)$^{-1}$

$EF_{3PRP,X}$ = emission factor for direct N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals, kg N_2O –N (kg N input)-1; X=CPP: Cattle, Poultry and Pigs; X=SO: Sheep and Other animals

$EF_{3(S)}$ = emission factor for direct N_2O emissions from manure management system *S* in the country, kg N_2O -N/(kg N in manure management system *S*)$^{-1}$

EF_4 = emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O -N (kg NH3-N + NOx-N volatilised)$^{-1}$

EF_5 = emission factor for N_2O emissions from nitrogen leaching and runoff, kg N_2O -N (kg N leached and runoff)$^{-1}$

Fractions

$Frac_{S(T,S)}$ = fraction of manure N excreted that is managed in manure management system *S* for each livestock species/category *T*, dimensionless

$Frac_{S(X,G)}$ = fraction of manure N excreted that is deposited by grazing cattle, poultry or pigs (X=CPP) or sheep or other animals (X=SO), dimensionless

$Frac_{GasMS(T,S)}$ = fraction of managed manure nitrogen for livestock species/category *T* that volatilises as NH3 and NOx in the manure management system *S*, %

$Frac_{LeachMS(T,S)}$ = fraction of managed manure nitrogen losses for livestock species/category *T* due to runoff and leaching during solid and liquid storage of manure (typical range 1-20%) in manure management system *S*, %

$Frac_{N2MS}$ = fraction of managed manure nitrogen for each livestock species/category *T* that is lost in the manure management system *S*, % as N_2, %

$Frac_{LossMS(T,S)}$ = total fraction of managed manure nitrogen for livestock category *T* that is lost in the manure management system *S*, %

$Frac_{GASM}$ = fraction of applied organic N fertiliser materials (FON) and of urine and dung N deposited by grazing animals (FPRP) that volatilises as NH3 and NOx, kg N volatilised (kg of N applied or deposited)$^{-1}$

$Frac_{LEACH-(H)}$ = fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff, kg N (kg of N additions)-1

$Frac_{APPL(T)}$ = fraction of animal manure N available for application to managed soils which is applied to managed soils for each livestock species/category *T*, dimensionless

$Frac_{FEED(T)}$ = fraction of managed manure used for feed for each livestock species/category *T*, dimensionless

$Frac_{FUEL(T)}$ = fraction of animal manure N available for application to managed soils used for fuel for each livestock species/category *T*, dimensionless

$Frac_{CNST(T)}$ = fraction of animal manure N available for application to managed soils used for construction for each livestock species/category *T*, dimensionless

$Frac_{AM,Rice}$ = fraction of animal manure N applied to managed soils which is applied to flooded rice, dimensionless

$Frac_{RET}$ = fraction of feed intake N that is retained by the animal in body mass or livestock products for each livestock species/category *T*, dimensionless

Annex 10A.5 Additional data and information for the calculation of N_2O from Manure Management of other animal

TABLE 10A.5-1
MANURE MANAGEMENT NITROUS OXIDE EMISSION FACTOR DERIVATION FOR OTHER ANIMALS

Animal	Animal Characteristics				[1]AWMS - MCF	Emission factors	
	Mass (kg)		Nitrogen excretion rate (kg/head/year)			(kg N_2O head^{-1} yr^{-1})	
	Range	mean±SD	Range	mean±SD		Range	mean±SD
Deer	50.00~126.52	71.50±30.78	8.48~34.00	16.65±6.76	NR	0.021~0.242	0.08±0.08
Reindeer	70	70±0.00	5.75~10.70	8.48±2.24	2.00%	NO	NO
Rabbits	1.60~4.30	2.32±1.191	0.96~9.00	6.30±2.86	1.00%	0.001~0.225	0.07±0.08
Fur-bearing animals	2.00~4.62	3.31±1.86	2.28~16.68	5.43±2.88	8.00%	0.018~0.146	0.05±0.04
Ostrich	120	120±0.00	2.98~15.61	11.6±5.99	8.00%	0.006~0.196	0.12±0.09

Calculated based on country submisison of CRF table to UNFCCC

Animal Waste Management System

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Annex10B Data and Explanatory Text for Development of New Parameters in the 2019 Refinement.

Annex10B.1 Raw data used to compile Annex A.1 enteric fermentation Tier 1 emission factors, volatile solids and nitrogen excretion for cattle and buffalo

This annex presents the data used to develop the default emission factors for methane emissions from Enteric Fermentation and for Nitrogen exretion rate for cattle and buffaloes. The Tier 2 method was implemented with these data.

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TABLE 10B.1-1
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF NORTH AMERICA IN TABLE 10A.1-1 AND TABLE 10A.1-3

Parameter[1]	**Unit**	**Value in Table 10A1-.1 Table 10A.1-3**	**Reference source**
Weight_DCA	kg/hd	635	Expert judgement of IPCC panel, with consideration of Appuhamy *et al.* (2016); Jayasundara *et al.* (2016); Niu *et al.* (2018) and consideration of National Statistics as represented in National Inventory Report submissions
Weight Gain_DCA	kg/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
Feeding Situation_DCA		Stall Fed	
Milk_DCA	kg/day	28	Expert judgement of IPCC panel, with consideration of Appuhamy *et al.* (2016); Jayasundara *et al.* (2016); Niu *et al.* (2018) and consideration of National Statistics as represented in National Inventory Report submissions. Milk production represents average production over a 365 day period taking into consideration a 60 day dry period.
Fat_DCA	%	3.7	
Protein_DCA	%	3.2	
Work_DCA	hrs/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
Pregnant_DCA	%	90	
DC_DCA	%	71	DC from Appuhamy *et al.* (2016)
CP_DCA	%	16.7	Expert judgement of IPCC panel, with consideration of Appuhamy *et al.* (2016); Jayasundara *et al.* (2016); Niu *et al.* (2018)
Day Weighted Population Mix %	%	100	Expert judgement of IPCC panel, no change from 2006 guidelines
Weight_MM	kg	820	Expert judgement of IPCC panel, considering consistency with IPCC 2006 and in consideration of Basarab *et al.* (2005); Ominski *et al.* (2007); Capper (2011); Stackhouse-Lawson *et al.* (2012); Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015); Legesse *et al.* (2016) and consideration of National Statistics as represented in National Inventory Report submissions
Weight Gain_MM	kg/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
Feeding Situation_MM		Pasture/Range	
DC_MM	%	62	Expert judgement of IPCC panel and consideration of National Statistics as represented in National Inventory Report submissions.
CP_MM	%	12	Expert judgement of IPCC panel, with consideration of Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015) and consideration of National Statistics as represented in National Inventory Report submissions
Weight_MF	kg	580	Expert judgement of IPCC panel, considering consistency with IPCC 2006 and in consideration of Basarab *et al.* (2005); Ominski *et al.* (2007); Capper (2011); Stackhouse-Lawson *et al.* (2012); Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015); Legesse *et al.* (2016) and consideration of National Statistics as represented in National Inventory Report submissions
Weight Gain_MF	kg/day	0	Expert judgement of IPCC panel, no change from

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TABLE 10B.1-1
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF NORTH AMERICA IN TABLE 10A.1-1 AND TABLE 10A.1-3

Parameter[1]	**Unit**	**Value in Table 10A1-.1 Table 10A.1-3**	**Reference source**
Feeding Situation_MF		Pasture/Range	2006 guidelines
Milk_MF	kg/day	7	Expert judgement of IPCC panel, with consideration of (Basarab *et al.* 2005; Ominski *et al.* 2007; Mulliniks *et al.* 2017). Basarab *et al.* (2005); Ominski *et al.* (2007); Mulliniks *et al.* (2017) Milk production was corrected for a five month lactation cycle. (the value 3 kg day was used in calculations, and is found in Tables A1.
Fat_MF	%	4	
Protein_MF	%	3.5	
Work_MF	hrs/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
% Pregnant_MF	%	80	
DC_MF	%	62	
CP__MF	%	12	Expert judgement of IPCC panel, with consideration of Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015)
Weight_Cmilk	kg	125	Expert judgement of IPCC panel, considering consistency with IPCC 2006 and in consideration of (Basarab *et al.* 2005; Ominski *et al.* 2007; Mulliniks *et al.* 2017). Basarab *et al.* (2005); Ominski *et al.* (2007); Mulliniks *et al.* (2017) and consideration of National Statistics as represented in National Inventory Report submissions
Weight Gain_Cmilk	kg/day	1	
Feeding Situation_Cmilk		Pasture/Range	Expert judgement of IPCC panel, no change from 2006 guidelines
Work_Cmilk	hrs/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
DC__Cmilk	%	95	
CP_Cmilk	%	16	Expert judgement of IPCC panel, with consideration of Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015)
Weight_C	kg	215	Expert judgement of IPCC panel, considering consistency with IPCC 2006 and in consideration of Basarab *et al.* (2005); Ominski *et al.* (2007); Capper (2011); Stackhouse-Lawson *et al.* (2012); Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015); Legesse *et al.* (2016) and consideration of National Statistics as represented in National Inventory Report submissions
Weight Gain_C	kg/day	1	
Feeding Situation_C		Pasture/Range	Expert judgement of IPCC panel, no change from 2006 guidelines
Work_C	hrs/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
CP_C	%	13	Expert judgement of IPCC panel, with consideration of Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015)
Weight_GrHS	kg	300	Expert judgement of IPCC panel, considering consistency with IPCC 2006 and in consideration of Basarab *et al.* (2005); Ominski *et al.* (2007); Capper (2011); Stackhouse-Lawson *et al.* (2012); Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015); Legesse *et al.* (2016) and
Weight Gain_GrHS	kg/day	0.9	

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TABLE 10B.1-1
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF NORTH AMERICA IN TABLE 10A.1-1 AND TABLE 10A.1-3

Parameter[1]	**Unit**	**Value in Table 10A1-.1 Table 10A.1-3**	**Reference source**
			consideration of National Statistics as represented in National Inventory Report submissions
Feeding Situation_GrHS		Pasture/Range	Expert judgement of IPCC panel, no change from 2006 guidelines
Work_GrHS	hrs/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
DC__GrHS	%	65	
CP__GrHS	%	13	Expert judgement of IPCC panel, with consideration of (Waldrip *et al.* 2013; Dong *et al.* 2014; Sheppard *et al.* 2015)
Weight_GrR	kg	400	Expert judgement of IPCC panel, considering consistency with IPCC 2006 and in consideration of Basarab *et al.* (2005); Ominski *et al.* (2007); Capper (2011); Stackhouse-Lawson *et al.* (2012); Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015); Legesse *et al.* (2016) and consideration of National Statistics as represented in National Inventory Report submissions
Weight Gain_GrR	kg/day	0.5	
Feeding Situation_GrR		Pasture/Range	Expert judgement of IPCC panel, no change from 2006 guidelines
Work_GrR	hrs/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
DC__GrR	%	62	
CP_GrR	%	12	Expert judgement of IPCC panel, with consideration of Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015)
Weight_FC	kg	500	Expert judgement of IPCC panel, considering consistency with IPCC 2006 and in consideration of Basarab *et al.* (2005); Ominski *et al.* (2007); Capper (2011); Stackhouse-Lawson *et al.* (2012); Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015); Legesse *et al.* (2016) and consideration of National Statistics as represented in National Inventory Report submissions
Weight Gain_FC	kg/day	1.4	
Feeding Situation_FC		Pasture/Range	Expert judgement of IPCC panel, no change from 2006 guidelines
Work_FC	hrs/day	0	Expert judgement of IPCC panel, no change from 2006 guidelines
% Pregnant_FC	%	0	
DC_FC	%	75	
CP_FC	%	14	Expert judgement of IPCC panel, with consideration of Waldrip *et al.* (2013); Dong *et al.* (2014); Sheppard *et al.* (2015) and consideration of National Statistics as represented in National Inventory Report submissions
Day Weighted Population Mix MM	%	2 – Mature males 36 – Mature females 11-Replacement/Growing Heifer 17 - Growing Heifer/Steers	Expert judgement of IPCC panel, no change from 2006 guidelines

TABLE 10B.1-1
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF NORTH AMERICA IN TABLE 10A.1-1 AND TABLE 10A.1-3

Parameter[1]	Unit	Value in Table 10A1-.1 Table 10A.1-3	Reference source
		16 - Calves on milk 8 – Calves on forage 11 – Feedlot cattle	

[1] DCA – dairy cattle, MM – mature males, MF – Mature females, Cmilk – Calves on milk, C – Calves on forage, GrHS - Growing Heifer/Steers, GrR - Replacement/Growing Heifer, FC - Feedlot cattle

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TABLE 10B.1-2
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF WESTERN EUROPE IN TABLE 10A.1-1 AND TABLE 10A.1-3[1]

Parameter[1]	**Unit**	**Value in Table 10A.1-1 Table 10A.1-3**	**Reference source**
Milk yield_DCA	kg/hd/d	19.0	FAOSTAT, 2017. Average value of EU-28 for 2010-2016
DC_DCA	%	73	Expert judgment based on Gerrits *et al.* (2014); Bannink *et al.* (2011), Hammond *et al.* (2016); Bannink *et al.* (2016); Spek *et al.* (2013)
CP_DCA	%	16.1	Spek *et al.* (2013)
CP_MM	%	14.7	FAO (2017)
CP_Gr	%	16.5	FAO (2017)
CP_Cmilk	%	17.1	Huuskonen (2017)
DC_Gr	%	65	Expert judgment based on Gerrits *et al.* (2014); Bannink *et al.* (2011), Hammond *et al.* (2016); Bannink *et al.* (2016); Spek *et al.* (2013)
DC_C	%	73	Gerrits *et al.* (2014)

[1] For those other parameters, which are not reported in the table, the values of IPCC 2006 (Table 10A.1-1 and Table 10A.1-2) were employed in Table 10A.1-1 and Table 10A.1-3.

[2] DCA – dairy cattle, MM – mature males, Gr – Growing/Replacement animals, Cmilk – Calves on milk, C – Calves on forage

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TABLE 1010B.1-3
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF EASTERN EUROPE IN TABLE 10A.1-1 AND TABLE 10A.1-3[1]

Parameter[2]	Unit	Value in Table 10A.1-1 Table 10A.1-3	Reference value (±SD)	Reference source
Weight_DCA	kg/hd	550	577	Kostenko and Pyrozhenko (2012)
Weight_DCA	kg/hd	550	562 563 571	Sharkaeva (2012)
Weight_DCA	kg/hd	550	548 - average 500 543 578	Zadnepryanskiy and Zakirko (2012)
Weight_DCA	kg/hd	550	607 505	Samorukov *et al.* (2013a)
Weight_DCA	kg/hd	550	517 488 519 541 508 515 494 485	Furaeva (2013)
Weight_DCA	kg/hd	550	520 516 538 543 545	Golubkov *et al.* (2015)
Weight_DCA	kg/hd	550	560 563 552 497 538 509	Samorukov *et al.* (2013b)
Weight gain_DCA	kg/hd/d	0	0	IPCC (2006)
Feeding situation_DCA		Stall Fed	Stall Fed	IPCC (2006)
Milk yield_DCA	kg/hd/d	10.24	10.24	FAOSTAT: value of 2006–2014 Faostat (2017)
Milk fat content_DCA	%	3.9	3.88 3.87 4.18 4.10 3.98 4.12	(Samorukov *et al.* 2013b)
Milk fat content_DCA	%	3.9	3.84 3.85	Sharkaev and Kochetkov (2012)
Milk protein content_DCA	%	3.19	3.09 3.07 3.46 3.44 3.32 3.23	Samorukov *et al.* (2013b)
Work_DCA	hr/day	0	0	IPCC (2006)
Pregnancy rate_DCA	%	85	85	Dunin *et al.* (2011)
DC_DCA	%	70	66.23±0.49	Gren (2013)
DC_DCA	%	70	72, average of: 70.70±1.20 73.80±2.20 72.10±0.75 74.15±1.40	Haysanov (2011)

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TABLE 1010B.1-3
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF EASTERN EUROPE IN TABLE 10A.1-1 AND TABLE 10A.1-3[1]

Parameter[2]	Unit	Value in Table 10A.1-1 Table 10A.1-3	Reference value (±SD)	Reference source
DC_DCA	%	70	72	Nosyreva Yu and Tokareva (2014)
DC_DCA	%	70	71.8	Azaubaeva (2008)
CP_DCA	%	15.1	14.8 15.3 N intake: 312.8±12.1	Kalnickij and Haritonov (2008)
CP_DCA	%	15.1	17.0	Nekrasov *et al.* (2013)
Weight_MF	kg/d	500	491 494 496	Dunin *et al.* (2011)
Weight_MF	kg/d	500	535	Kostenko and Pyrozhenko (2012)
Weight_MF	kg/d	500	630 - average	Sheveleva and Bakharev (2013)
Weight gain_MF	kg/hd/d	0		IPCC (2006)
Feeding situation_MF		Pasture	Pasture	IPCC (2006)
Milk yield_MF	kg/hd/d	3.0	Calculated as: milk yield of 1000-1200 (1194, 1065, 1093, 1146, 1173) kg/hd/yr divided by 365	Bakharev (2012)
Milk fat content_MF	%	4.16	4.30±0.17 4.08±0.17 4.16±0.17 4.09±0.17 4.19±0.22	Bakharev (2012)
Milk protein content_MF	%	3.66	3.65±0.05 3.44±0.07 3.56±0.06 3.92±0.14 3.71±0.14	Bakharev (2012)
Work_MF		0		IPCC (2006)
Pregnancy rate	%	80	84.1 84.1 81.6	Dunin *et al.* (2011)
Pregnancy rate_MF	%	80	76 79 77.8 83.3 70.2 83.4 73.6 63.8 75.3 77.2	Sharkaeva (2013)
DC_MF	%	70	70	DC value of 'Dairy cattle'
CP_MF	%	15.1	15.1	CP value of 'Dairy cattle'
Weight_MM	kg/hd	600	759	Dunin *et al.* (2011)
Weight_MM	kg/hd	600	570 (1 yr) 700 (2 yr) 750 (4yr)	Amerkhanov *et al.* (2016)
Weight gain_MM	kg/hd/d	0	0	IPCC (2006)
Feeding situation_MM		Pasture	Pasture	IPCC (2006)
Work_MM	hr/day	0	0	IPCC (2006)

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TABLE 1010B.1-3
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF EASTERN EUROPE IN TABLE 10A.1-1 AND TABLE 10A.1-3[1]

Parameter[2]	Unit	Value in Table 10A.1-1 Table 10A.1-3	Reference value (±SD)	Reference source
DC_MM	%	65		DC value of 'Growing/Replacement cattle'
CP_MM	%	14.2		CP value of 'Growing/Replacement cattle'
Weight_Gr	kg/hd	350	512 (740d)	Tekeev and Chomaev (2011)
Weight_Gr	kg/hd	350	454.1±2.23 (18m)	Gayirbegov and Mandjiev (2013)
Weight_Gr	kg/hd	350	489.6±4.64 (18m) 512.6±5.68 (18m) 535.4±5.04	Gubaidullin *et al.* (2011)
Weight_Gr	kg/hd	350	(14m) 410.5±5.3 409.0±5.6 428.0±3.5 416.0±4.5	Goncharova and Kibkalo (2011)
Weight_Gr	kg/hd	350	(18m) 425.2±4.39 443.5±5.38 448.6±5.82 438.5±5.19	Levakhin *et al.* (2011)
Weight_Gr	kg/hd	350	(18m) 523.0±8.97 514.7±6.70 562.7±7.75 538.0±7.29	Litovchenko (2012)
Weight_Gr	kg/hd	350	420 (18m) 370 (18m)	Samorukov *et al.* (2013b)
Weight_Gr	kg/hd	350	(16m) 607.7±36.0 611.5±30.2	Leontev *et al.* (2013)
Weight gain_Gr	kg/hd/d	0.40	0.37 (calculated value based on the data reported in table 1)	Tekeev and Chomaev (2011)
Weight gain_Gr		0.40	872±22.24 (g/d, between 12m and 18m)	Gayirbegov and Mandjiev (2013)
Weight gain_Gr		0.40	g/d - feedlot 731±20.2 822±28.4 843±21.5 801±25.0	Levakhin *et al.* (2011)
Feeding situation_Gr		Pasture	Pasture	IPCC (2006)
Work_Gr	hr/day	0		IPCC (2006)
DC_Gr	%	65	62-68: 61.42±0.74 62.05±0.47 65.12±0.47 67.8±0.23 60.05±0.64 61.4±0.34 63.33±0.62 65.80±0.49	Gayirbegov and Mandjiev (2013)
CP_Gr	%	14.2	13.6	Shevkhuzhev *et al.* (2015)
CP_Gr	%	14.2	14.4	Golubkov (2015)
CP_Gr	%	14.2	13.9 14.4	Mamaev *et al.* (2017)
Weight_C	kg/hd	180	263 (320d)	Tekeev and Chomaev (2011)

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Table 1010B.1-3
Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Eastern Europe in Table 10A.1-1 and Table 10A.1-3[1]

Parameter[2]	Unit	Value in Table 10A.1-1 Table 10A.1-3	Reference value (±SD)	Reference source
Weight_C	kg/hd	180	345 (12 m) 450 (18 m) 400-430 – at the first insemination (15m old)	Pracht (2013)
Weight_C	kg/hd	180	(12 m) 296.7±1.03 297.0±1.48 295.0±1.59 296.0±1.54	Gayirbegov and Mandjiev (2013)
Weight_C	kg/hd	180	32 (0d) 30.8±0.25 28.8±0.46 34.4±0.36 340-350 (12m) 328.3±3.52 340.9±3.29 351.2±3.57	Gubaidullin *et al.* (2011)
Weight_C	kg/hd	180	305 (12 m)	Goncharova *et al.* (2009)
Weight_C	kg/hd	180	(0d) 32.8±1.5 33.3±1.5 32.8±1.3 33.0±1.4 (12m) 356.5±5.1 355.4±6.2 317.5±4.6 361.0±5.2	Goncharova and Kibkalo (2011)
Weight_C	kg/hd	180	270 (11m)	Levakhin *et al.* (2011)
Weight_C	kg/hd	180	(0d) 32.5±1.30 32.8±1.48 35.1±1.67 33.9±1.84 (12m) 340.6±4.78 333.9±3.55 366.3±4.47 350.0±4.68	Litovchenko (2012)
Weight_C	kg/hd	180	(0d) 40.8±1.94 40.4±1.90 450 (12m) 443.0±6.10 464.0±5.91	Leontev *et al.* (2013)
Weight gain_C	kg/hd/d	0.70		A weight-range between 34 (birth weight) and 320 (MW). The weight gain was calculated as 0.70kg/hd/d.
Feeding situation_C		Pasture	Pasture	IPCC (2006)
Work_C	hr/day	0	0	IPCC (2006)
DC_C	%	65	64.4	Ilichev *et al.* (2011)

TABLE 1010B.1-3
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF EASTERN EUROPE IN TABLE 10A.1-1 AND TABLE 10A.1-3[1]

Parameter[2]	Unit	Value in Table 10A.1-1 Table 10A.1-3	Reference value (±SD)	Reference source
DC_C	%	65	62-68	Gayirbegov and Mandjiev (2013)
CP_C	%	14.3	14.6	Shevkhuzhev *et al.* (2015)
CP_C	%	14.3	N input: 206.6±5.1	Ilichev *et al.* (2011)
CP_C	%	14.3	14.0	Golubkov (2015)
Day weighted population	%	9/39/27/25	Of 100%: 9 – Mature Males 39 – Mature Females 27 – Growing 25 – Calves	RUSSTAT (2016)

[1] For those other parameters, which are not reported in the table, the values of IPCC 2006 (Table 10A.1-1 and Table 10A.1-2) were employed in Table 10A.1-1 and Table 10A.1-3.

[2] DCA – dairy cattle, MF – Mature females, MM – mature males, Gr – Growing/Replacement animals, Cmilk – Calves on milk, C – Calves on forage

TABLE 1010B.1-4 -
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF OCEANIA IN TABLE 10A.1-1 AND TABLE 10A.1-3[1]

Parameter[2]	Unit	Value in Table 10A.1-1 Table 10A.1-3	Reference source
Weight_DCA	kg/hd	488	Based on data derived from Australia (Dairy Technical Working Group (2015)) and (Dairy NZ and LIC (2018))
Feeding_DCA		Range/ Pasture	IPCC (2006)
Milk yield_DCA	kg/day	12.1	Based on data from Dairy Australia (2018) and Dairy NZ and LIC (2018)
Milk fat_DCA	%	4.8	Derived from NZ data only (Dairy NZ & LIC 2018)
Milk protein_DCA	%	3.7	Based on data derived from Australia (Dairy Technical Working Group 2015) and New Zealand (Dairy NZ & LIC 2018)
Pregnant_DCA	%	92	Derived from NZ data only (Dairy NZ & LIC 2018)
DC_DCA	%	77	Based on data from Australia (Dairy Technical Working Group 2015) and NZ (Pickering and Wear, 2013)
CP_DCA	%	22.3	Based on data from Australia (Dairy Technical Working Group 2015) and NZ (Pickering and Wear, 2013)
Weight_MF	kg/hd	416	Based on data derived from Australia (Dairy Australia (2018)), Australian Bureau of Agricultural and Resource Economics and Sciences (2018) and NZ (Statistics NZ, 2018a)
Weight_MM	kg/hd	467	
Weight_Y	kg/hd	185	
Weight gain_Y	kg/day	0.41	Derived from data from NZ (Fick 2016) and Australia (Australian Government Department
Feeding_MM_MF_Y		Pasture/ Range	Derived from data from NZ (Dairy NZ & LIC 2018) and Australia (Australian Government Department of Climate Change 2006)
Milk yield_MF	kg/day	1.72	Derived from data from NZ (Dairy NZ & LIC 2018) and Australia (Australian Government Department of Climate Change 2006)
Milk fat_MF	%	4.8	
Milk protein_MF	%	3.7	
Preganant_MF	%	81	Derived from NZ data only (Dairy NZ and LIC (2018))
DC_MF	%	61	Based on data of Australia ((Dairy Technical Working Group 2015) and New Zealand (Dairy NZ and LIC (2018)) Derived from NZ (Statistics NZ, 2018b) and Australia (Australian Bureau of Agricultural and Resource Economics and Sciences (2018)) Derived from data from NZ (Fick 2016) and Australia Australian Government Department of Climate Change (2006)
DC_MM	%	62	
DC_Y	%	61	
CP_MF	%	14	Derived from data from NZ (Fick 2016) and Australia (Australian Government Department Derived from data from NZ (Fick 2016)) and Australia (Australian Government Department of Climate Change (2006))
CP_MM	%	14	
CP_Y	%	14	
Day Weighted Population Mix %	%	45 – Mature females 25 – Mature males 30 – Young	

[1] For those other parameters, which are not reported in the table, the values of IPCC 2006 (Table 10A.1-1 and Table 10A.1-2) were employed in Table 10A.1-1 and Table 10A.1-3.

[2] DCA – dairy cattle, MM – mature males, Y - Young animals

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TABLE 1010B.1-5
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF LATIN AMERICA IN TABLE 10A.1-1 AND TABLE 10A.1-3

Parameter[1]	Unit	Country of Latin America	Reference value[2]	Reference source [3]
Weight_DCA_low	kg/hd	Brazil: 450	450-459 511 Spring-Summer 502 Autumn-Winter 408.55 (Holstein x Gyr type) 423.33 (Simental x Gyr) 393.08 (Gyr) 550 450-500 (Crossbred) 550-600 (Holstein) 530 (Gir+Holstein) 599 ± 12.66 kg (Gir+Holstein)	Machado Filho *et al.* (2014) Peres *et al.* (2012) McManus *et al.* (2011) Cândido *et al.* (2015) http://simentalsimbrasil.org.br/biblioteca/modelos_de_producao_de_leite_a_pasto.pdf Teixeira *et al.* (2013) Cardoso *et al.* (2017)
Weight_DCA_high	kg/hd	Brazil: 500	464 (Holstein) 478 (Jersey) 487 (Holstein-maximum weight) 439 (Jersey-maximum weight) 499 (Brown Swiss – maximum weight) 500 (medium production systems) 550 (high production systems) 450-459 519 ± 53.3 (Holstein x Gyr cows (Bos indicus)) 524 ± 57 kg (Holstein x Gyr cows (Bos indicus)) 450 ± 23.59 kg (pregnant heifers) 529.8; 514	Teodoro and Madalena (2002) Teodoro and Madalena (2005) Personal Communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle). Machado Filho *et al.* (2014) Ribeiro *et al.* (2016) Mata e Silva *et al.* (2017) Cunha *et al.* (2016) Kolling *et al.* (2018)
Weight_DCA_high	kg/hd	Uruguay	580	Personal Communication from Dr. Laura Astigarraga, Faculty of Agronomy, Uruguay.
Weight_DCA_high	kg/hd	Argentina	600	Sebastian Galbusera, National GHG inventory compiler of Agrenttina. Personal communication.
Feeding_DCA_low		Brazil: Pasture/Grazing + concentrate	Pasture/Range	
Feeding_DCA_high		Brazil: Grazing + Concentrate and Stall Feed	Pasture/Concentrate	
Milk yield_DCA_low	kg/hd/d	Brazil: 2.9	2.9 3.0 6.2 (Mexico- dual purpose cattle) 5.95 (2,174 kg/cow/year)	Based on livestock national statistics (IBGE, 2017) Albertini *et al.* (2012) Castro *et al.* (2012) Albarrán-Portillo *et al.* (2015)
Milk yield_DCA_high	kg/hd/d	Brazil: 7.2	7.2 12-17 (semi-intensive and intensive production systems, respectively)	Based on livestock national statistics (IBGE, 2017) Simões *et al.* (2009)

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Milk yield_DCA_high	kg/hd/d	Uruguay	12.3 17.8	Anuario estadístico. Ministerio de Ganadería, Agricultura y Pesca del Uruguay (2017). Santiago Fariña. Dirceto of the Dairy Redearch Program. National Institute of Agricultural Research. Uruguay.
Milk yield_DCA_high	kg/hd/d	Argentina	12.6	Sebastian Galbusera, National GHG inventory compiler of Argentina. Personal communication.
Milk fat_DCA_low	%	Brazil: 4	3.29-3.24 4.14 (Sugar cane silage) 4.09 (Sorghum silage) 4.27 (Corn silage) 4.11 (Fresh sugarcane) 3.2 (Mombasa grass) 3.68 (Crossbreed) 4.08 (mineral mixture)	Machado Filho *et al.* (2014) Santos *et al.* (2011) Peres *et al.* (2012) Verruma and Salgado (1994) Silva *et al.* (2017)
Milk fat_DCA_low	%	Region-average	4.0	GLEAM (FAO 2017)
Milk fat_DCA_high	%	Brazil: 4	4.77 (Sindi breed) 3.37 (Holstein) 3.73 (Jersey) 3.77 (Brown Swiss) 3.61- 4.0	Huhn *et al.* (1982) Teodoro and Madalena (2005) Mata e Silva *et al.* (2017)
Milk fat_DCA_high	%	Region-average	4.1	GLEAM (FAO 2017)
Milk protein_DCA_low	%	Brazil: 3.2	2.95 – 2.94 3.2 3.06 3.06 3.34 3.22 3.42	Machado Filho *et al.* (2014) Personal communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle). Santos *et al.* (2011) Silva *et al.* (2017)
Milk protein_DCA_low	%	Region-average	3.2	GLEAM (FAO 2017)
Milk protein_DCA_high	%	Brazil: 3.1	3.02 (Holstein) 3.1 (Jersey) 3.16 (Brown Swiss) 3.13-3.15	Teodoro and Madalena (2005) Mata e Silva *et al.* (2017)
Milk protein_DCA_high	%	Uruguay	3.27	Personal Communication from Dr. Laura Astigarraga, Faculty of Agronomy, Uruguay.
Milk protein_DCA_high	%	Region-average	3.2	GLEAM (FAO 2017)
Pregnancy rate_DCA_low	%	Brazil: 58	60 51.6 (Mexico) – duble purpose cattle	Based on personal communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle). Barajas Merchan *et al.* (2017)
Pregnancy rate_DCA_low	%	Region-average	66.6	GLEAM (FAO 2017)
Pregnancy rate_DCA_high	%	Brazil: 68	60-75	Based on personal communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle).
Pregnancy rate_DCA_high	%	Argentina	78.1	Sebastian Galbusera, National GHG inventory compiler of Argentina. Personal communication.
Pregnancy	%	Uruguay	80.9	Anuario estadístico. Ministerio de

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rate_DCA_high				Ganadería, Agricultura y Pesca del Uruguay (2017).
Pregnancy rate_DCA_high	%	Region-average	79.0	GLEAM (FAO 2017)
DC_DCA_low	%	Brazil: 60	60	Based on personal communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle).
DC_DCA_low	%	Region-average	63.6	GLEAM (FAO 2017)
DC_DCA_high	%	Brazil: 65	65 70	Based on personal communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle). Cunha *et al.* (2016)
DC_DCA_high	%	Argentina	65	Sebastian Galbusera, National GHG inventory compiler of Argentina. Personal communication.
DC_DCA_high	%	Uruguay	68	Personal Communication from Dr. Laura Astigarraga, Faculty of Agronomy, Uruguay.
CP_DCA_low	%	Brazil: 11	10 10 (Mombasa grass in Spring-Summer) 10 (Mombasa grass in Autumn-Winter) 10.2 (Guinea grass) 4.1 (Palisade grass – Urochloa brizantha) 10.8 (Signal grass – Urochloa decumbens) Note: Urochloa represents 50% of pastures in Brazil 11.6 (Tanzania grass) 13.43 (Tanzania grass) 9.6 (pasture – *Urochloa decunbens*) 13.11 (pasture +sugarcane and urea) 19.91 (pasture +concentrate) 15.19 (pasture+sorghum sillage + concentrate) 8.37 (pasture+sorghum sillage)	Machado Filho *et al.* (2014) Peres *et al.* (2012) Lima *et al.* (2018) Silva *et al.* (2017) Oliveira *et al.* (2014) Cardoso *et al.* (2017)
CP_DCA_high	%	Brazil: 17	17 18 16.8	Based on personal Communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle). Primavesi *et al.* (2004) Kolling *et al.* (2018)
CP_DCA_high	%	Uruguay	15.8	Personal Communication from Dr. Laura Astigarraga, Faculty of Agronomy, Uruguay.
Day weighted population mix_DCA	%	Brazil	Brazil: 59% Low productivity systems 41% High productivity systems	Based on personal Communication from Dr. Luiz Gustavo Ribeiro Pereira (Embrapa Dairy Cattle). Financiera Rural. Bovino y sus derivados. Dirección General Adjunta de Planeación Estratégica y Análisis Sectorial. http://www.gbcbiotech.com/bovino

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				s/industria/Bovino%20y%20sus%20derivados%20Financiera%20Rural%202012.pdf Accessed in June 08, 2018
Day weighted population mix_DCA	%	Region-average	85% Low productivity (1,183 kg/head/yr), 15% High productivity (4,578 kg/head/yr).	GLEAM (FAO 2017)
Weight_MF_low	kg/hd	Argentina	400	Argentina: Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016.
Weight_MF_low	kg/hd	Brazil	420 447 (Nelore breed)	based in personal communication from Embrapa Beef Cattle researchers(*) Rosa *et al.* (2001)
Weight_MF_low	kg/hd	Peru	330	Bartl *et al.* (2009)
Weight_MF_low	kg/hd	Uruguay	350 (British breeds)	Based on personal communication with Dr. Pablo Soca, Faculty of Agronomy.
Weight_MM_low	kg/hd	Argentina	600	Argentina: Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016.
Weight_MM_low	kg/hd	Brazil	600	Based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_MM_low	kg/hd	Peru	440	Bartl *et al.* (2009)
Weight_MM_low	kg/hd	Uruguay	550 (British breeds)	Based on personal communication with Dr. Pablo Soca, Faculty of Agronomy.
Weight_Cmilk_low	kg/hd	Brazil	50	Brazil: based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_Cmilk_low	kg/hd	Peru	50	Quispe *et al.* (2016) Bartl *et al.* (2009)
Weight_Cmilk_low	kg/hd	Uruguay	70 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_C_low	kg/hd	Argentina	160	Argentina: Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Weight_C_low	kg/hd	Brazil	150	Brazil: based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_C_low	kg/hd	Peru	120	Quispe *et al.* (2016)
Weight_C_low	kg/hd	Uruguay	140 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_ GrHS_low	kg/hd	Brazil	250	Brazil: based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_ GrHS_low	kg/hd	Peru	215	Sgroi (2017)
Weight_ GrHS_low	kg/hd	Uruguay	200 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_ Gr_high	kg/hd	Argentina	240	Argentina: Sebastián Galbusera

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				used for the for the Tier 2 National GHG Inventory, 2016
Weight_ Gr_high	kg/hd	Brazil	300	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_ Gr_high	kg/hd	Peru	250	Sgroi (2017)
Weight_ Gr_high	kg/hd	Uruguay	285 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_MF_high	kg/hd	Argentina	400	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Weight_MF_high	kg/hd	Brazil	480 532.98±11.29 body weight at calving high forage availability (Angus-Nelore) 565.07±16.97 (Simmental-Nellore)	based in personal communication from Embrapa Beef Cattle researchers(*) Ítavo *et al.* (2014)
Weight_MF_high	kg/hd	Peru	560	Pajuelo (2003)
Weight_MF_high	kg/hd	Uruguay	400 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_MM_high	kg/hd	Argentina	600	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Weight_MM_high	kg/hd	Brazil	600	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_MM_high	kg/hd	Peru	600	Pajuelo (2003)
Weight_MM_high	kg/hd	Uruguay	550 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_Cmilk_high	kg/hd	Brazil	80	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_Cmilk_high	kg/hd	Brazil	94.2-95.2 (Nellore) 117-119.3 (Nellore-Red Angus)	Mariani *et al.* (2009)
Weight_Cmilk_high	kg/hd	Peru	80	Pajuelo (2003) Barrantes (2000)
Weight_Cmilk_high	kg/hd	Uruguay	90 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_C_high	kg/hd	Argentina	180	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Weight_C_high	kg/hd	Brazil	200 247.74 ±5.63 Calf body weight at weaning to Angus-Nellore 248.16±7.31 Simmental-Nellore at weaning	based in personal communication from Embrapa Beef Cattle researchers(*) Brazil: Ítavo *et al.* (2014) Brazil: Ítavo *et al.* (2014)
Weight_C_high	kg/hd	Peru	140	Pajuelo (2003) Chavez (2010)
Weight_C_high	kg/hd	Uruguay	175 (British breeds)	Becoña (2012), p.42.

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Weight_ GrHS_high	kg/hd	Brazil	300	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_ GrHS_high	kg/hd	Peru	270	Pajuelo (2003)
Weight_ GrHS_high	kg/hd	Uruguay	280 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_Gr_high	kg/hd	Brazil	350	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_Gr_high	kg/hd	Peru	380	Pajuelo (2003)
Weight_Gr_high	kg/hd	Uruguay	350 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight_FC_high	kg/hd	Brazil	500	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight_FC_high	kg/hd	Peru	350	Based in personal communication from Beef Cattle producers.
Weight_FC_high	kg/hd	Uruguay	430 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_Cmilk_low	kg/day	Brazil	0.2	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight gain_Cmilk_low	kg/hd/day	Peru	0.5	Quispe *et al.* (2016)
Weight gain_Cmilk_low	kg/hd/day	Uruguay	0.5 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_C_low	kg/hd/day	Brazil	0.2	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight gain_C_low	kg/hd/day	Peru	0.5	Quispe *et al.* (2016)
Weight gain_C_low	kg/hd/day	Uruguay	0.4 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_ GrHS_low	kg/hd/day	Brazil	0.3	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight gain_ GrHS_low	kg/hd/day	Peru	0.2	Sgroi (2017)
Weight gain_ GrHS_low	kg/hd/day	Uruguay	0.2	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_Gr_low	kg/hd/day	Brazil	0.3	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight gain_Gr_low	kg/hd/day	Peru	0.2	Sgroi (2017)
Weight gain_Gr_low	kg/hd/day	Uruguay	0.2 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_Cmilk_high	kg/hd/day	Brazil	0.25	based in personal communication from Embrapa Beef Cattle

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				researchers(*)
Weight gain_Cmilk_high	kg/hd/day	Peru	1.0	Pajuelo (2003) Barrantes (2000)
Weight gain_Cmilk_high	kg/hd/day	Uruguay	0.8 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_C_high	kg/hd/day	Brazil	0.3	based in personal communication from Embrapa Beef Cattle researchers(*)
Weight gain_C_high	kg/hd/day	Peru	0.9	Pajuelo (2003) Chavez (2010)
Weight gain_C_high	kg/hd/day	Uruguay	0.6 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_ GrHS_high	kg/hd/day	Argentina	0.89	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Weight gain_ GrHS_high	kg/hd/day	Brazil	0.4	Based in personal communication from Embrapa Beef Cattle researchers(*)
Weight gain_ GrHS_high	kg/hd/day	Peru	0.7	Pajuelo (2003)
Weight gain_ GrHS_high	kg/hd/day	Uruguay	0.6 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Weight gain_Gr_high	kg/hd/day	Argentina	0.89	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Weight gain_Gr_high	kg/hd/day	Brazil	0.4	Based in personal communication from Embrapa Beef Cattle researchers(*)
Weight gain_Gr_high	kg/hd/day	Peru	0.6	Pajuelo (2003)
Weight gain_Gr_high	kg/hd/day	Uruguay	0.6 (British breeds)	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Feeding situation_all categories_low		Brazil	Tropical grazing	based in personal communication from Embrapa Beef Cattle researchers(*)
Feeding situation_all categories_low		Peru	Grazing	Rojas and Gómez (2005)
Feeding situation_all categories_low		Uruguay	Grazing temperate grasses	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Feeding situation_all categories_high		Brazil	Tropical grazing/Grazing +Concentrate+ Feedlot	based in personal communication from Embrapa Beef Cattle researchers(*)
Feeding situation_all categories_high		Peru	Forage + concentrate	Rodriguez (2018) Pajuelo F. (2008)
Feeding situation_all categories_high		Uruguay	Grazing + concentrate.	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Milk yield_MF_low	kg/hd/d	Argentina	0.78	Argentina: Sebastián Galbusera used for the for the Tier 2 National

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				GHG Inventory, 2016
Milk yield_MF_low	kg/hd/d	Brazil	3.0	Albertini *et al.* (2012)
Milk yield_MF_low	kg/hd/d	Peru	3.0	Bartl *et al.* (2009)
Milk yield_MF_low	kg/hd/d	Uruguay	1.8	Carriquiry (2013)
Milk yield_MF_high	kg/hd/d	Argentina	1.25	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Milk yield_MF_high	kg/hd/d	Brazil	5.0	Albertini *et al.* (2012)
Milk yield_MF_high	kg/hd/d	Peru	3.4	Bartl *et al.* (2009)
Milk yield_MF_high	kg/hd/d	Uruguay	2.7	Carriquiry (2013)
Milk fat_MF_low	%	Brazil	4.9	Restle *et al.* (2003)
Milk fat_MF_high	%	Brazil	4.9	Restle *et al.* (2003)
Milk protein_MF_low	%	Brazil	3.0	Medeiros *et al.* (2010)
Milk protein_MF_high		Brazil	3.0	Medeiros *et al.* (2010)
Work	hr/d	Brazil	0	based in personal communication from Embrapa Beef Cattle researchers(*)
Pregnancy rate_MF_low	%	Argentina	44	Argentina: Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Pregnancy rate_MF_low	%	Brazil	65 60 50 (South region)	Based in personal communication from Embrapa Beef Cattle researchers(*) Amaral *et al.* (2007) Reis (1998); Antoniazzi (2004)
Pregnancy rate_MF_low	%	Peru	55	Anco E. (2015)
Pregnancy rate_MF_low	%	Uruguay	60	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.
Pregnancy rate_MF_high	%	Argentina	81	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
Pregnancy rate_MF_high	%	Brazil	85	based in personal communication from Embrapa Beef Cattle researchers(*)
Pregnancy rate_MF_high	%	Peru	76	Ruiz and Sandoval (2014)
Pregnancy rate_MF_high	%	Uruguay	88	Dr. Pablo Soca, Faculty of Agronomy. Personal communication. Becoña (2012)
DC_all categories_low	%	Argentina	53	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
DC_all categories_low	%	Brazil	57.7 60.7 (30 days) 59.4 (60 days)	Euclides and Medeiros (2003) Queiroz *et al.* (2011)
DC_all categories_low	%	Peru	55 (adult) 60 (Young)	Based in IPCC (2006)
DC_all categories_low	%	Uruguay	52	Dr. Pablo Soca, Faculty of Agronomy. Personal

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				communication.
DC_all categories_high	%	Argentina	60	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
DC_all categories_high	%	Brazil	62 (Adult female and male, Calves on forage, Growing heifers and steers, Replacement) 75 (Feedlot)	based in personal communication from Embrapa Beef Cattle researchers(*)
DC_all categories_high	%	Peru	65	Based in IPCC (2006)
DC_all categories_high	%	Uruguay	58	Becoña (2012), p.42.
CP_all categories_low	%	Argentina	8	Sebastián Galbusera used for the for the Tier 2 National GHG Inventory, 2016
CP_all categories_low	%	Brazil	9	based in personal communication from Embrapa Beef Cattle researchers(*)
CP_all categories_low	%	Peru	9	Peru: {Bartl, 2009 #2293@@author-year
CP_all categories_low	%	Uruguay	9	Dr. Pablo Soca, Faculty of Agronomy. Personal communication. Modernel *et al.* (2013)
CP_all categories_high	%	Brazil	11 (Adult female and male); 12 (Calves on forage, Growing heifers and steers, Replacement) 13 (Feedlot)	based in personal communication from Embrapa Beef Cattle researchers(*)
CP_all categories_high	%	Uruguay	12	Becoña (2012), p.42.
Day weighted population mix_low	%		Brazil: 40% Adult female, 2% Adult Male, 10% Calves on milk, 10% Calves on forage, 19% Growing heifers/steers, 19% Replacement/growing	Brazil: based in personal communication from Embrapa Beef Cattle researchers(*)
Day weighted population mix_low	%		Peru: 30% Adult female, 10% Adult Male, 15% Calves on milk, 15% Calves on forage, 20% Growing heifers/steers, 10% Replacement/growing	Peru: Experts judgement.
Day weighted population mix_low	%		Uruguay: 42% Adult female, 3% Adult Male, 13% Calves on milk, 12% Calves on forage, 10% Growing heifers/steers, 10% Replacement/growing 10%	Uruguay: Dr. Pablo Soca, Faculty of Agronomy. Personal communication
Day weighted population mix_high	%	Brazil	35% Adult female, 1% Adult Male, 11% Calves on milk, 11% Calves on forage, 20% Growing heifers/steers, 16% Replacement/growing 6% Feedlot	Brazil: based in personal communication from Embrapa Beef Cattle researchers(*)
Day weighted population mix_high	%	Peru	40% Adult female, 0% Adult Male, 10% Calves on milk, 10% Calves on	Peru: Experts judgement.

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			forage, 20% Growing heifers/steers, 10% Replacement/growing 10% Feedlot	
Day weighted population mix_high	%	Uruguay	33% Adult female, 1% Adult Male, 12% Calves on milk, 12% Calves on forage, 23% Growing heifers/steers, 17% Replacement/growing 1.5% Feedlot	Agricultural Planning Office. Ministry of Agriculture.
Day weighted population_low/high productivity	%	Brazil	80/20	based in personal communication from Embrapa Beef Cattle researchers(*)
Day weighted population_low/high productivity	%	Peru	70/30	Based on National statistics from Agriculture Ministry of Peru.
Day weighted population_low/high productivity	%	Uruguay	75/25	Dr. Pablo Soca, Faculty of Agronomy. Personal communication.

[1]DCA – dairy cattle, MM – mature males, MF – Mature females, Cmilk – Calves on milk, C – Calves on forage, GrHS - Growing Heifer/Steers, GrR - Replacement/Growing Heifer, FC - Feedlot cattle

[2] Brazilian non-dairy cattle is composed by around 80% of zebuine breed (Bos indicus) and of 20% of taurine breeds (Bos taurus). The systems of production are characterized by great extension with continuous pasture management, and cattle face periodic scarcity of forage. Uruguayan non-dairy cattle is composed almost 100% of British breeds (Hereford and Aberdeen Angus). Gyr Dairy breed (Girolando) is found in more than 80% of the Brazilian dairy herds.

[3] Experts consulted: Brazil: Dr. Davi Bungestad, Dr. Sérgio Raposo Medeiros - Embrapa Beef Cattle, Uruguay: Dr. Pablo Soca – Livestock Department, Faculty of Agronomy, Uruguay

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
Philippins	DCA_weight_high, kg DCA_milk_high, kg/hd/d	Small farm, Holstein-Sahival 350-410 kg – weight Total milk production for the first 100 days PP was 513.6_129.1 kg (Site I) and 518.8_136.6 kg (Site II). Mean milk production for the whole lactation was 1088.7_450.4 kg (Site I) and 988.9_469.5 kg (Site II)	Alejandrino *et al.* (1999)
China	DCA_pregnancy_low_high,%	There is a considerable seasonal variation in conception rate, which is the lowest in July,Aug. and Sept. (range 48.1% to 51.9%) compared with other months (range 58.1% to 68.5%).	Zi *et al.* (2003)
Indonesia	Day-weighted population,%	Bali cattle, PO cattle, and Madura cattle become a mainstay to meet the needs of meat in Indonesia, while the Holstein Friesian cattle become a mainstay to meet the needs of milk. Beef cattle population in Indonesia is currently about 12.3 million, and dairy cattle is about 500,000. These cattle consist of Bali cattle (33.73%), PO cattle (23.88%), Madura cattle (5.16%), and others (13.45%).	Sutarno (2015)
Vietnam	Milk yield_low_high, kg/h/d DCA_ Milk fat_low_high,%	Region_Farm size_fat(SE) HCM Large_3.762±0.01 Medium_3.790±0.02 Small_3.771±0.01 LamDong Large_3.766±0.02 Medium_3.778±0.02 Small_3.794±0.02 BinhDuong Large_3.675±0.06 Medium_3.668±0.03 Small_3.683±0.02 LongAn Large_3.618±0.02 Medium_3.593±0.02 Small_3.622±0.01 Milk yield_taken from Fig.1: 4300, 4900, 5100	Hieu Vu *et al.* (2016)

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
Indonesia	C_weight_low, kg Gr_weight_low, kg MM_weight_low, kg	Sub-categories of beef cattle in Indonesia based on production level, live weight and each composition in the population Weaning (0-1 year) 100 19.30 Yearling (1-2 year) 200 25.85 Young (2-4 year) 250 18.15 Mature (>4 year) 400 26.89 Imported (fattening) 350 9.81	Widiawati *et al.* (2016)
Indonesia	C_weight_low, kg	Bali cattle Birth weight_WW (205d)_Yearling weight(365d) Male_17.73±1.72_89.50±8.80_142.45±3.25 Female_17.55±1.70_85.58±9.61_130.25±2.58	Gunawan and Jakaria (2011)
Philippines	C_CP_high,% Gr_CP_high,% C_DC_high,% Gr_DC_high,% MM_CP_high,% MF_CP_high,% MM_DC_high,% MF_DC_high,%	crossbred cattle_crossbred buffaloes CP,%_10.7_9.8 – calculated values DM apparent digestibility_54.7_56.6	Lapitan *et al.* (2008)
Vietnam	C_weight_low_high, kg Gr_weight_low_high, kg	Beef growth (i.e. 0 to 21 months) under grazing and indoor fattening (i.e. 22 to 25 months) data for Local Yellow×Red Sindhi (*B. indicus*; Lai Sind; LSD), and 1/2 Limousin (LS), 1/2 Drought Master (DS), and 1/2 Red Angus (RS) cattle were obtained from a household farming study Data taken from Fig. Local Yellow breed 3mo – 50 kg 12 mo – 100 kg 21 mo – 220 kg Crosses:	Ramírez-Restrepo *et al.* (2017)

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
		3mo – 75 kg 12 mo – 200 kg 21 mo – 250-300 kg	
Indonesia	DCA_weight_low, kg DCA_pregnancy_low,% DCA_milk yield_low, kg/h/d MF_weight_low, kg C_weight_low, kg Gr_weight_low, kg MM_weight_low, kg MF_weight_low, kg MF_pregnancy_low,% MF_milk yield_low, kg/h/d	Number of heads, Breed: Ongole_ Bali_ Madura_ Others 1 033 000_ 2 632 000_ 1 131 000 _4 980 000 Reproductive performance and milk production of Bali cattle Bali_ NTT_ NTB_South Sulawesi Age at puberty, year _2.0_ 2.5_ 2.0 _2.5 Calving age, month _32_ 41_ 36 _36 Calving interval, month _14 _15.4_ 16_ 15.7 Calving rate, %_ 66.3 _66.6_ 51.7_ 60.4 Milk production, kg ⁄ 6 month _274.5 _165_..._ 164 Production traits of Bali cattle females Region_ Bali _NTT _NTB _South Sulawesi Birth weight, kg_ 16.8 _11.9 _12.7 _12.3 Weaning weight, kg_ 82.9 _79.2 _83.9 _64.4 Yearling weight, kg _127.5_ 100.3_ 129.7_ 99.2 Weight at puberty, kg_ 170.4 _179.8_ 182.6 _225.2 Mature cows weight, kg_ 303.3_ 221.5 _241.9 _211.0 Adult males weigh between 600–800 kg, whiles adult females weigh between 500–650 kg	Martojo (2012)
Philippines	Day-weighted population,%	As of July 1, 2017, the total Cattle inventory was estimated at 2,561,270 heads. Around 93.94 percent or 2,406,109 heads were raised in backyard farms and the remaining 6.06 percent or 155,161 heads were found in commercial farms. Cattle population, heads	PhillippinesStatisticsAuthority (2017)

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TABLE 10B.1-6 **EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4**			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		Total_Backyard_Commercial Total_2,555,527_2,391,406_164,121 Bulls (male, 3yo and above)_294,465 _281,107_13,358 Cows (female, 3yo and above)_1,102,428_1,029,428_73,000 Heifers (2 to 3 yo)_454,613_421,593_33,020 Yearling (0 to 2 yo)_477,984_448,189_29,795 Others-226,037_211,089_14,948	
Vietnam	C_weight_high, kg Gr_weight_high, kg	Fresh milk until 12 weeks old Liveweight_Fed on milk_standard Birth weight_35_31 3mo_99_80 6mo_146_134 9mo_189_174 12mo_236_220 15mo_278_275	Moran (2012)
China	MF_weight_low, kg	27 female local yellow cattle (*Bos indicus*) with an average body weight of 144 kg and an age range from 18 to 25 months	Thanh (2014)
Philippines	DCA_DC_high,% DCA_CP_high,%	Feed intake and digestibility in cattle and crossbred buffaloes CP%_14.2_ 15.0 DM,%_ 68.3_ 72.4	Ichinohe *et al.* (2014)
Vietnam	C_weight_low_high, kg Gr_weight_low_high, kg MM_weight_low_high, kg MF_weight_low_high, kg C_weight gain_low_high, kg/hd/d Gr_weight gain_low_high, kg/hd/d	Beef productivity of native cattle is low because of slow growth rate, small size, and low carcass percentage. Live weight at 24 months is only 150 kg (female) and 175 (male) Local breed: Parameter_Female_Male Birth weight_12_14 6mo_65_85 12mo_80_100 24mo_150_175 Weight at adult_180_250	Dinh (2007)

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
		Crossed Sind: Parameter_Female_Male Birth weight_14_16 6mo_90_95 12mo_150_160 24mo_230_280 Weight at adult_250_320 Live weight of some F1 crossbreds in different rearing conditions <u>Low nutrition level</u>_at birth_12mo_18mo_weight gain,g/d F1 Charolais _23.12 _173.0 _232.0_ 380 F1 Limousin _20.50 _139.0_ 170.0 _272 F1 Hereford _22.60_ 145.8_ 178.9 _284 F1 Simental _21.15 _168.0_ 250.5_ 417 F1 S. Gertrudis_ 18.70 _163.0_ 183.3_ 299 Lai Sind _18.50 _122.6_ 156.1 _251 F1 Charolais _**_**_148.0 _233 F1 S. Gertrudis _**_**_153.0_ 242 F1 Hereford _**_**_144.0_ 225 <u>2/ Medium nutrition level (b)</u> F1 Charolais _21.30_ 159.1_ 308.8 _523 F1 Hereford_ 21.10 _149.6_ 291.6_ 493 F1 Simental_ 20.20 _145.7_ 220.2_ 364 hybrid Sind _19.30 _120.1 _205.5 _339 <u>3/ High nutrition level (c)</u> F1 Charolais _22.7_ 244.7 _320.7_ 543 F1 Droughtmaster _18.5_ 214.7_ 289.8 _494 F1 Brahman_ 16.9 _193.0_ 269.2_ 459 Lai Sind _13.8_ 167.0_ 233.4 _400	

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
		Meat quality of some crossbreds after fattening by high concentrate ration Parameter_Lai Sind_ F1Brahman_F1Charolais_F1Drought Master Weight before fattening, kg _216.30_ 307.70_ 349.00 _297.60 Weight after fattening,kg _284.60 _407.00_ 452.30_ 379.60 Weight of pure White Brahman & Droughtmaster calves in Vietnam White Brahman-Male_ White Brahman-Female_Droughtmaster-Male_ Droughtmaster-Female Weight at Birth, kg _23.6 _22.9_ 23.5_ 20.6 Weight at 6 months, kg_ 137.9_ 128.8_ 152.0_ 140.8 Weight at 12 months ,kg_ 207.7_ 223.0 _244.9 _239.4 Weight at 18 months,kg_ 286.0_ 280.2_ 343.7_ 329.3 Gain (birth to 12 months) ,g/day _504_ 548_ 614.9_ 607.8 Gain (birth to 18 months), g/day_ 480 _470 _583 _562 Age of first service, month _25.17_**_**_ 24.1 Age of first calving ,month _36.29_**_**_ 34.8 Calving interval ,day _482 _**_**_474.4	
Malasya	C_weight_low_high, kg Gr_weight_low_high, kg C_weight gain_low_high, kg/hd/d Gr_weight gain_low_high, kg/hd/d DCA_Milk yield_low_high, kg/h/d DCA_Milk_fat_low_high,%	The indigenous breed of cattle is the Kedah-Kelantan, found predominantly in the northern states of Peninsular Malaysia. It is mainly used for beef production and is considered by many to be the breed of choice for subsistence farming and integration with oil palm. The Department of Veterinary Services has about 1,000 head of purebred Kedah-Kelantan cattle at its Tanah Merah nucleus and conservation farm. Performance of Major Breeds of Beef Cattle Breed_Production system_Birth weight_ADG, kg/d_2yo_Calving interval Kedah-Kelantan _Extensive _16_ 0.18 _188_ 367 KK crosses _Integration _21_ 0.27_ 220 _401 Brahman _Integration _27_ 0.34 _300_ 537 Brahman crosses _Feedlot _22 _0.79 _218_ 559 Nelore_ Extensive _25_ 0.29_ 245_ 542	Department of Veterinary Services (2013)

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		Droughtmaster _Extensive _35_ 0.29_ 320 _460 Brakmas _Extensive_ 23 _0.31 _316_ 780 Charoke_ Feedlot _24 0.82_ 325_ --- Sahiwal-Friesian _Feedlot _23 _0.65_ 272 _424 Bali Cattle_ Extensive_ Male: 15, Female: 14_Male: 0.29, Female: 0.26_At 36 mths: Male: 320, Female: 260_439 Status of the Dairy Industry in Sabah (1990 – 2010) (dairy crosses) Parameter_2000_2005_2010 Total Dairy Animals 2,360_ 3,632_ 7,180 No. of Milking Cows _1,830_ 2,725_ 4,204 Milk Yield per Cow per lactation (liters) _ 2,009_ 2,325_ 2,470 Lactation Length (days) _ 275_ 282 _267 Calving Interval (days) _ 402 _381_ 398	
Malasya	DCA_Milk yield_high, kg/h/d	Genotype (% Friesian)_Milk Yield 50% _1859 ± 64, 1406 ± 74 50%_ 2214 ± 90 smallholder, 1859 ± 64 50% (F1)_ 1501 ± 42 50% (F2)_ 1486 ± 56 56%_ 1596 ± 92 63%_ 2270 ± 67 75%_ 1611± 97 25%_ 1125 ± 47 38%_ 1247± 102 5 50% (F1)_ 1470± 17 50% (others)_ 1206± 21 56% _1255± 137 63%_ 1309± 57 63% _2337± 87 75% _1528± 62	Panandam and Raymond (2005)

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Table 10B.1-6 Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Asia in Table 10A.1-2 and Table 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		50% (F1) 1024± 32 50% (F2) 1339± 35 50% (F3) 1413±38 56% 1535± 57 63% 1375±90 222.9±11.2 75% 1677± 62	
Vietnam	DCA_Milk yield_high, kg/h/d DCA_Milk_fat_high,% DCA_milk protein_high,%	The average daily milk yield was 16 kg/day/cow (n = 360 cows). The average fat, protein and lactose contents were 4.1% (SD = 0.54), 3.2 (SD =0.15) and 4.7% (SD = 0.25), respectively. Smallholder models are common in peri-urban areas Cows were generally fed with green grasses, rice straw and industrial byproducts, which are available in the area, supplemented with commercial concentrate. Farmers estimated that around 0.5 kg of concentrate was required to produce 1 L milk per cow per day. Holstein Friesian crosses dominates in smallholder dairy farms	Lam (2011)
Vietnam	DCA_weight_high, kg DCA_Milk yield_high, kg/h/d	Hosltein cattle: Weight,kg – 481.1±59.4 MY, kg – 4950.8±1106.2	Gioi *et al.* (2012)
Malasya	DCA_weight_low_high, kg C_weight_low_high, kg Gr_weight_low_high, kg C_weight gain_low_high, kg/hd/d Gr_weight gain_low_high, kg/hd/d MF_weight_low_high, kg	Existing beef smallholdings are characterized by their small herd size (less than 10 head), low production inputs, lacking in husbandry innovations and poor marketing network, and adoption of KK cattle as the breed of choice. Oil palm byproducts such as palm kernel cake and oil palm fronds have the potential to fully feed cattle and buffalo in semi-intensive cow-calf production and intensive feedlotting of feeder cattle and buffalo Existing beef smallholdings are characterized by their small herd size (less than 10 head), low production inputs, lacking in husbandry innovations and poor marketing network, and adoption of KK cattle as the breed of choice. Approximately 67% of the cattle population in Malaysia belongs to the Kedah-Kelantan breed. Major body conformation of Yellow Cattle resembles that of draught-type cattle. Most of the Yellow cattle imported into this country were of the Southern type characterized by its small body size and lighter weight at maturity and were reported to perform well when reared in oil palm plantations with high calving rate of more than 97% and low calf mortality rate of 2.1%.	Ariff *et al.* (2015)

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

<table>
<tr><th>Country of Asian region</th><th>Parameter [1]</th><th>Reference value (± SD)</th><th>Reference source</th></tr>
<tr><td></td><td></td><td><table>
<tr><td>Parameter/Breed type</td><td>Hereford-KK</td><td>Friesian-KK</td><td>Brahman-KK</td><td>KK</td></tr>
<tr><td>Birth wt (kg)</td><td>20.1 (31.0%)</td><td>19.9 (29.7%)</td><td>20.2 (31.7%)</td><td>15.4</td></tr>
<tr><td>6-mo wt (kg)</td><td>97.9 (28.9%)</td><td>92.9 (22.3%)</td><td>89.9 (17.1%)</td><td>76.8</td></tr>
<tr><td>12-mo wt (kg)</td><td>154.3 (58.5%)</td><td>145.2 (48.5%)</td><td>120.3 (23.3%)</td><td>97.6</td></tr>
<tr><td>24-mo wt (kg)</td><td>261.1 (35.9%)</td><td>249.6 (30.0%)</td><td>215.6 (12.2%)</td><td>192.2</td></tr>
<tr><td>Pre-weaning daily gain (kg)</td><td>432.2 (28.2%)</td><td>405.7 (20.4%)</td><td>382.1 (13.4%)</td><td>337.0</td></tr>
<tr><td>Post-weaning daily gain (kg)</td><td>313.1 (60.9%)</td><td>222.2 (85.2%)</td><td>174.1 (45.1%)</td><td>120.0</td></tr>
</table>
21% of the cattle population in this country are raised in smallholders’ herds in oil palm plantations. Cattle destined for the slaughter market are sourced from feedlots of varying capacity located in many localities throughout the country and also from smallholders’ herds in the villages and oil palm plantations.
In 2013 there were 751,497 head of cattle in the country, with 58% of the cattle distributed in the states of Pahang (16.1%), Kelantan (14.6%), Johor (14.3%) and Trengganu (13.0%). One reason for the high concentration of cattle in these states is the propensity of many villagers in the states of Pahang, Kelantan and Trengganu, where cattle rearing has long been a traditional practice in the villages, to rear cattle as an additional economic activity among smallholders and recent investment in cattle breeding stock by JCorp in Johor.
made available to cattle producers for extensive beef production. </td><td></td></tr>
<tr><td>Indonesia</td><td>Day-weighted population,%</td><td>Breed composition,%:
Bali – 32
Ongole – 29
Madura – 9
Other – 30
Sex,%: Females in herd – 68
The vast majority of cattle in Indonesia are held by small-holders in integrated crop-livestock systems.
Few animals are now kept for draught value.</td><td>Waldron et al. (2015)</td></tr>
</table>

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
Indonesia	MM_weight_low, kg MF_weight_low, kg	Aceh cattle (average 550 days of age) Variables Mean SD Range *Male (*n=39) BW (kg) 131.23 27.28 67.00 – 183.00 *Female (*n=40) BW (kg) 127.55 34.21 71.00 – 223.00 *Total (*n=79) BW (kg) 129.37 30.84 67.00 – 223.00	Putra *et al.* (2015)
Vietnam	DCA_weight_high, kg DCA_Milk yield_high, kg/h/d DCA_Milk_fat_high,% DCA_milk protein_high,%	Farm_VN2_VN4_VN5 Breed_HF cross_HF cross_HF cross Liveweight_420_420_420 Milk yield_4083_3928_3838 Fat/Protein content_3.7/3.3_3.7/3.3_3.7/3.3 Cow culling rate,%/yr_20_17_12 Feeding_Stall fed+grazing_Stall fed_Stall fed+grazing The adaptability of these crosses is mainly due to the Red Sindhi and Yellow Cattle, which are most commonly used for crossbreeding.	Garcia *et al.* (2006)
China	DCA_weight_high, kg DCA_Milk yield_high, kg/h/d DCA_Milk_fat_high,% DCA_milk protein_high,%	Experiment 1: 12 Holstein dairy cows, averaging 176 DIM (SD11), 26 kg (SD2) of milk yield per day and 570 kg (SD15) of body weight (BW) at the beginning of the study were classified according to DIM 15 multiparous Holstein dairy cows, averaging 91 DIM (SD11), 35 kg (SD2) of milk yield per day and 590 kg Effect of dietary protein concentration on milk production Diet_A _B_ C_ D_SE DMI (kg/day)_ 17.94_ 17.85 _17.96 _17.91_ 0.02 Milk yield (kg/day)_ 23.10 _23.50 _23.50_ 23.70 _0.40 Milk composition (%) Fat _3.69 _3.70_ 3.74_ 3.72 _0.04 Protein _3.31 _3.28_ 3.30_ 3.29_ 0.03	Zhai *et al.* (2006)
Asia	DCA_DC_low_high_%	DC_high,% - 70%	Calculated based on

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
		DC_low,% - 65%	FAO, IDF and IFCN, 2014 Gerber *et al.* (2011)
China	DCA_weight_high, kg DCA_CP_high,%	Eight lactating Holstein dairy cows 578 ± 21 Kg body weight (BW) CP,%-17.27, 17.24	Xie *et al.* (2016)
China	DC_weight_high, kg	commercial dairy farm housing 520 Holstein dairy cows in northwestern China All cows were housed in a free-stall barn with access to an adjoining sod-based paddock.	Cui *et al.* (2014)
China	DCA_feeding DCA_Milk yield_high, kg/h/d DCA_Milk_fat_high,% DCA_milk protein_high,%	Chinese Holstein cows were housed in cubicle sheds Milk yield, kg/d – 27.51±9.60 Fat content,% - 3.91±0.41 Protein content,% - 3.10±0.28	Yang *et al.* (2013)
China	MM_weight_low_high, kg MF_weight_low_high, kg C_weight_low_high, kg Gr_weight_low_high, kg C_weight gain_low_high, kg/hd/d Gr_weight gain_low_high, kg/hd/d	four Chinese beef cattle breeds were enrolled in this study: Nanyang cattle (NY, Nanyang City, Henan Province, China), Qinchuan cattle (QC, Fufeng country, Shaanxi Province, China), Luxi cattle (LX), Heze city, Shandong Province, China), and Chinese Caoyuan cattle (CY), Tongyu country, Jilin Province, China), with a corn–corn silage from weaning to slaughter Age_ Growth traits _ Median (n = 85) P-value 6 months Body weight (kg) _ 155.80 ± 3.13_ 0.102 Average daily gain (kg) _ 0.70 ± 0.02 _0.111 12 months Body weight (kg) _ 222.14 ± 3.98 _0.975 Average daily gain (kg) _ 0.37 ± 0.02_ 0.236 18 months Body weight (kg) _ 303.03 ± 4.76 Average daily gain (kg) _ 0.46 ± 0.04_ 0.142 24 months Body weight (kg) _ 372.69 ± 6.30_ 0.607 Average daily gain (kg) _ 0.39 ± 0.04_ 0.069	Xue *et al.* (2014)
China	DCA_weight_high, kg	A total of 4680 Holstein cows	Dong *et al.* (2015)

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		All of the cows enrolled in the study aged 3–5 years, were around 400 kg in body weight	
China	DCA_weight_high, kg DCA_pregnancy_high,%	Milk yield per lactation is around 6,000 kg in average, ranging from 2,500 to 12,000 kg with 3.0% of milk-fat content Data on 479 AIs in heifers shows that the conception rate following AI is 66.6%, i.e. the modal number for services per conception is about 1.50. Comparable figures on 1205 AIs of 253 cows are 57.4%	Zi *et al.* (2003)
China	MF_milk yield_low_high, kg/h/d MM_weight_low_high, kg MF_weight_low_high, kg	Most Chinese dairy cattle (Chinese Black and White) are derived from cross-breeding between the local yellow cattle and Holstein. According to data collected by the CDCA in 1981, in 28 provinces and the autonomous regions of China, adult have a height of 133 cm and weigh 550 kg, while bulls are 150 cm high and weigh 1020 kg, entirely meeting the breeding programme requirements. On average, 80 000 cows produce more than 5 000 kg of milk each per lactation (305 days). Of these, 22 000 are registered a yield of 6 400 kg. On major breeding farms, the average annual milk production for the herd reached 7 000 kg/cow. Dual-purpose cattle: Sanhe cattle were the first dual-purpose cattle to be bred in China. Chinese Red Steppe and Xinjiang Brown cattle are being bred as dual-purpose animals. Northern yellow cattle: Grazing all year round in the severe local weather conditions has resulted in thicker skins, coarser hair, sturdier bones, broader chests and a better constitution, and they are well adapted to poor feeding and management conditions. Central plain yellow cattle: The average height of bulls at the wither is 141.7 cm, with a body weight of 590 kg. The cow stands 124.5 cm high and weighs 380 kg. On national farms, bulls weigh between 800 and 1 000 kg. The cows have a height of 130 cm and weigh 450 kg. The Qinchuan represents the main source of animal draught power on the Guanzhong Plain, with-the male's maximum drawing ability being 475 kg and the female's 281 kg. The average milk yield is 715.8 kg for one lactation of 210 days. The milk contains 4.7 percent fat, 4 percent proteiin Beef cattle: China does not have special-purpose beef cattle.	Huai *et al.* (1993)
China	DCA_Milk yield_high, kg/h/d	Suburban areas Location_ Farm size (head) _Yield (kg)	Ma *et al.* (2007)

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Table 10B.1-6 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Asia in Table 10A.1-2 and Table 10A.1-4**			
Country of Asian region	**Parameter** [1]	**Reference value (± SD)**	**Reference source**
		Suburban state-collective dairy farms Zhengzhou Center _220 _3,878 Guangzhou South_ 330_ 4,000 Guiyang Southwest _3,400_ 5,500 Lanzhou West_ 330_ 5,949 Xining West _594_ 6,125 Hangzhou Southeast _882_ 6,414 Changchun Northeast _380 _6,540 Hefei Southeast _902 _6,667 Jinan East _1,184_ 6,750 Wuhan Center _3,500 _6,940 Shijiazhuang North _147 _7,044 Shanghai East_ 216 _7,494 Wulumuqi Far east _1,138_ 7,939 Beijing North _512_ 8,421 Suburban specialized household dairy farms Kunming Southwest _11 _3,770 Nanning South_ 9_ 4,424 Xian West _2_ 4,861 Changsha South _15_ 4,900 Qingdao East_ 3_ 5,000 Yinchuan West_ 43_ 5,116 Zhengzhou Center_ 8_ 5,169 Chengdu Southwest_ 17_ 5,290 Harbin Northeast _6_ 5,334 Taiyuan Center _9 _5,362 Shenyang Northeast _30_ 5,705 Huhehaote North_ 12_ 6,003	

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Table 10B.1-6 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Asia in Table 10A.1-2 and Table 10A.1-4**			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		Jinan East_ 8 _6,169 Beijing North _171 _6,409 Tianjin North_ 152_ 6,454	
China	DCA_ Day-weighted population,%	Evolution of Chinese dairy farm production structure over time Share of cow numbers, % Year _Backyard farm_ Small farm _Medium farm_ Large farm 2004 _56.6_ 23.5 _15.0 _4.9 2005 _52.6 _25.0 _17.4 _5.0 2006 _51.0 _25.4 _17.8 _5.7 2007 _49.0 _24.6 _19.0 _7.4 2008 _42.9 _27.2 _19.8 _10.1 The average yield was 4,977 kg on backyard farms 5,569 kg on medium farms, and 6,262 kg on large farms over the period from 2004 to 2008.	Ma *et al.* (2012)
China	DCA_Milk yield_low_high, kg/h/d Feeding	Milk yield, kg/an/yr Buffalo - 510 Cattle – 1640 Type of farm_Farmer_State/City_Collective_Corporation_Farmer Milk output_5000_5687_4444_7434_3750 Farming_Pen_Tie/Free stalls+paddock _tie stalls+paddock _tie stalls+paddock _tie stalls+paddock	Wattiaux *et al.* (2002)
China		Breed_Native province_Number, thousand_Color Qinchuan_Shaanxi_ 1000 _Red, Yellow Luxi _Shangdong _500_ Yellow, Red Nanyang _Henan_ 1300_ Yellow, Red, White Jingnan _Shanxi_ 800 _Red Mongol_ Inner Mongolia_ 4000_ Black ,Yellow, Red Yanbian_ Jilin_ 300 _Fair Yellow, Yellow There are 26 breeds of Yellow Cattle. Almost all provinces have their own native breeds, but most of the Yellow Cattle are distributed in the middle of China	Zhou (1998)

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		Yellow Cattle used to be slaughtered at the age of 5 years or more, after being used as animal power.	
China	DCA_weight_high, kg DCA_Milk yield_high, kg/h/d DCA_Milk_fat_high,% DCA_milk protein_high,%	The main breeds of dairy cattle in China include Holstein, Jersey, Simmental, and Xinjiang Brown as well as San-he. Chinese Holstein, which first appeared in 1985, is the dominant breed of dairy cattle. At present, over 80% of dairy cattle bred in China are Chinese Holstein cattle and their crossbreeds. Scale and organization of three major types of dairy farming in China Farms_Small Household Farmer_Farming communities (cooperative dairy farms)_Large-scale dairy farms Cow numbers_ 5-30_ >100 _>200 Average annual milk production (t/cow)_4-5 _>5.5 _>6.5 Ratio(%)_ 40_ 30_ 30 Farm size_ Yearly Milk Yield(t/cow) _Milk fat(%) _Milk protein(%) 500-1,000_ 7.00_ 3.90_ 3.50 300-500_ 6.20_ 3.80_ 3.20 200-300_ 6.00_ 3.70_ 3.15 100-200_ 5.50_ 3.50_ 3.10 50-100_ 5.00_ 3.45_ 3.12	Beldman *et al.* (2014)
China	C_CP_low,% Gr_CP_low,% MM_weight_high, kg	In China, there are approximately sixty-nine local cattle breeds, the four most dominant being Luxi, Qinchuan, Jinnan, and Fuzhou. Before 1980, although there was a large population of cattle, they were mainly used for draft purposes and only older animals were slaughtered for their meat. With the economic development of the last 30 years, beef consumption has risen rapidly in China. However, the local cattle cannot meet the demand for meat from farmers and retailers because of their low growth performance and dressing percentage. Growing period_Finishing period CP,%_9.40_11.40 Final weight, kg Breed_Limousin_Simmental_Luxi_Jinnan_Qinchuan Weight,kg_555_422_330_339_334	Xie *et al.* (2012)
China	DCA_weight_high, kg DCA_DC_high,%	A total of thirty two Holstein heifers (body weight of 231.33 kg, SD=16.44 kg and days of 254.55, SD=18.99) DC,% - 69.83	Qiao *et al.* (2013)

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
	DCA_CP_high,%	CP,% -11.36	
China	Gr_weight_low_high, kg Gr_weight gain_low_high, kg/hd/d Gr_CP_low_high,% Gr_DC_low_high,%	Eighteen Chinese Holstein heifers at approximately 230_14 day of age were used in this experiment at Jinshan dairy farm, Shanghai Diet_Low_Medium_High CP,%_10.85_12.78_14.63 DC,%_68.8_69.5_70.2 Weight,kg_315_314_311±22.9	Dong *et al.* (2017)
China	MM_weight_low, kg MF_weight_low, kg C_weight_low, kg	China`s beef cattle industry has many indigenous cattle breeds which can be divided into three general categories according to their production orientation, genetic characteristics, and geographical region where they are predominant: yellow cattle, buffalo, and yak. Yellow cattle have both the widest geographic distribution and the largest population. According to a nation-wide study conducted by the National Animal Husbandry Service of China, there are more than 50 different yellow cattle breeds in China and almost 100 million yellow cattle in China. China has introduced many high-performance, foreign, beef cattle breeds into its yellow cattle herds since the 1960s. These introduced breeds mainly include Angus, Limousin, Simmental, Charolais, and Piedmontese. The breed improvement work is gradually increasing productivity of yellow cattle. However, the average productivity of beef production is much lower than in other developed countries because of the large yellow cattle herds. Breeds: Yanbian Body weight of an adult bull and cow are 644.4 kg and 365.5 kg respectively. From the age of 18 to 24 months, average daily gain averages 813 g. Dressing percentage is 57.7% for cattle slaughtered at 24 of months of age. Luxi Body weight of an adult bull and cow are 465.5 kg and 365.2 kg. Average daily gain is 610 g for adult cattle. Dressing percentage is 57.3% for cattle slaughtered at 18 months of age, and 58.1% for adult cattle over 24 months of age. Birth weight averages 22-35 kg for males and 18-30 kg for females. Qinchuan Body weight of an adult bull and cow are 594.5 and 381.3 kg. Average daily gain averages 700 g for adult cattle. Birth weight averages 26.7 and 25.3 kg for male and female, respectively. Nanyang Body weight of and adult bull and cow are 647.9 and 411.9 kg. Average daily gain averages 813 g for adult cattle.	Han *et al.* (2016)

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
		Birth weight averages 31.2 and 28.6 kg for male and female respectively. Jinnan Bodyweight of an adult bull and cow are 607.4 and 339.4 kg. Angus Body weight of an adult bull and cow ranges from 700-900 kg and from 500 to 600 kg. Average daily gain is about 1000 g. Birth weight ranges from 25 to 32 kg. Simmental Body weight of an adult bull ranges from 800-1200 kg, of cow ranges from 650 to 800 kg. Average daily gain is above 1000 g. Birth weight is 41.6 kg. Piedmontese Body weight of an adult bull is 800 kg and of cow is 500 kg. Average daily gain is about 1000 g. Dressing percentage is about 62.8% for adult. Birth weight is 41.3 kg for male, and 38.7 kg for female respectively. Charolais Body weight of an adult bull ranges from 1100 – 1200 kg and of an adult cow ranges from 700 to 800 kg. Average daily gain is about 1400 g. Dressing percentage is 60-65% for adult cattle. Birth weight is approximately 45 kg for males, and 42 kg for females, respectively. Limousin Body weight of an adult bull is 1200-1500 kg and of an adult cow is 600-800 kg. Average daily gain is 1500-2000 g. Dressing percentage is 63% for cattle slaughtered at age of 18 months. Birth weight ranges from 35-39 kg.	
China	DCA_weight_low_high, kg DCA_CP_low_high,% DCA_Milk yield_low_high, kg/h/d	Farm_Peri-urban_Cooperative farm_Small-holder subsistence farm Facility_Advanced_Outdated_Outdated Management_Good_Mid-level_Poor CP,%_16.0_15.2_14.2 Milk yield, kg_27.0_22.3_17.2	Wang *et al.* (2014)
Asia	MM_weight_low, kg MF_pregnancy_low,% MF_milk yield_low, kg/h/d MF_milk fat_low,%	Production and performance of some of the indigeous dairy cattle breeds Asia: Breed_Weight at mature,kg_Age at first calving, m_Milk yield per lactation, kg_fat,% Sahiwal_301-544_37.4-48.8_972-2523_4.3-5.2 Red Sindhi_317-454_39.0-50.9_835-1869_4.5-5.2	Taneja (1999)

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Table 10B.1-6 Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Asia in Table 10A.1-2 and Table 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		Rathi_295-386_40.0-52.0_1325-2129_3.7 Kankrej_430-650_45.0-47.0_576-1850_ Gir_319-568_43.3-61.5_1126-1859_4.5-4.6 Ongole_363-591_36.0-54.0_613-1590_5.1 Harlana_287-499_41.0-60.0_656-1783_4.3-5.3 Tharparkar_293-544_37.5-53.0_911-2449_5.0-5.2 Irani_272-363_33.0-45.0_603-1035_ Damascus_136-318_***_1500-3000_4.0-5.0 Lebanese_230-350_***_972-2523_4.0-5.0 Africa: Creole_343-500_30.0-41.0_500-3481_4.6-5.1 Boran_259-380_35.0-52.0_454-1814_4.1-6.8 Sudanese_250-500_24.0-54.0_454-2723_4.7-5.5	
Asia	DCA_Milk_fat_low,% DCA_milk protein_low,%	Production of some of the dairy buffalo breeds Breed_Weight at maturity, kg_Age at first calving, m_Milk per lactation, kg_Fat,% Murrah_461 (446-567)_43.8_1805(1276-2272)_6.1-8.3 Nili-Ravi_533 (454-567)_41.2_1833(1585-2164)_6.5 Surti_319-413_50.5_1278(1126-1552)_8.0 Bhadawari_346-467_48.7_1009(976-1040)_7.0 Kundi_320-575_***_1208-2000_7.0 Mehsana_335-567_46.8_1605(1308-1838_7.4 Egyptian_369-535_38.2_1412(1078-2112)_6.1-7.4 Iraqi_***_37.5_1342_7.5-9 Comparative performance of Nili-Ravi breed of Pakistan, Murrah of India and Egyptian Buffalo Indicator_Nili-Ravi_Murrah_Egyptian Weight at first calving,kg_529(499-523)_467(375-557)_432(369-510) Lacation milk,kg_1854(1600-1997)_1654(948-2040)_1185(749-1784)	Taneja (1999)

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TABLE 10B.1-6 **EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4**			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		Milk fat,%_6.4(6.1-9.8)_6.6(6.2-7.4)_6.5(5.0-8.4) Milk protein,%_3.9(3.3-4.7)_3.9(3.4-4.1)_3.7(3.3-4.1) Composition of buffalo and cow milk Breed_fat,%_protein,% Egyptian_7.96_4.16 Chinese_12.6_6.04 Carabaos_10.35_5.88 Murrah_7.38_3.60 European cow_3.90_3.47 Zebu cow_4.97_3.18 Crossbred cow_4.0_3.46	
China	C_weight_low, kg Gr_weight_low, kg C_weight gain_low, kg/hd/d Gr_weight gain_low, kg/hd/d MM_weight_low, kg MF_weight_low, kg MF_pregnancy_low,% MF_milk yield_low, kg/h/d MF_milk fat_low,%	Famous elite native breeds include Qinchuan Cattle, Luxi Cattle, Nanyang Cattle, Jinnan Cattle and Yanbian Cattle. Nanyang Cattle and Yanbian Cattle are located in hilly regions, and the other three breeds are distributed in plains. These native cattle breeds are sound in confirmation and very strong with good draft capacity, fine meat performance. They are the basis for developing China's beef cattle. 1. Qinchuan The body weight are 381.3kg for adult females, and 594.5kg for males The daily gain in the fattening period is 0.7kg, 0.55kg and 0.59kg for the bulls, the cows and the bullocks respectively. The milk yield is 715.8kg per lactation (about 7 months), and 3.2kg per day with the milk fat percentage of 4.7%. Bulls reach to sex maturity at the age of 12 months and begin to be bred at 2 years old. Cows are bred at 2 years old with one calf every parity. 2. Nanyang The withers height and body weight are 144.9cm and 647.9kg for adult males respectively, and 126.3cm, 411.9kg for females respectively. The average daily gain for the normal fattening ones is 813g. 3. Luxi Adult males weigh on average 644.4kg and females 365.6kg . he body weighs and body height of the 1-year-old calf are 238kg and 111.1cm respectively. The females reach sex maturity early and are able to be pregnant at the age of 8 months.	FAO (2003)

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
		4. Jinnan Adult males weigh on average 607.4kg and female's 339.4kg. The lactation period lasts 7-9 months with milk yield of 715.8kg and milk fat percentage of 5.5-6.1%. 5. Bohai Black Male calves weigh on average 20.3kg and female calves 17kg while 426.3kg and 298.3kg for adult males and females respectively. 6. Jiaxian Red Adult males weigh on average 425kg and female's 364.6kg. 7. Jinan Adult bulls weigh on average 396.2kg and cows 310.2kg and 383.6kg for bullocks. 8. Pinglu Mountainous Adult males weigh on average 325kg and female's 268kg The average daily gain for the fattening cattle is 736.3g. 9. Yanbian (including Yanbian, Chaoxian and Yanjiang) Adult bulls weigh on average 465.5kg and cows 365.2kg. The lactation period lasts 6-7 months, with milk yield and milk fat percentage of 500-7700kg and 5.8-6.6% respectively. The Yanbian reaches its maturity at 14 and 13 months of age for bulls and cows respectively.. 10. Fuzhou Adult bulls weigh on average 764kg and cows 415kg. Females weigh on average 32.8kg and cows 31.7kg at birth, and weights reach 152kg and 138kg at 6 months of age respectively. 11. Mongolian The body weight and the body size vary among different grassland types. And the average body weight are 206.3-365.5kg respectively. The Wuzhumuqin is the largest framed one, reaches 176.7kg at 1 year old, and stops growing at 6. The average milk yield of 100 days is 518kg,and the milk fat percentage is 5.2% with the highest record of 9%. 12. Kazak Adult bulls weigh on average 369.2kg and cows 301.5kg. The lactation period lasts 5-6 months, with milk yield 718.4kg(not including suckling the calves). 13. Zhoushan	

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		The birth weights are 34kg and 36kg for the male and female calves. Adult bulls weigh on average 441.5kg, and cows of 336.4kg.. 14. Wenling Humped The birth weights are 19.5kg and 18.9kg for the male and female calves. Adult bulls weigh on average 423kg, and cows of 290kg. 15. Taiwan Adult bulls weigh on average 280kg, and cows of 250kg. 16.Wannan Adult bulls weigh on average 301.4-371.3kg and cows 233.9-301.3kg. The milk yield in one lactation period is 300-400kg.. 17. Guangfeng Adult bulls weigh on average 276kg, and cows of 231kg. 18. Minnan Adult bulls weigh on average 327kg, and cows of 258kg. The daily milk yield is 2.4-2.8kg. The reproductive rate and the survival rate of reproduction are 33.1-36.3% 19.Dabie Mountainous (including Dabie Mountain and Huangpo) Birth weight on average: male 18.7kg and females 15kg. Adult bulls weigh on average 322.1kg and cows 271.0kg. Bulls are managed to first use at 2.5 years old, and the reproductive rate is 37.8%. 20. Zaobei Adult bulls weigh on average 402.4kg and cows 303.9kg 21. Bashan (including Xuanhan, Yunba, Qinba, Miao, Xizhen, Pingli and Ciya) Males weigh on average 17-20.9kg and cows 18.8kg at birth . Adult bulls weigh on average 277.2-422.9kg and cows 261.1-329.6kg. And the reproductive rate may reach about 80%. 22. Wuling (including Enshi, Xiangxi and Sinan) Adult bulls weigh on average 294.7-334.3kg , cows 218.7-240.2kg and bullocks 345.9kg. 23. Panjiang	

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		Adult bulls weigh on average 296kg; cows 237.2kg. The Panjiang breed reaches its sex maturity at the age of 8-10 months. The females are managed to first breeding at about 2 years old and males at 2.5 years old. The reproductive rate is 34%, and in few regions, it may reach to 70%. 24. Leiqiong (including Xuwen and Hainan) Adult bulls weigh on average 282.4kg, and cows of 215.6kg. The milk yield is 400-500kg with an average daily milk yield of 4-5kg. 25.Sanjiang Males weigh on average 17.5kg and cows 16.7kg at birth. Adult bulls weigh on average 375kg; cows 266.4kg. 26. Ebian Spotted Adult bulls weigh on average 318.6kg; cows 254.5kg 27. Yunnan Humped The birth weights are 13.3kg and 13kg for the male and female calves. Adult bulls weigh on average 291-301.6kg, and cows of 213.7kg 28.Tibetan Adult bulls weigh on average 215.8kg; cows 197.7kg. The lactation period lasts 267.9 days with an average milk yield of 205.4kg and a daily milk yield of 0.77kg. The females are managed to first breeding at about 2.5 years old and males 3.5 years old. 29. Taihang Adult bulls weigh on average 280kg; cows 200kg. The females usually reach their puberty at 8 months old. 30. Dangjiao Adult bulls weigh on average 499.59kg and cows 427.27kg. The duration of lactation is 3-4 months with an average milk yield of 168-224kg. The Dangjiao usually reaches their puberty at 2-2.5 years old and are managed to first breeding at about 3 years old.. 31. Xuzhou The males weigh on average 534kg at 4 years old, and cows 282kg at 2. The Xuzhou grows fast at 1-3 years old.	

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TABLE 10B.1-6 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Country of Asian region	**Parameter [1]**	**Reference value (± SD)**	**Reference source**
		The duration of lactation is 6 months with an average milk yield of 360-630kg and an average daily milk yield of 2-3.5kg. 32. Ji'an Adult bulls weigh on average 223kg and cows 233.7kg The males reach their sex maturity at 1-1.5 years old, and females 1 year old. 33. Jinjiang Adult bulls weigh on average 269kg and cows 202kg at the age of 5. The males show libido at about 1 year old, reach their sex maturity at 2 years old and are managed to breeding. 34. Meng Mountainous Adult bulls weigh on average 477.8kg and cows 310.3kg. The average weigh at birth are 21.3kg and 20.7kg for the males and females calves respectively. 35. Nandan Adult bulls weigh on average 355kg and cows 260kg. The females reach their sex maturity at 2.5 years old, and are managed to breeding at 3-3.5 years old. The milk yield of parity is 285kg. 36. Weizhou Adult bulls weigh on average 280kg and cows 200kg The males reach their sex maturity at 6-8 months old, and are managed to breeding at 2 years old, while those of females are 8-10 months old and 1.5-2 years old, respectively. 39. Pingwu The lactation period last 180 days with a milk yield of 115kg. 40. Chuannan Mountainous Adult bulls weigh on average 323.2kg, cows 260kg and bullocks 321.9kg The daily gain for the 1-year-old bullocks in fattening period is 478g. The daily milk yield is 0.6-1.8kg. The Chuannan Mountain reaches its puberty at 1.5 years old, and is managed to breeding at the age of 3-4 years. 42. Liping Adult males weigh on average 288.1kg and female's 196.2kg. Under the extensive managing system in countryside, the weight at birth is relatively light, 11.8kg and 11.5kg for bulls and cows respectively.	

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	Parameter [1]	Reference value (± SD)	Reference source
		The Liping reaches sex maturity comparatively earlier than other breeds and is managed to breeding at 1-1.5 years old for males and 2 years old for females. 43. Weining Adult males weigh on average 269.3kg and female's 200.6kg 44. Dengchuan Adult males weigh on average 239kg and female's 227.5kg. The milk yield of 300 days is 838.3kg with the daily maximal milk yield of 110kg, milk fat percentage of 5.58%, and dry matter percentage in milk of 14.83%. The reproductive rate is 82.5% 45. Diqing The adult weigh on average 212.9kg, 185.5kg and 258.4kg for the bulls, cows and bullocks respectively The location period is 220-250 days, with the milk yield of 416-480kg and the milk fat percentage of 5.7%. The reproductive rate of cows is 78.3%. 46. Zhaotong The adults weigh on average 259.2kg, 211.1kg and 310kg for the bulls, cows and bullocks respectively, The reproductive rate of cows is about 50%. 47. Lhasa Adult males weigh on average 187.6kg, and female's 170.9kg The average lactation period is 267.8 days with the milk yield of 206.2kg. The Lhasa is managed to breeding at 2.5 years old. 48. Chaidamu Adult bulls weigh on average 344.6kg, and cows 232kg. The average monthly milk yield of the first calves is 63.7-64.4kg, and delivered cows of 72.4-72.6kg, with a milk fat percentage of 4.2%. The cows are managed to breeding at 2-3 years old, and bulls at 2 years old.. 49. Aletai White Head Adult bulls weigh on average 585kg, and cows 365.8kg, with an average withers height of 120cm for cows. The average milk yield of 150 days is 693.8kg. The Altai White Head is managed to breeding at about 2 years old.	

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<table>
<tr><th colspan="4">TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4</th></tr>
<tr><th>Country of Asian region</th><th>Parameter [1]</th><th>Reference value (± SD)</th><th>Reference source</th></tr>
<tr><td></td><td></td><td>50.Apeijiaza
Adult bulls weigh on average 243.1g, and cows of 213.1kg with an average wither height of 106.1cm and 101.7cm respectively.
The lactation period of cows is 209 days with an average unit milk yield of 539kg.</td><td></td></tr>
<tr><td>China</td><td>Feeding</td><td>In the pastoral areas there is a crisis each winter and many livestock lose 30% of their bodyweight between November and March each year
It also means that younger animals do not reach slaughter weight until at least three years of age.</td><td>Wang et al. (2017)</td></tr>
<tr><td>China</td><td>Feeding</td><td>Beef production in China at this stage has divided into the traditional farmer raising, specialized household raising, and large-scale cattle farms. Overall, the traditional farmer raising has produced over 80% of cattle</td><td>MAAR (2013)</td></tr>
<tr><td>China</td><td>Feeding</td><td>The representative breed of Northern Cattle is the Mongolian, adapted to grazing in the Temperate Zone Steppe and Temperate Zone Meadow. Excellent breeds are Wuzhumuqin Cattle, Kazakh Cattle and Sanhe Cattle, all dual-purpose breeds.
Central Plains Cattle are found in the flat agricultural tracts of the Temperate Zone Deciduous Broad-leaf Forest and are mainly stall fed, with some grazing. There are many excellent breeds, such as the Qinchuan, Nanyang, Luxi and Bohai Black. These are famous draught animals, and their raising depended, historically, on lucerne cultivation.
South China Cattle are in the hilly tropical and subtropical zones, and include Hainan Cattle, Guangxi Cattle and Yunnan Cattle.</td><td>Zizhi and Degang, 2006</td></tr>
<tr><td>China</td><td>Day-weighted population,%</td><td>Herd structure of dairy cows during measurement period, heads
<table>
<tr><th>Calves</th><th>Calves</th><th>Heifers</th><th>Mature Cows</th><th>Total</th></tr>
<tr><td>18</td><td>80</td><td>102</td><td>500</td><td>700</td></tr>
<tr><td>50</td><td>90</td><td>100</td><td>400</td><td>640</td></tr>
</table></td><td>Gao et al. (2011)</td></tr>
<tr><td>China</td><td>MM_weight_low, kg
MF_weight_low, kg</td><td>Breed_mature weight, kg_MM_MF
Mongolian_396_306
Ujumgin_475_374
Kazakh_498_330
Yanbian_465_365
Qinchuan_575_366
Nanyang_517_347
Jinnan_650_380</td><td>Cheng (1984)</td></tr>
</table>

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TABLE 10B.1-6
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF ASIA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Country of Asian region	**Parameter [1]**	**Reference value (± SD)**					**Reference source**
		Luxi_450_350					
China	Day-weighted population,%	Characteristics of herd structure of dairy and beef industry of China, heads					Gao *et al.* (2013)
			Heads*10^6		Heads*106		
		Lactating cows	7.48	61%	56.65	41%	
		Heifers	4.71	38%	35.62	26%	
		Bulls	0.08	0.6%	0.57	0.4%	
		Bull replacement	0.08	0.6%	0.58	0.4%	
		Females			13.48	10%	
		Males			31.04	23%	
			12.35		137.94		

[1] DCA – dairy cattle, MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, Cmilk – Calves on milk, C – Calves on forage; _low and _high subscribt corresponds to low producing systems and high producing systems, accordingly

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
Weight_DCA_low	kg/hd	270	FAO (2017)
Weight_DCA_high	kg/hd	250	FAO (2017)
Feeding_DCA_low		Pasture/Range	FAO (2017)
Feeding_DCA_high		Pasture/Range	FAO (2017)
Milk_DCA_low	kg/hd/yr	1.2	FAO (2017)
Milk_DCA_high	kg/hd/yr	5.8	FAO (2017)
Milk_fat_DCA_low_high	%	4.3	FAO (2017)
Milk_protein_DCA_low_high	%	3.6	FAO (2017)
Pregnancy_DCA_low	%	52	FAO (2017)
Pregnancy_DCA_high	%	57	FAO (2017)
DC_DCA_low	%	51	FAO (2017)
DC_DCA_high	%	50	FAO (2017)
CP_DCA_low	%	86, g/kg	FAO (2017)
CP_DCA_high	%	78, g/kg	FAO (2017)
Day weighted population	%	49/51 – low/high producing cows	FAO (2017)
Africa	Non-dairy cattle population structure_high_low,%	Non-dairy population structure, 2012:	FAOSTAT, 2018

Country	Heads	%
Ethiopia	43,278,576	18%
Sudan	22,476,000	10%
Nigeria	16,856,928	7%
Tanzania, of UR	15,900,000	7%
Kenya	13,409,800	6%
South Africa	12,957,898	6%
Uganda	9,355,900	4%

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Table 10B.1-7 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Africa in Table 10A.1-2 and Table 10A.1-4**			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		Niger 8,606,903 4% Namibia 2,682,451 1% Botswana 1,917,893 1% ∑ 55%	
Ethiopia	Day-weighted population structure_high_low,%	Ethiopia: Distribution of cattle population by sex and age, varies with region,%: Males: 3.5-7 – <6 month 3.1-6 – 6 month – 1yr 4-12 – 1-3 yr 10–34 – 3-10 yr 1-3 – 10 yr + 21-51 – all male cattle Females: 5-9 – <6 month 5-8 – 6 month – 1yr 9-13 – 1-3 yr 31–48 – 3-10 yr 1-2 – 10 yr + 52-80 – all female cattle	Gebre Mariam *et al.* (2013)
Ethiopia	Day-weighted population structure_high_low,% Feeding	Cattle type _Overall_ Indigenous_ Crossbred,%: Cow 31 _ 20 _ 11 Heifer 8 _ 4 0_ 4 Calf 28 _ 17 _ 10 Bull 7 _ 5 _ 2 Ox 26 _ 23 _ 3 Total_100_70_30	Abraha *et al.* (2009)
Ethiopia	Day-weighted population structure,%	Borana cattle are predominantly distributed in the semi-arid and arid areas of Southern Ethiopia, Northern Kenya and South Western Somalia and are maintained by pastoralists.	Mandefro *et al.* (2017)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	MM_weight_low_high, kg MF_weight_low_high, kg	The estimated population size of the Ethiopian Borana cattle was reported to be 1,896,000 Mature body weight of the breed ranges from 318 to 680 kg in males and 225–454 kg in females The weight of improved matured Borana bulls and cows ranged from 450 to 850 kg and 300–550 kg, respectively Horro cattle breed is widely distributed in South Western and Western Oromia National Regional State, West Ethiopia. Mature live weight of 320–480 kg and 210–400 kg were reported for males and females of Horro cattle, respectively. Population size of the breed was estimated to be 3,286,000	
Ethiopia	Feeding	<u>Breed/population _Breed group _ Production system</u> Ambo_Small East African Zebu _Mixed crop-livestock Arsi _Large East African Zebu _ Mixed crop-livestock Borana_Large East African Zebu _ Pastoral Danakil _Sanga _ Pastoral Horro _Zenga _ Mixed crop-livestock	Edea *et al.* (2013)
Ethiopia	MM_weight_low, kg MF_weight_low, kg	Abergelle breed, kg 234 – Male 153 – Female Irob breed, kg 245 – Male 200 – Female	Zerabruk and Vangen (2005)
Ethiopia	All parameters for low-producing animals: MM_weight, kg MF_weight, kg MF_pregnancy, %	Mature females: Weight – 200 Pregnancy, % - 66.6 DC, % - 59.4 CP, g/kg – 102.4 Mature males: Weight – 250 DC, % - 58.9	FAO (2017) - GLEAM (FAO 2017) cc– country average

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	MF_DC, % MM_DC, % MF_CP,% MM_CP,% Gr_weight, kg Gr_AWG, kg/d/hd Gr_DC, % Gr_CP,% C_weight,kg C_AWG, kg/d/hd Cr_DC, % C_CP,%	CP, g/kg – 98.8 Replacement females: Weight – 107 Daily gain, kg/d – 0.120 DC, % - 58.8 CP, g/kg – 42.6 Replacement males: Weight – 132 Daily gain, kg/d – 0.162 DC, % - 58.8 CP, g/kg – 98.8 Growing heifers: Weight – 107 Daily gain, kg/d – 0.120 DC, % - 59.2 CP, g/kg – 102.2 Growing steers: Weight – 107 Daily gain, kg/d – 0.162 DC, % - 58.5 CP, g/kg – 101.8 Birth weight - 13	
Ethiopia	Day-weighted population structure_low_high,%	Population structure Total_Male_Female Total - 53,382,194 _ 23,917,347 _ 29,464,846 Under 6 m -4,947,931 _ 2,348,148 _ 2,599,782 6m- 1 yr - 4,669,113 _ 2,176,962 _ 2,492,152 1yr-under 3yr - 8,228,733 _ 3,606,810 _ 4,621,923 3yr-under 10yr - 33,967,441 _ 14,884,790 _ 19,082,651	Ethiopia (2011)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		10yr+ -1,568,977 _ 900,637 _ 668,339 Cattle by Breed: Total – 53,382,194 _ 23,917,347 _ 29,464,846 Indigenous – 52,989,537 _ 23,775,083 _ 29,214,454 Hybrid - 339,646 _ 125,245 _ 214,401 Exotic - 53,010 _ 17,019 _ 35,991 Aged 3 – 10 Years by Purpose Total -33,967,441 _ 14,884,790 _ 19,082,651 Used for Milk - 7,447,238 _ 7,447,238 Used for Draught - 13,501,418 _ 13,346,297 _ 155,120 Used for Beef - 463,918 _ 390,655 _ 73,263 Used for Breeding - 10,899,324 _ 635,968 _ 10,263,357 Used for Other- 1,655,543 _ 511,870 _ 1,143,673 Dairy Animals Dairy Cows.- 7,447,238 _ 7,447,238 Milking Cows-10,676,783 _ 10,676,783	
Ethiopia	MM_weight_low, kg MF_weight_low, kg Feeding	Ethiopia, Borana breeds: Pastoral management system 318 to 680 kg in males and 225–454 kg in females Horo breed: Mature live weight of 320–480 kg and 210–400 kg were reported for males and females of Horro cattle	Mandefro *et al.* (2017)
Ethiopia	MM_weight_low_high, kg MF_weight_low_high, kg	564±18.8 - Non-working FresianxBoran crossbred oxen 290±18.8 - Non-working Ethiopian highland zebu 484±13.3 - Working FresianxBoran crossbred oxen 290±13.3 - Working Ethiopian highland zebu	Alemayehu *et al.* (2013)
Ethiopia	Gr_weight_high, kg	BoranxHolstein-Fresian	Dekeba *et al.* (2006)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	C_weight_high,kg	24.4±0.14 - Birth weight 140.7±2.62 - Weaning weight, 8 months	
Ethiopia	Gr_weight_low, kg C_weight_low,kg	Fogera cattle breed Birth weight, kg 21.8±0.11 - Male 20.9±0.10 – Female Weaning weight: 98.91±0.95 - Male 105.42±0.90 – Female	Tesfa *et al.* (2016)
Ethiopia	Feeding	Ethiopia, production systems 22% - low pastoral system 78% – highland crop-livestock The lowland pastoral and agro-pastoral production system: The lowlands cover around 60 % of the land area and are situated below 1500 m a.s.l. The lowlands are situated in Eastern, Southern and Western part of the central highlands. Livestock are the principal source of subsistence providing milk and cash income to cover family expenses for food grains and other essential household requirements (mostly consumer goods). Also the pastoral areas are under pressure due to encroachment by crop farmers. The pastoral lowlands are a major source of goats and sheep for export. The highland crop- livestock mixed farming system: this part covers around 40 % of the total land surface and is located 1500 m above sea level (a.s.l.). The highlands are situated in the Northern, North-eastern and central part of the country. It is featured by a mixed farming system where crop cultivation and livestock production are undertaken side-by-side complementing each other. Livestock is primarily kept on small-holdings where it provides draught power for crop production, manure for soil fertility and fuel, and serves as a source of family diet and source of cash income (from the sale of livestock and livestock products) particularly when markets for crops are not favorable.	Nell (2006)
Ethiopia	Day-weighted population structure_low,%	Ethiopia, Horro cattle breed Horro cattle are sole source of milk production and draught power as well. The present population constitutes 22,343 (46.8%) breeding females, 7,507 (15.7%) breeding males, 11,623 (24.3%) draught oxen and 6,268 (13.1%) calves. Extensive grazing system is a common feeding management practice	Mekonnen *et al.* (2012)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
Ethiopia	Gr_weight_low, kg/hd Gr_weight gain_low, kg/d/hd C_weight_low,kg/hd	Animals were allowed to graze the natural pasture for eight hours and during dry season they were provided with hay harvested from the natural grazing pasture Forera cattle breed, weight,kg_AWG,g/day: 22.0_423 – birth weight 35.1_ – 1 month 49.8_309 – 3 month 68.2_257 – 6 months 109_319 – 9 months 113_252 – 1yr Cross of Forera: 23.5_826 – birth weight 47.2_ – 1 month 63.1_438 – 3 month 92.7_385 – 6 months 132_398 – 9 months 126_291 – 1yr	Addisu *et al.* (2010)
Ethiopia	MF_milk_low, kg/hd/d	Milk yield, liters/lactation: 527 - Abidar 128 - Gurage 326 - Horro 627 – Sheko Age 1st mating, M,F_Age 1st calving, yr: 3.3,3.0_4.0 - Abidar 4.8,4.6_5.5 - Gurage 4.0,3.6_4.7 - Horro 3.5,3.5_4.5 – Sheko	Stein *et al.* (2009)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
Ethiopia	MM_weight_low, kg MF_weight_low, kg Gr_weight_low, kg C_weight_low,kg Gr_ weight gain_low, kg/d/hd C_ weight gain_low, kg/d/hd Feeding	Boran cattle breed and crosses The herd at Holetta was grazed on natural pasture. Except for the lactating cows, which were supplemented with approximately 3–4 kg of concentrate at each milking, no other animal received any regular concentrate supplement. The cattle in Debre Zeit farm were not grazed because of the problem of tick infestation. Thus, they were all stall-fed. Boran breed: 23.3±0.36 - BWT – birth weight 54.0±1.2 - WWT – weaning weight 79.0±1.51 - SMWT – 6-month weight 111.2±2.35 - YWT – yearning weight 149.4±3.57 - EWT – 18-months weight 195.3±5.03 - TWT – 2 yr weight 438.7±8.4 - ADG1 – gain from birth to 6 month 219.6±9.40 - ADG2 – gain from 3m to 2 yr Crosses of Boran breed: 26.0±0.15- 31.4±0.36- BWT – birth weight 54.2±1.2-56.8±0.5 - WWT – weaning weight 89.2±1.57-92.1±0.65 - SMWT – 6-month weight 142.5±1.89-146.9±1.14 - YWT – yearning weight 197.5±4.02-203.0±1.84 - EWT – 18-months weight 257.7±2.67-263.0±5.79 - TWT – 2 yr weight 495.4±8.7-511.7±3.16 - ADG1 – gain from birth to 6 month 310.1±11.0-342.7±10.9 - ADG2 – gain from 3m to 2 yr	Haile *et al.* (2011)
Ethiopia	Day-weighted population structure_high,% MF_milk_low_high, kg/hd/d	Cattle herd composition across production systems: Rural_Peri-Urban_Urban, heads Total herd suze_11.67_12.72_9.88 No local cattle_7.2_7.33_4 Male calves_0.55_0.77_0.42 Female calves_0.23_0.4_0.37	Abera (2016)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Heifers_0.72_0.55_0.22 Bulls_0.78_0.67_0.38 Oxen_3_2.6_2.02 Cows_1.82_2.02_1.25 No crossbred cattle_4.47_5.15_5.4 Male calves_0.45_0.85_0.57 Female calves_0.65_0.67_0.98 Heifers_0.9_1.13_1.1 Bulls_0.45_0.13_0.4 Oxen_0.13_0.03_0.13 Cows_1.73_2_2 Age at 1st service, month_Age at 1st calving Rural – 46.35±0.62_54.22±0.068 Peri-Urban – 45.84±0.88_53.34±0.098 Urban – 38.1±0.098_49.50±0.108 Av.for crosses - 26.86±0.54_35.87±0.10 Milk production, l/d/day_Local_<50% cross_50-75%_>75% Rural – 2.02±0.19_4.95±0.26_11.86±3.5_13.70±0.50 Peri-Urban - 2.27±1.0_8.77±2.43_14.59±5.62_15.30±6.89 Urban - 2.28±0.16_8.83±2.0_20.78±8.29_26.76±5.87 Rural_Peri-urban_Urban Total – 8.13±3.4_10.34±5.37_14.70±9.33 Av for crosses – 4167.33±0.87 – milk yield per lactation	
Ethiopia	Feeding	Management: Urban Keep both crossbreds and indigenous cattle; high input, use external input (AI, feed), in-door housing, stall feeding (intensive management); use separate house; milking	Tegegne *et al.* (2013)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		predominantly handled by household wives; combination of early weaning and partial sucking; informal and formal marketing of dairy products; market-oriented Peri-urban Keep indigenous and crossbreds, medium external input (AI and feed), internal input; semi-intensive management; mixed crop–livestock; milking predominantly handled by household wives; informal marketing dominates; moderately marketoriented for milk Rural highland Keeps indigenous and few crossbreds, low input, high human density; extensive husbandry; milking predominantly handled by males; informal marketing; not market-oriented for milk, moderately for local butter Rural lowland Keep solely indigenous dairy animals, low input, low human density; extensive husbandry; informal marketing; mixed market orientation for milk and local butter	
Ethiopia	Feeding	Traditionally, fattening of animals in both systems concentrates on male animals and on females which are either infertile or have finished their reproductive cycle. In the lowland agro-pastoral system, grazing is the most common source of feed, with limited use of crop residues, whereas in the highland system, crop residues are the most important source of animal feed. During the wet season, when crop residues are scarce in the highlands, male animals are taken to the lowland areas for grazing Male calves, which are primarily used for draught purposes for six to eight years after which they are sold into the meat supply chain; almost entirely destined for domestic markets Cattle fattening practices in Ethiopia is categorized in to three major fattening systems are traditional system, by product-based system and Hararghe fattening system. In traditional system, farmers usually sell oxen after the plowing season when they are in poor condition and too old for the draught purposes. fattening system is mainly based on agro- industrial by-product such as molasses, cereal milling by-product and oilseed meals. Intensive feeding of available feed supply to young oxen used for draught power could best describe the Hararghe fattening practice. Only a small fraction of Ethiopian beef is raised in feedlots smallholders throughout the country fatten the vast majority of cattle in backyard systems.	Halala (2015)
Ethiopia	Day-weighted population	Cattle breed herd population_Weight M,F_main uses	Rege (1999)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	structure_low,%	Sheko – 31,000_......_meat, work Ethiopian Boran-1,896,000_300-385,300-350_milk, meat Murle - ..._300-410,220-320_milk,meat, draft Arsi – 2,012,000_..._work, meat,milk Bale – 738,000_...._work,meat, milk Jem-Jem– 434,000_...._work,meat, milk Jijiga – 100,000_...._work,meat, milk	
Sudan		Sudanise beef breeds: Baggara Kenana Ambroro	Haren and Idris (2015)
Sudan	Day-weighted population structure_low,%	Breed population_weight M,F_main uses Butana – 258,000_395-600,300-440_milk,meat Kenara – 1,670,000_400-610,300-435_milk, meat Baggara – 3,270,000_300-600,230-450_meat, milk, work Mongola – 240,000_....,130-225_milk,meat	Rege (1999)
Sudan	MF_milk_low, kg/hd/d MF_pregnancy_low, %	Southern States/southern cattle breeds Production system_herd size Dinka – Twic – 352d lactation-1215kg/d Nuer-Gaawier – 190d lactation-1.74 kd/d Shilluk – 240_1.7 Dinka-Ngok – 300_0.8 Dinka-agropastoral – 352_463 Butana – 538.26 per lactation-58% calving rate Kenana – 598.76 per lactation-71% calving rate Baggaga pastoral – 582 per lactation (270d), 59% calving Baggaga – 480 (300d), 48.7% calving	Behnke and Osman (2012)
Sudan	MF_milk_low, kg/hd/d	Baffara cattle	Osman (1985)

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<table>
<tr><th colspan="4">TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4</th></tr>
<tr><th>Parameter 1 / Country of African region</th><th>Unit / Parameter 1</th><th>Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)</th><th>Reference source</th></tr>
<tr><td></td><td>C_weight_low,kg
C_ weight gain_low, kg/d/hd
Gr_weight_low, kg
Gr_ weight gain_low, kg/d/hd</td><td>Age at 1st calving – 66.7±0.13
Daily milk yield – 3.58±0.10
Lactation - 232±5.4

Body weight – M_F
23.4_21.4 - Birth
116.1_108.0 - 210 age
151.3_142.5 - 365 age
M_F
Pre-weaning weigh gain, kg 0.44_0.41
Post-weaning daily gain,kg – 0.23_0.22</td><td></td></tr>
<tr><td>Sudan</td><td>MF_milk_high, kg/hd/d
Day-weighted population structure_high,%
MF_milk-fat_high, %
MF_milk-protein_high, %</td><td>The average milk production per cow per day was 1.882 kg in extensive system and 2.188 kg in semi- extensive system.
Herd structure
<table>
<tr><th></th><th>Calves</th><th>Heifers</th><th>Bulls</th><th>Pregnant cows</th><th>Lactating cows</th><th>Dry cows</th></tr>
<tr><td>Extensive system</td><td>13.65 ± 10.42</td><td>13.28 ± 9.70</td><td>10.05 ± 9.39</td><td>15.95 ±13.13</td><td>20.00 ±11.49</td><td>18.00 ±12.74</td></tr>
<tr><td>Semi-extensive system</td><td>6.30 ± 6.94</td><td>5.28 ± 3.54</td><td>2.16 ±1.24</td><td>5.51 ± 5.80</td><td>8.30 ± 5.33</td><td>5.05 ± 5.29</td></tr>
</table>
Semi-intensive:
Milk fat, % - 5.08±1.05
Milk protein,% - 3.62±0.31</td><td>Bashir and El Zubeir (2013)</td></tr>
<tr><td>Sudan</td><td>C_weight_high,kg</td><td>Birth weight of crosses with local:
Baggaga – 25.41±0.80
Butana – 24.50±0.89
White Nileand Kenana – 24.68±0.79</td><td>Ali et al. (2015)</td></tr>
<tr><td>Sudan</td><td>MM_weight_low, kg</td><td>At maturity the average body weights of males and females range from 300-500 kgand</td><td>Yousif and El- Moula</td></tr>
</table>

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TABLE 10B.1-7 **EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4**			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	MF_weight_low, kg Day-weighted population structure_low,% Feeding	250-350 kg respectively. The total population of Kenana and Butana cattle as major milk producers comprises 25% of the whole cattle population of Sudan. About 90% of the cattle population is owned by pastoralists The traditional range grazing system is considered to be the most common and is the system under which more than 80% of livestock is raised. It includes the pastoral and semi-pastoral types. More than 80% of milk production in big cities and towns in Sudan is still provided by the traditional sector.	(2006)
Sudan	MF_weight_low, kg	Live weight of Baggaga cattle sub-types: Nyalawi_Mesairi (±SE) 1PP – 200.84±4.49_193.33±5.18 2PP – 217.93±4.40_214.77±4.65 3PP – 267.24±4.31_247.35±7.04 4PP – 310.65±4.37_279.13±7.04 Overall – 249.17±2.19_233.65±2.69 PP – pair of permanent incisors	Alsiddig *et al.* (2010)
Sudan	C_weight_high,kg C_ weight gain_high, kg/d/hd	Crosses with local: Birth weight – 27.14±4.60 6 month weight – 148.5±31.5 12 month weight - 290±48.7 Daily weight gain, g/d, 1-6 month Baggage – 0.75±0.02 Butane– 0.68±0.03 White Nile– 0.68±0.05 Weight at 6m.o, kg Baggage – 160 Butane– 145 White Nile– 150	Elrshied and Ishag (2015)
Sudan	MF_milk-fat_low, %	Milk composition of local breeds:	Ahmed Hassan (2010)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	MF_milk-protein_low, % Feeding	Fat – 4.89±0.13...5.25±0.29 Protein – 3.80±0.3....3.90±0.08 Baggara cattle make up to 80% of the cattle population of Sudanese cows ecotypes. It is essentially meat cattle than milk. Feeding systems reported are offering natural grazing (53%), crop residue (42%) natural grazing (2%) and crop residues and Natural grazing and supplements (3%)	
Sudan	MM_weight_low_high, kg C_weight_low_high,kg C_ weight gain_low_high, kg/d/hd MF_milk_low_high, kg/hd/d	Sudan: 500 - Kenara bulls 400 – Kenara cows Baggara breed 17.6 – 1 month old 29.4 – 3 month old 41.2 – 6 month old 58.9 – 8 month old 79.3 – 12 month old Growth rate of the first year – 169 g/day Kenana and Butana breeds: 23.5, 25, 24 – birth weight 308 – 23 months old – bulls sexual maturity – low plane of nutrition 243 – 40 months old – bulls sexual maturity high plane of nutrition 281 – 16 months old – heifers - sexual maturity – low plane of nutrition 241 – 31 months old – heifers sexual maturity high plane of nutrition Age at the fist calving: 38.4, 57 months old – Kenana 44, 50.3 months old – Butana Milk yield: 1836±186 – Kenana 2264±131 – Butana	Abdel Rahman (2007)
Sudan	C_weight_high,kg	Sudan, with supplementary feeding system	Ismail *et al.* (2014)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	Gr_weight_high, kg MM_weight_high, kg MF_weight_high, kg	128.56 - Mature male 85.35 – Male weaner 111.30 – Male yearning 104.28 – Male, 1-2.5 yr 128.14 – Mature female 102.31 – Female weaner 114.33 – Female yearning 121.0 – Female, 1-2.5 yr	
Sudan	C_weight_low_high,kg	Sudan, birth weight 26.4 – Butana 25.2 - Kenana	Ageeb and Hillers (1991)
Sudan	MM_weight_low, kg MF_weight_low, kg	A total of 247 Sudanese indigenous Baggara bulls were used for the study. Their live weights ranged from 170 to 390 Kg.	Abdelhadi and Babiker (2009)
Sudan	MM_weight, kg MF_weight, kg	Sudan, Kenana cattle breed 188.0±10.56_184.24±8.62 – 1-2years – Males_Female 292.32±12.0_284.22±16.29 – 3-4 years – Males_Female 380.33±12.32_338.83±11.62 – 5-7years – Males_Female -_307.28±4.62 – 8-10 years – Males_Female -_297.96±19.12 – >10years – Males_Female 281.81±3.53_293.9±16.34 – overall – Males_Female	Musa *et al.* (2011)
Sudan	Day-weighted population structure,%	Cattle herd structure in the Baggaga system, % Age,m_Breeding_Males pack_Total_Females_Combined sexes <7 - --_--_8.7_10.7_19.4 7-24 - --_--_8.4_10.1_18.5 22-30 - --_--_4.4_5.2_9.6 31-39 - 1.8_1.3_3.1_5.2_8.3 40-48 – 1.4_1.3_2.7_6.3_9.0 >48 – 1.5_2.4_3.9_31.3_35.2	Young *et al.* (2005)

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Table 10B.1-7 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Africa in Table 10A.1-2 and Table 10A.1-4**			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		Total – 4.7_5.0_31.2_68.8_100.0	
Sudan	Day-weighted population structure,%	This study showed herd strcuture and husbandry practices in 60 dairy farms at different pre-urban areas of Khartoum, Khartoum North and Omdurman of Khartoum State (20 farms from each town). Herd structure,%_Farm1_Farm2_Farm3 Lactating cows_51.8±21.615_76.45±24.31_50.07±6.89 Heifers_18.66±8.931_21.42±6.76_23.7±8.68 Calves_17.48±10.797_13.9±6.73_10.43±5.76 Milk yield_581.25±248.08_885.15±261.67_517.15±203.14	Ahmed and Zubeir (2013)
Sudan	MM_weight, kg MF_weight, kg MF_pregnancy, % MF_DC, % MM_DC, % MF_CP,% MM_CP,% Gr_weight, kg Gr_ weight gain, kg/d/hd Gr_DC, % Gr_CP,% C_weight,kg C_AWG, kg/d/hd Cr_DC, % C_CP,%	Mature males: Weight – 450 DC, % - 56.5 CP, g/kg – 94.8 Replacement females: Weight – 170 Daily gain, kg/d – 0.205 DC, % - 56.5 CP, g/kg – 94.8 Replacement males: Weight – 235 Daily gain, kg/d – 0.295 DC, % - 56.5 CP, g/kg – 94.8 Growing heifers: Weight – 145 Daily gain, kg/d – 0.205 DC, % - 57.0 CP, g/kg – 95.28 Growing steers:	FAO (2017) GLEAM – country-average

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Weight – 145 Daily gain, kg/d – 0.295 DC, % - 57.0 CP, g/kg – 95.28 Birth weight - 20	
Nigeria	Day-weighted population structure,%	Proportion of cattle population: 37.2 – Bunaji (White Fulani) 31.6 – Sokoto Gudani 22.0 – Rahaji 6.6 – Wadara 1.9 – Adamawa Gudali 0.7 - Azawak	Blench (1999)
Nigeria	MM_weight, kg MF_weight, kg MF_milk, kg/hd/d Day-weighted population structure,%	The White Fulani cattle : bull weighs about 500 kg and cows 325 kg. Sokoto Gudali: At maturity, the female weighs an average of about 330 kg, while the male weighs about 450 kg. The female produces an average of 1,500 kg of milk per lactation. The young animals contributed about 50% of the herd size, with more females (35%) than males (15%). The proportion of breeding cows in the herd was 49.1%, while the proportion of the breeding bulls was 6%.	Kubkomawa (2017)
Nigeria	Day-weighted population structure,%	Grazing Life stage_March_June Calf female (<1) _ 9.2 _ 6.6 Calf male (<1) _ 6.0 _ 6.3 Juvenile female (1 to 2) _ 13.5 _13.7 Juvenile male (1 to 2) _ 12.8 _ 9.6 Steer (3 to 4) _ 4.7 _ 0.3 Steer (5 to 7) _ 0.4 _ 1.2 Steer (8 to 10) _ 0.0 _ 0.3	

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Steer (>10) _ 0.0 _ 0.1 Bull (3 to 4) _ 4.7 _ 6.6 Bull (5 to 7) _ 2.9 _ 3.4 Bull (8 to 10) _ 0.7 _ 0.5 Heifer (3 to 4) _ 10._ 14.0 Heifer (5 to 7) _ 0.7 _ 1.3 Cow (3 to 4) _ 5.8 _ 2.5 Cow (5 to 7) _ 18.8 _ 21.4 Cow (8 to 10) _ 8.2 _ 8.6 Cow (>10) _ 1.0 _ 3.0 Draught male (>4) _ 0.0 _ 0.7 Sub-total females _ 67.8 _ 71.1 Sub-total males _ 32.2 _ 29.0 Grand total _ 100.0 _ 100.0	
Nigeria	MF_milk-fat, % MF_milk-protein, %	Parameter_White Fulani_Red Bororo_Muturu Milk fat,%_3.60±0.11_4.45±0.56_3.40±0.16 Milk protein,%_3.68±0.11_3.54±0.72_3.66±0.14	Adesina (2012)
Nigeria	Day-weighted population structure,%	Breed, population_weight,M,F_main uses NDama – 4,863,000_220-360,180-300_meat, milk, manure (all coastal countries) Murutu – 58,000_...,150-225_meat Sokoto – 4,352,000_495-660,240-355_milk, meat,work White Fulani – 9,645,000_425-665,250-380_milk,meat, work (+Cameroon,CAfrica) Red Fulani – 4,924,000 (+Cameron,CAfrica) Shuwa – 45,54,000_350-475,250-300_work, milk,meat (+Chad , Cameroon)	Rege (1999))
Nigeria	Day-weighted population structure,% MM_weight_low_high, kg MF_weight_low_high, kg Gr_weight_low_high, kg	11,478,145 heads – pastoral 2,358,078 heads – village 49,590 – Urban NDamaxZebu: 18.1, 15.9 – Males, Females –Birth weight	Adebambo (2001)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	C_weight_low_high,kg	54.6, 54.3 – Males, Females – 3 months old -, 92.1 – Males, Females – 6 months old 119.3, 112.4 – Males, Females – 9 months old 137.4, 124.6 – Males, Females – 12 months old 181 – Cow weight 1-2 yr 252 – Cow weight 4-5 yr 275 – Cow weight 5-6 yr Zebu: 26.5, 22.7– Males, Females –Birth weight 78.0, 77.5 – Males, Females – 3 months old 130.4, 128.6 – Males, Females – 6 months old 178.2, 165.0 – Males, Females – 9 months old 206.7, 193.2 – Males, Females – 12 months old 242 – Cow weight 1-2 yr 323 – Cow weight 4-5 yr 374 – Cow weight 5-6 yr	
Nigeria	C_weight_high,kg	Nigeria, crosses of NDama 19.48 – 26.27 - crosses 18.1 - Birth weight of purebred	Essien (2003)
Nigeria	Gr_weight_low_high, kg C_weight_low_high,kg MF_milk_low_high, kg/hd/d	Nigeria indigenous cattle breeds There are 11 breeds of cattle (Ingenious) in Nigeria. Namely Azawak, Wadara, Bunaji, Rahaji, Adamawa gudali and the Sokoto gudali belonging to the Bos indicus group. Other are Biu cattle, N'dama, Keteku, Kuri and the Muturu all of Bos tuarus group. All the taurines that is, N'dama, Kuri, Biu cattle, Keleku and Muturu breeds are endangered Keteku breed, traditional farm Age at 1st calving – 38-47 m	Gwaza and Momoh (2016)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Weaning weight at 12 m – 131 kg Weaning weight at 12 m, female – 149 kg Age at slaughter 48 m Kuri breed, traditional farm – milk, beef Age at 1st calving – 40 m Milk production – 1255 kg / 280 d Birth weight , male_female – 25_23 NDama – traditional Age at 1st calving – 39.2 m Birth weight - 10.4 kg Weaning age - 12 m Age at slaughter 35 m Live weight at slaughter – 203-254 kg	
Nigeria	Gr_weight_low_high, kg C_weight_low_high,kg MM_weight_low_high, kg MF_weight_low_high, kg	Weight: NDama / Muturu / Crosses Birth: 16.17 / 9.97 / 12.76 6 m: 74.97 / 45.38 / 71.30 12 m: 115.76 / 93.24 / 126.84 24 m: 207.78 / 162.93 / 201.6	Nweze *et al.* (2012)
Nigeria	Day-weighted population structure_low_high,% Feeding C_weight_low_high,kg	northern Nigeria: Management system, Adjusted prev. (%)_95%CI Zero-grazing 23.8 (6.8-59.2) Commercial 15.9 (9.5-25.5) Agro-pastoral 22.0 (17.3-27.8) Pastoral 45.1 (38.6-51.9)	Mai *et al.* (2012)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	MF_pregnancy_low_high, %	Breed, Adjusted, prev. (%)_95%CI Bunaji - 27.5 (22.5-33.2) Gudali - 26.3 (22.1-31.1) Bos taurus - 15.1 (6.6-31.0) B. taurus x B. Indicus - 21.8 (11.7-37.0) Other B. indicus - 24.7 (17.8-33.5) Pregnancy status : Pregnant - 17.2 (13.6-21.5) Non-pregnant - 27.8 (22.9-33.5) Lactation status : Lactating - 25.3 (20.7-30.5) Non-lactating - 23.2 (19.3-29.9)	
Nigeria	MM_weight_high, kg MF_weight_high, kg	The cattle were semi-intensively managed Bunaji bulls and Bunaji cows: 201 – Bulls 249 – Cows 249 – Bulls Bunaji cows 491 – Bunaji x Friesian Cows	Kanai and Zagi (2013)
Nigeria	Gr_weight_low, kg C_weight_low,kg MM_weight_low, kg MF_weight_low, kg	White Fulahi breed: Males: Age / Mean / ±SD 0 / 23.7 / 2.58 3 / 55.6 / 21.6 6 / 86.9 / 11.8 12 / 130.9 / 7.21 Females: Age / Mean / ±SD 0 / 24.2 / 4.13 3 / 46.2 / 17.5	Salako (2014)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		6 51.7 2.88 12 133 7.47 18 155 5.59 24 176 - 30 265 35.3 N'dama breed: Males: Age Mean ±SD 0 18.3 1.90 3 71.7 16.3 6 99.6 24.3 12 113 12.8 18 142 21.5 24 151 29.0 30 213 13.1 36 - - 42 - - 48 278 0 Females: Age Mean ±SD 0 13.7 2.00 3 49.9 17.2 6 107 18.3 12 135 22.1 18 146 29.6 24 176 20.3 30 193 11.9 36 207 32.4 42 207 32.2 48 219 34.7	
Nigeria	MF_milk_low_high, kg/hd/d	Breed_Yield, kg_Lactation length,d Milk purpose White Fulani – 763_196 White Fulani – 1019_196 White Fulani – 1301±68_291±7	International Livestock Centre for Africa (1977)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	Gr_weight_low_high, kg C_weight_low_high,kg	Sokoto Gudeli – 1312±126_279±17 White Fulani - 835±17_246 Pre-weaning weight Breed_Purpose_birth weight_3mo_6mo_daily gain, g Sokoto Gudeli_milk_22±0.27_62±1.72_96±2.72_406 Sokoto Gudeli_beef_22±0.27_76±2.0_113±2.67_497 Wadara_beef_23±0.23_80±2.3_113±2.72_492 Wadara_milk,beef_23,24±0.09_62±0.6_101,129±0.7_426,580 White Fulani_milk_22±0.4_64.5±1.5_130±2.8_590 White Fulani_beef_23±0.5_81±1.4_130±3.5_585 Post-weaning weight Breed_Purpose_12mo_18mo_24mo_30mo Sokoto Gudeli_milk_126±3.5_165±4.4_208±5.1_245±5.8 Sokoto Gudeli_beef_113±2.77_199±5.2_240±4.3_300±10.1 Wadara_beef_145±2.7_189±3.2_201±3.0_257±4.7 Wadara_milk _111±2.2_135±2.5_160±3.7_178±3.6 White Fulani_milk_150±1.1_188±0.9_226±1.5_266±2.2 White Fulani_milk_180±3.2_236±4.1_277±5.3_299 White Fulani_beef_209±6.2_255±8.0_333±8.1	
Nigeria	All parameters for low-producing animals: MM_weight, kg MF_weight, kg MF_pregnancy, % MF_DC, % MM_DC, %	Mature females: Weight – 200 Pregnancy, % - 46.8 DC, % - 57.9 CP, g/kg – 92.7 Mature males: Weight – 250 DC, % - 58.1 CP, g/kg – 92.0 Replacement females:	GLEAM (FAO 2017)

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Table 10B.1-7 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Africa in Table 10A.1-2 and Table 10A.1-4**			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	 MF_CP,% MM_CP,% Gr_weight, kg Gr_AWG, kg/d/hd Gr_DC, % Gr_CP,% C_weight,kg C_AWG, kg/d/hd Cr_DC, % C_CP,%	Weight – 107 Daily gain, kg/d – 0.110 DC, % - 57.7 CP, g/kg – 92.6 Replacement males: Weight – 135 Daily gain, kg/d – 0.140 DC, % - 58.1 CP, g/kg – 92.0 Growing heifers: Weight – 107 Daily gain, kg/d – 0.110 DC, % - 57.8 CP, g/kg – 92.4 Growing steers: Weight – 110 Daily gain, kg/d – 0.140 DC, % - 56.8 CP, g/kg – 93.8 Birth weight - 13	
Nigeria	MF_milk_high, kg/hd/d	It was found that 69.07% kept Sokoto Gudali, 18.32% kept White Fulani and 12.61% kept others. Both the husbandry system and milking method were 100% semi-intensive and hand milking Milk yield per lactation (values taken from a Fig, therefore approximate): 10,000 5,000 6,000 23,000 1,000 7,000	Shittu *et al.* (2008)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		9,000	
Nigeria	MF_milk_low, kg/hd/d MF_milk-fat_low, % MF_milk-protein_low, %	Total milk (kg/day): 4.31, 5.19, 4.70, 2.84; Protein 3.6, 4.6, 4.3, 4.1; Fat 3.8, 3.0, 3.1, 3.0; Milk production from these animals is low with lactation yields varying from as low as 295 to 650 kg under extensive management, and 800 to 1300 kg with high nutrient intake The management system adopted by most farmers in Nigeria is the extensive system where cattle are grazed on poorly managed native pastures.	Olorunnisomo (2013)
Nigeria	MM_weight_low, kg MF_weight_low, kg MF_pregnancy_low, % Gr_weight_low, kg C_weight_low,kg	White Fulani breed Weight-mature cow – 340 kg Weight-mature bull – 523 kg Parameter_White Fulani (WF)_ NDama (ND)_WFxND Age at 1st calving,m_48.88_38.22_48.77 Calving rate,%_61.21_22.22_49.21 Birth weight, kg_19.66_13.93_17.33 Weaning weight, kg_79.88_63.66_70.88	Ahamefule *et al.* (2007)
Tanzania	Feeding	the ‘typical’ livestock farmer keeps about 20 animals, including four (4) indigenous cattle; five (5) indigenous goats and sheep; and eleven (11) poultry	Central Statistical Agency (2017)
Tanzania	Feeding	A. Traditional systems with local zebu cattle: a. Pastoralism and transhumance: pastoralists move with their cattle through a fairly large area according to available grazing on natural pasture or harvested crop land. It is a low input system mainly occurring in arid and semi-arid areas. Milk is an important product for home consumption and seasonal surpluses are available for marketing provided there is an opportunity to sell; b. Agro-pastoralism: Agro-pastoralists graze their cattle on communal grazing land during the wet season and on crop land after harvest when crop residues are available, owners of the crop land benefit from manure for improved soil fertility. Also agro-pastoralists use milk for home consumption and seasonal surpluses can be marketed. Establishment of a marketing channel could be easier because herds do not move over a large area and return often to the same spot in the evening; it is a low input system, prevalent in semi-arid areas;	Nell *et al.* (2014)

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Table 10B.1-7 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Africa in Table 10A.1-2 and Table 10A.1-4**			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		c. Small holder mixed farmers (sedentary): a production system mainly in the subhumid areas e.g. cattle under coconuts or banana farmers who keep cattle for manure (e.g. in Kagera). Cattle are important for manure and soil fertility. Cattle density is generally low because of other important income opportunities but also due to disease problems (tick-borne diseases and trypanosomiasis) and there is less tradition of cattle keeping. Milk production is low and consequently milk offtake/km2 is low with high collection cost. Milk production and consumption are less common for the owners. B. Dairy production systems with grade cattle: a. Rural smallholder dairy: small mixed farms with crops and livestock in the rural areas away from the cities, farms with 1– 5 dairy cows mainly originating from smallholder dairy development programmes; cattle are kept under semi-zero grazing systems based on cultivated fodder, crop residues and cut grasses from waste or communal land with varying levels of inputs (AI, bull services, veterinary care by CAHW, supplementary feed, feed conservation). Direct marketing to consumers is limited and farmers rely on milk collecting centres or middlemen. Farmers use inputs depending on marketing opportunities for milk and on their milk income; b. Urban / peri-urban smallholder dairy: this sub-system is similar to the above group but uses a higher level of inputs (depending on milk price), especially for feed and animal health services. The major part of the milk is marketed through the informal market. At present supplying the informal market is often more profitable than selling at the formal market. Marketing problems could occur for the more distant farmers during the wet season when middlemen could buy enough milk close to the cities; c. Medium and large scale dairy farming (private): Farms keeping crossbred and purebred dairy cattle, having land available for fodder production and conserving roughage (hay or silage) for the dry season. Farmers are responsible for organizing external inputs, (e.g. animal health care, feed premixes). Farmers deliver direct to milk plants or milk is processed on the farm and products sold in the cities. For new farmers it is hard to develop this model due to poor infrastructure, credit facilities, communications and transport. There are not many of this type of farms.	
Tanzania	MM_weight_low, kg MF_weight_low, kg	Among the Ufipa cattle some farmers (59.3%) allow their calves to go for grazing with adult cattle after 3 months of age as milking is rarely done. However, a small portion of farmers (8.3 %) reported to graze their calves with adult	Msanga *et al.* (2012)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		cattle from the age of 6 months. Young calves (< 2 weeks) are usually tethered and left around homesteads. Usually calves are separated from their dams during evening times, so as to prepare animals for the subsequent morning milking. Majority of farmers (95.6%) interviewed indicated to castrate their cattle at an age of more than 12 months (ranging from 1 – 2 years). The main reasons for castration were: to prepare it for draft work and for better temperament. Thus most of male cattle kept in a householdare mainly castrates. Ufira breed – dual purpose : 340 (279-426) - Mature cows 447 (370-460) - Mature castrates >6 yr Av milk production, l/d – 3(1-6) Iringa red breed – dual: 263 (161-347) - Mature cows 357 (318-428) - Mature castrates >6 yr	
Tanzania	Low- and high-producing animals: Day-weighted population structure,% MM_weight, kg MF_weight, kg MF_pregnancy, % MF_milk, kg/hd/d	In 2003 16,424,574 – Indigenous cattle 20,256 – Beef- Improved cattle 390,973 – Dairy- Improved cattle 16,836,073 – total In 2008 20,517,616 – Indigenous cattle 95,053 – Beef- Improved cattle 512,583 – Dairy- Improved cattle 21,125,252 – total Production parameters: Traditional sector 40-50 - Calving rate, % 200–350 - Mature weight, kg	Ministry of Livestock and Fisheries Development of Tanzania (2014)

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Table 10B.1-7
Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Africa in Table 10A.1-2 and Table 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		200 - Milk yield per lactation, litres 180-220 - Age at weaning, days 30 - Age at first calving, months 6-7 - Age at slaughter, yrs Small scale semi-intensive (graded and pure animals): 70 - Calving rate, % 250–350 - Mature weight, kg 1,800 - Milk yield per lactation, litres 90 - Age at weaning, days 36 - Age at first calving, months Small scale intensive (graded and pure animals): 70-80 - Calving rate, % 300-400 - Mature weight, kg 2,500 - Milk yield per lactation, litres 90 - Age at weaning, days 36 - Age at first calving, months Large scale dairy production: 75 - Calving rate, % 350 - Mature weight, kg 2,200 - Milk yield per lactation, litres 95 - Age at weaning, days 34 - Age at first calving, months Commercial beef: 55-73 - Calving rate, % 250-350 - Mature weight, kg 800 - Milk yield per lactation, litres 160 - Age at weaning, days 40 - Age at first calving, months	
Tanzania	Feeding	Cattle are owned by 35% of livestock-producers in Tanzania. Although cattle numbers have increased 5% p.a. since 2003, productivity gains are non-existent or very low. In	Ministry of Livestock and Fisheries Development of

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		Tanzania, 98% of red meat products originate from indigenous breeds, with 80% produced by agro-pastoralists and 14% from pastoralists. Average age of off-take for these cattle is 8-10%, with animals harvested at an average of 6-7 years.	Tanzania (2015)
Tanzania	Feeding	Most of the cattle are raised for beef cattle by pastoralists and agro-pastoralists in arid and semi-arid areas of the country. Tanzania, which account for about 39% of the beef cattle in the country Cattle fattening operators in the Lake Zone are entrepreneurs who buy lean beef cattle from nomadic pastoralists and agro-pastoralists and then feed the cattle until they gain weight up to a marketable level. The animals were then sold after 3 to 4 months of feeding, depending on the rate of weight gain	Mlote (2013)
Tanzania	C_weight_low_high,kg Gr_weight_low_high, kg	Tanzania: grazing Birth weight (±SE): 26.8±1.05 – Angus 27.0±0.83 – Boran 28.6±1.32 – Charolais 28.2±1.14 – Chianina 24.4±1.31 – Fresian 26.9±1.16 – Hereford 26.8±1.22 – Limousin 26.4±1.01 – S.Devon Weaning weight: 126.7±7.62 – Angus 114.0±5.48 – Boran 137.3±5.78 – Charolais 133.5±5.84 – Chianina 108.9±7.51 – Fresian 133.1±5.49 – Hereford 120.9±7.32 – Limousin 133.0±5.12 – S.Devon	Said *et al.* (2003)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		Slaughter weight (4 years): 452.4±10.32 – Angus 411.8±8.15 – Boran 470.7±12.78 – Charolais 491.3±11.15 – Chianina 455.1±12.87 – Fresian 467.9±11.41 – Hereford 465.6±12.01 – Limousin 496.3±9.72 – S.Devon	
Tanzania	MM_weight_low, kg MF_weight_low, kg	Tanzania, shorthorn zebu cattle: Males: 164±18.6 – less than 2 years old 204±18.3 – 3 to less than 3 249±23.6 – 3 to less than 4 332±32.9 – 4 and above Females: 199±14.3 – less than 2 years old 237±7.8 – 3 to less than 3 255±4.3 – 3 to less than 4 332±33.3 – 4 and above the country has 19 million head of cattle, in which over 95% are known as the Tanzania Shorthorn Zebu 80% of the TSHZ cattle are kept in the agro-pastoral system which is characterized by poor resource investment	Kashoma *et al.* (2011)
Tanzania	MM_weight_low, kg MF_weight_low, kg	Slaughter weight of six indigenous breeds: 195 - < 1 yr 216 - 1-2 yr 241 - 2-3 yr 264 - > 4 yr The overall market weight of indigenous herd ranged from 202 to 266 kg live weight	Shirima *et al.* (2016)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
Tanzania	MM_weight_low, kg MF_weight_low, kg	adult animals 285±5.54 - Bagamoyo 287±5.47 - Mufundi 233±8.06 - Muheza 284±5.47 - Njombe	Mwambene *et al.* (2014)
Tanzania	MM_weight_low, kg	Steers - 2.5–3.0 years of age, 200±5	Asimwe *et al.* (2015)
Tanzania	Feeding	Most of the livestock species were of indigenous type livestock in Tanzania. 99.9% of the country's livestock is kept by small holder farmers leaving	Engida *et al.* (2015)
Tanzania	MM_weight_low_high, kg MF_weight_low_high, kg	Tanzania, highlands Nkasi breed: 362±12.39 - Bulls 447.21±13.06 - Castrates 291±12.15 – Cows Sumbawanga urban: 300±11.35 - Bulls 384.73±13.20 - Castrates 286.25±11.54 – Cows Sumbawanga rural: 271.62±12.70 - Bulls 371.69±11.72 - Castrates 277.83±11.16 – Cows	Mwambene *et al.* (2012)
Tanzania	All parameters for low-producing animals: MM_weight, kg MF_weight, kg MF_pregnancy, %	Mature females: Weight – 200 Pregnancy, % - 68 DC, % - 58.4 CP, g/kg – 102 Mature males: Weight – 250	GLEAM (FAO 2017)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	MF_DC, % MM_DC, % MF_CP,% MM_CP,% Gr_weight, kg Gr_AWG, kg/d/hd Gr_DC, % Gr_CP,% C_weight,kg C_AWG, kg/d/hd Cr_DC, % C_CP,%	DC, % - 58.4 CP, g/kg – 102 Replacement females: Weight – -- Daily gain, kg/d – --- DC, % - 58.4 CP, g/kg – 92.7 Replacement males: Weight – --- Daily gain, kg/d – --- DC, % - 58.4 CP, g/kg – 102 Growing heifers: Weight – -- Daily gain, kg/d – --- DC, % - 58.3 CP, g/kg – 102.4 Growing steers: Weight – -- Daily gain, kg/d – --- DC, % - 58.3 CP, g/kg – 102.7 Birth weight - 13	
Kenya	Feeding	Most of Kenya (80%) is classified as arid and semi-arid. The climatic conditions in these regions are so harsh for crops that only livestock production can thrive. These regions provide the bulk of beef consumed in the country, which is produced via two main systems: large-scale dairy-meat commercial ranching and small-scale dairy-meat production. In both these systems, production is pasture-based. The animals kept are the highly adapted indigenous zebu (small East African zebu and Boran) or exotic beef (for example, Hereford, Simmental, Charolais, Angus) breeds and	Kahi *et al.* (2006)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		their crosses kept mainly by the commercial ranchers. The large-scale commercial ranchers keep high-yielding improved Boran and exotic beef cattle, including Hereford, Simmental, Charolais and Angus, to produce high-quality beef via modern breeding methods and targeted towards specialized local and export markets. Small-scale dairy-meat production systems use the SEAZ as a dual-purpose animal, which has comparatively low production performance. The Boran or its crosses with the SEAZ can also be found in this system. Agro-pastoralism and pastoralism in which 25% of cattle are kept; pastoral ranching, which supports 50% of the cattle, and commercial ranching that raises 25% of the cattle *Small-scale dairy–meat production system* Milk, not beef, is the main product. It is a low-input–low-output system. *Large-scale dairy–meat production system* - The system can be subdivided into pastoral ranching, commercial large-scale ranching and intensive feedlot systems. *Pastoral ranching*. This is practised by pastoralists in the rangelands where cattle are kept in mixed herds together with indigenous sheep, goats and camels Commercial production of beef is the objective of this system, while the milk is meant for domestic consumption. The animals are grazed on natural pasture *Commercial large-scale ranching*. Commercial large-scale ranching has played a major role in the Kenyan beef industry Beef is the main output and its production is based on either natural or cultivated pastures as the major feed input. The main constraints observed in this system include dry season feeding, breeding management, marketing of the high-quality beef produced and invasion of the ranches by pastoralists during the dry season in search of water	
Kenya	Day-weighted population structure_low,%	Herd structure: i) Milk herd _ 14.5 ii) Dry cows _ 8.2 iii) Heifers (9-36months) _ 25.1 iv) Weaners Males _ 6.3 Females _ 7.6 v) Calves Males _ 8.8	Muhuyi *et al.* (1999)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Females _ 9.4 vi) Bulls _ 12.6 and Steers _ 7.5 *Total* _ 100	
Kenya	Day-weighted population structure_low_high,%	Population, heads_off-take, heads_dressing weight, kg 11,915,973_1,787,396_125 - Kenyan pastoralists 5,311,800_419,632_125 - Dairy producers and other highland 240,000_36,000_240 - Commercial ranches	Farmer and Mbwika (2012)
Kenya	MM_weight_low, kg MF_weight_low, kg Gr_weight_low, kg C_weight_low,kg	Weight, kg Females >2 years old: 216.3±3.8 (dry season) 220.6±3.9 (wet season) 214.5±3.9 (dry season) 214.2±4.4 (dry season) Females 1-2 years old: 143.8±9.8 (dry season) 160.9±11.2 (wet season) 168.9±12.5 (dry season) 174.1±14.8 (dry season) Males >2 years old: 140.5±9.1 (dry season) 147.3±9.4 (wet season) 140.0±7.2 (dry season) 149.0±7.6 (dry season) Calves < 1 year old: 63.4±3.3 (dry season) 72.6±4.0 (wet season) 76.0±3.7 (dry season) 81.6±4.1 (dry season)	Goopy *et al.* (2018)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
Kenya	MF_DC_low, % MM_DC_low, %	Kenya_DC,% 59.6, 59.2, 63.8 (dry season) 58.2, 60.0, 64.1 (wet season) 59.3, 57.5, 55.9 (dry season) 56.2, 57.7, 56.8 (dry season)	Goopy *et al.* (2018)
Kenya	Low and high-producing animals: MM_weight, kg MF_weight, kg Gr_weight, kg C_weight,kg MF_pregnancy, % MF_milk, kg/hd/d	Small-scale dairy_Small-scale dairy and meat_Large-scale dairy and meat Birth weight females (kg) 28.1_15.8_ 19.7 Birth weight males (kg) 28.3 _15.8_ 19.9 Weaning weight female (kg) 51.8_ 65.5 _64.0 Weaning weight males (kg) 51.8_ 65.5_ 64.0 Weaning age (years) 0.33_ 1.0_ 1.0 Maturity age females (years) 3.4_ 3.5_ 4.0 Maturity age males (years) 3.0 _4.0 _4.0 Maturity weight cows (kg) 300_ 212.7_ 180.5 Maturity weights bulls (kg) 450_ 216.2_ 180.5 Calving rate 65.9_ 65 _64.3 Milk yield per lactation (kg) 2434 _600.0 _305 Herd sizes 3.8_ 10_ 100	Onono *et al.* (2013)
Kenya	MM_weight_low_high, kg MF_weight_low_high, kg Gr_weight_low_high, kg	Boran Pure beef systems: SMB, LMB, SHB, LHB Dual-purpose systems: LLD, LMD Sale slaughter weight of steers, kg: 301 - SMB 419- LMB 400 - SHB 545 - LHB 377 - LLD 419 – LMD Sale slaughter weight of heifers, kg:	Rewe *et al.* (2006)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		276 - SMB 356- LMB 350 - SHB 444 - LHB 330 - LLD 356 – LMD Cow weight_Milk yield: 359_1533 - SMB 359_1533 - LMB 359_1533 - SHB 359_1533 - LHB 323_1398 - LLD 359_1533 – LMD Wearning age, days_Wearning weight, kg: 210_154 - SMB 210_154 - LMB 210_154 - SHB 210_194 - LHB 252_139 - LLD 126_90 – LMD	
Kenya		3,498 - Grade cattle: 475 (milk, mln kg) 9,522,000 - Zebu cattle: 2345 (milk, mln kg) 13,739 - Indigenous cattle: 102 (milk, mln kg) Tanzania: 5,000 - Grade cattle: 400 (milk, mln kg) 17,700,000 - Zebu cattle: 960 (milk, mln kg) Uganda: 680 - Grade cattle: 280 (milk, mln kg) 6,120 - Zebu cattle: 1120 (milk, mln kg)	Kurwijila and Bennett (2011)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
Kenya	Feeding	Milk production in Kenya is mainly from cattle (dairy, grade and zebu or indigenous breeds), Grade cattle are about 50 percent pure breeds (mainly Friesian, followed by Ayrshire, Jersey and Guernsey) and crosses. 1000 heads_milk, mln kg 3579.4_2174.5 - Dairy 9320.9_490 – Zebu The feed/forage used by farmers includes maize stovers, poultry waste (dried), hay (usually purchased pure Lucerne, grass or Lucerne/grass mix), silages (by a few farmers), home-made rations of locally available grains and other ingredients, and grazing (the most common feed source). Commercial dairy feeds include dairy meal, dairy cubes, calf pullets, maize germ, maize bran, molasses, cottonseed cake, wheat pollard and wheat bran	Muriuki (2011)
Kenya	Gr_weight_low, kg C_weight_low,kg MM_weight_low, kg MF_weight_low, kg	Kenya, Sahiwal cattle breed 21.86 – Birth weight 48.59 – weaning weight 133.98 – yearling weight 162 – pre-weaning average daily gain, g/day 322 – post-weaning daily gain, g/day 337.62 – mature weight	Ilatsia *et al.* (2011)
Kenya	Feeding	In the intensive system, dairy cattle are enclosed in zero-grazing units, where they are provided with all their requirements for feed and water. This method is mainly practised where grazing land is scarce. In Kenya it is mainly practised in high-potential areas of central Kenya and also by urban and peri-urban farmers; in Tanzania it is practised on the slopes of Mt Kilimanjaro and in Uganda around Kagada. The forage can be grown on farm or purchased. In the extensive system, the cattle are reared on pasture. It is practised where grazing land is available. In East Africa the grazing land mainly comprises natural unimproved grass. In Kenya it is practised in most parts of the Rift Valley, where farmers own large tracts of land. In the semi-intensive system, the cattle graze for some time during the day and in the afternoon or evening they are supplemented with other forages like Napier grass. This method is a compromise between intensive and extensive systems, whereby land is not limiting as in the intensive system but on the other hand is not enough to allow free	Lukuyu *et al.* (2012)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		grazing throughout the day.	
Kenya	Gr_weight_high, kg	Weight_heifers_cows 40-60% exotic_195±40.7_228±39.5 61-80% exotic_212±42.6_268±52.6 >80% exotic_215±50.2_325±57.7	Lukuyu *et al.* (2016)
Kenya	Day-weighted population structure_low,%	mean value±SD Total cattle in herd-71 Steers – 2.8±2.0 Entire males >6y – 7.0±9.7 Entire males 1 to 6 yr – 7.5 ±7.5 Entire males 1-3 yr – 8.2 ±13.2 Cows >6 yr – 16.5 ±31.3 Cows-3-6yr – 9.9 ±12.3 Female cattle 1-3yr – 9.3 ±17 Male calves – 4.5 ±7.3 Female calves – 5.3±10.4 Ratio of steers to other males 1:8; Ratio of reproductive males to reproductive females 1:2; Reproductive females 37.2 % of cattle All calves 13.8 % of cattle	Mwanyumba *et al.* (2015)
Kenya	All parameters for low-producing animals: MM_weight, kg MF_weight, kg MF_pregnancy, % MF_DC, % MM_DC, %	Mature females: Weight – 200 Pregnancy, % - 68.9 DC, % - 59.1 CP, g/kg – 99.9 Mature males: Weight – 250 DC, % - 59.1 CP, g/kg – 99.9 Replacement females:	GLEAM (FAO 2017)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	 MF_CP,% MM_CP,% Gr_weight, kg Gr_AWG, kg/d/hd Gr_DC, % Gr_CP,% C_weight,kg C_ weight gain, kg/d/hd Cr_DC, % C_CP,%	Weight – -- Daily gain, kg/d – --- DC, % - 59.1 CP, g/kg – 92.5 Replacement males: Weight – --- Daily gain, kg/d – --- DC, % - 59.1 CP, g/kg – 99.9 Growing heifers: Weight – -- Daily gain, kg/d – --- DC, % - 59.1 CP, g/kg – 100.2 Growing steers: Weight – -- Daily gain, kg/d – --- DC, % - 59.0 CP, g/kg – 100.6 Birth weight - 13	
South Africa	Low and high-producing animals: MM_weight, kg MF_weight, kg Gr_weight, kg C_weight,kg	South Africa: Bonsmara and Belmont Red breeds 36.9±5.2 - Birth weight 133±28.8 – 100 day weight (46-197) 201±35.2 – 205-day weight (148–272) 260±64.9 – 365-day weight (271-450) 326±83.5 – 540-day weight (453-628) Daily gain, kg/day	Corbet *et al.* (2006)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		1.08±0.38 (333-709) 360-day weight 287±2.9 – Males 237±2.1 – Females 540-day weight : 398±6.3 – Males 312±3.0 – Females	
South Africa	Low and high-producing animals: MM_weight, kg MF_weight, kg Gr_weight, kg C_weight,kg	Weaning weight (205-days old): 213 - Bonsmara – commercial 213 - Bonsmara – emerging farmers 210 - Brahman – emerging farmers 151 - Nguni – commercial 151 - Nguni – emerging farmers 226 - Non-descript – commercial 226 - Non-descript – emerging farmers Slaughter weight: 434 - Bonsmara – commercial 357 - Bonsmara – emerging farmers 369 - Brahman – emerging farmers 321 - Nguni – commercial 341 - Nguni – emerging farmers 424 - Non-descript – commercial 3566 - Non-descript – emerging farmers	Strydom *et al.* (2008)
South Africa	Low and high-producing animals: MM_weight, kg MF_weight, kg Gr_weight, kg	Weaning weight (205-days old): 199 – Dnakens-berger – commercial 185 - Tuli – emerging farmers Slaughter weight (+130 days): 454 – Dnakens-berger – commercial	Strydom (2008)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	C_weight,kg	418 - Tuli – emerging farmers	
South Africa	Low and high-producing animals: Gr_weight, kg C_weight,kg Gr_ weight gain, kg/d/hd C_ weight gain, kg/d/hd	Sub-Saharian Africa: Birth weight: 26.8±0.2 – N 46.8±0.9 – C 34.0±1.7 – Ch 32.2±0.6 – CxN 31.3±0.8 – SxN 29.6±0.8 – ChxN Preweaning growth rate, g/day: 761±5 – N 836±18 – C 796±49 – Ch 893±16 – CxN 896±22 – SxN 900±23 – ChxN 205-days weight, kg: 183±1.0 – N 222±3.9 – C 199±10.6 – Ch 215±3.6 – CxN 215±4.8 – SxN 214±4.9 – ChxN Birth weight: 35±0.8 – A 47±0.9 – C 43±1.1 – S 36±0.9 – H 33±1.1 – B	Scholtz and Theunissen (2010)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		42±1.1 – CxA 40±0.9 – SxA 37±0.9 – HxA 41±0.9 – BxA Weaning weight: 184±3 – A 222±4 – C 2343±5 – S 179±4 – H 199±5 – B 219±5 – CxA 210±4 – SxA 195±4 – HxA 206±4 – BxA Nguni (N), Chianina (Ch) , Charolais (C), Simmentaler (S) Brahman (B), Hereford (H) , Afrikaner (A)	
South Africa	MM_weight_high, kg MF_weight_high, kg Gr_weight_high, kg C_weight_high,kg	South Africa, Brahman cattle 32.3±4.0 – BWT 212±37 - WWT 274±54 - YWT 361±62 - FWT	Pico (2004)
South Africa	Gr_weight_high, kg C_weight_high,kg	Slaughter weight (7 months + 112 days) 283, 338 - Afrikaner 249, 302 - Nguni 349, 412 - Bonsmara 366, 446 - Santa Gertrudis 336, 424 - Pinzgauer 401, 449 - Brown Swiss	Strydom *et al.* (2000)
South Africa	High-producing animals:	Crossbred breeds	Theunissen *et al.* (2013)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	MM_weight, kg MF_weight, kg Gr_weight, kg C_weight,kg	Birth weight: 37.1 - Afrikaner 41.1 - Brahman 42.2 - Charolais 37.8 - Hereford 40.6 – Simmentaler Weaning weight: 200 - Afrikaner 226 - Brahman 233.8 - Charolais 216.3 - Hereford 227.8 – Simmentaler Heifer weight, 19 months old: 323.9 - Afrikaner 336.1 - Brahman 381.7 - Charolais 345.0 - Hereford 371.6 – Simmentaler Cow weight at partus: 434.3 - Afrikaner 495.9 - Brahman 506.5 - Charolais 449.1 - Hereford 497.1 – Simmentaler	
South Africa	Low and high-producing animals: MM_weight, kg MF_weight, kg	Dairy – concentrate feed_weight_WG, g/day 590_0.1 - Lactating cows 503_0.55 - Lactating heifers 590_0.1 - Dry cows 394_0.5 - Pregnant heifers	Du Toit *et al.* (2013)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	Gr_weight, kg C_weight,kg Gr_ weight gain, kg/d/hd C_ weight gain, kg/d/hd MF_DC, % MM_DC, % Gr_DC, % C_DC, %	322_0.83 - Heifers >1 year 172_0.78 - Heifers 6 - 12 months 55_0.33 - Heifers 2 - 6 months 35_0.33 - Calves Dairy - pastoral_weight_WG, g/day 540_0.1 - Lactating cows 438_0.35 - Lactating heifers 540_0.1 - Dry cows 333_0.35 - Pregnant heifers 254_0.527 - Heifers >1 year 142_0.622 - Heifers 6 - 12 months 54_0.59 - Heifers 2 - 6 months 36_0.30 – Calves Beef cattle, commercial_weight_WG, g/day: 733 - Bulls 475 - Cows 365_0.22-0.55 - Heifers 430_0.11-0.77 - Oxen 193_0.60-0.96 - Young oxen 190_0.69-0.96 - Calves Beef cattle, communal_weight_WG, g/day: 462 - Bulls 360 - Cows 292_0.27-0.44 - Heifers 344_0.09-0.62 - Oxen 154_0.49-0.76 - Young oxen 152_0.49-0.76 - Calves 55.8% - DC_beef_commercial_communal	

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		Dairy – concentrate feed_DC_CP 76_17 - Lactating cows 76_17 - Lactating heifers 60.3_13.5 - Dry cows 63_13.5 - Pregnant heifers 63_12 - Heifers >1 year 68_16 - Heifers 6 - 12 months 71_18 - Heifers 2 - 6 months 82_18 - Calves Dairy – pasture_DC_CP 74-83_21.6 - Lactating cows 74-83_21.6 - Lactating heifers 65.6-82_21.58 - Dry cows 65.6-82_21.58 - Pregnant heifers 65.6-82_21.58 - Heifers >1 year 65.6-82_21.58 - Heifers 6 - 12 months 65.6-82_21.58 - Heifers 2 - 6 months 65.6-82_21.58 - Calves	
South Africa	MM_weight_high, kg MF_weight_high, kg Gr_weight_high, kg C_weight_high,kg	Africaner beef breed BirthWeight_32.1±4.1 WeaningWeight_183.7±32.1 YearlingWeight_218.1±47.9 FinalWeight_300.9±62.7 AgeWW(age of calf at weaning)_210.8±29.7 AgeYW_368.6±39.2 AgeFW_547.7±41.2 AgeDam (age of dam at calving)_75.7±36.3	Groeneveld *et al.* (1998)
South Africa	Day-weighted population structure_low,%	Average herd composition, % Cows – 35.6	Strous (2010)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	MF_pregnancy_low, %	Heifers – 18.9 Calves – 10.7 Steers (1-3 years) – 22.5 Oxen – 9.2 Bulls – 3.2 Calving rate in Africa, %: Botswana – 36-50 Ethiopia – 55 Mali – 55 Niger – 60 Sudan – 40 Zambia – 44-88 Zimbabwe – 40-52	
Botswana	Day-weighted population structure_low_high,% Feeding	The beef cattle production system in Botswana is dualistic in structure in that it includes both traditional and commercial production systems The majority of the beef cattle (approximately 80% of the cattle herd) in Botswana are found within the traditional, communal grazing system. The communal livestock grazing systemis largely undeveloped; characterised by extensive grazing on tribal grazing areas with no defined property rights and uncontrolled grazing Commercial beef production system has exclusive grazing rights with fenced pastures on private land Beef production under this systems solely for commercial purposes and is highly specialised; employing modern animal husbandry practices and strategic feeding to produce high-value beef animals Variable_Tranditional production(+SD)_Commercial production: Birth rate,%_55.33±9.59_38.51±17.76 Local breeds,%_55.03±19.63_50.84±28.96 Exotic breeds,%_4.44±7.07_34.83±23.18 Crossbreed,%_40.53±19.73_57.08±25.91	Temoso *et al.* (2016)
Botswana	Gr_weight_low_high, kg	Performance of Tswana cattle and its crosses	Mpofu (1996)

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Table 10B.1-7 Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Africa in Table 10A.1-2 and Table 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	C_weight_low_high,kg MF_pregnancy_low_high, %	Genotype_Calving rate,%_WW,kg_Weight at 18m,kg Pure Tswana_76_177.2_284.4 Pure Africander_67_170.1_270.6 Pure Bonsmara_85_173.5_283.3 Pure Brahman_na_176.1_291.8 Tuli/Tswana_80.3_179.1_293.5 Bonsmara/Tswan_82.1_193.6_303.0 Brahman/Tswana_83.1_189.9_319.7 Simmental/Tswana_83.1_189.9_319.7 Pure Tswana_88_179.3_265.8 Tuli_86_173.1_247.5 Bonsmara_68_190.2_273.8 Composite_90_190.5_286.3	
Botswana	MF_pregnancy_low_high, % Day-weighted population structure_low,%	Birth rate,%: Traditional_Commerical,% 2012_53.7_48.6 2013_52.1_40.4 2014_48.8_... Cattle population by type of breed, heads: Total traditional – 1,596,605 Tswana – 705,607 Crosses – 811,746 Exotic – 79,252 Cattle herd composition, heads: Bulls – 29,680 Oxen – 100,150 Cows – 70,704 Tollies – 290,031 Heifers – 182,171 Males calves – 131,341	Statistics Botswana (2016)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Females calves – 152,528 Total cattle population – 1,596,605	
Namibia	MF_pregnancy_low, % MM_weight_low, kg MF_weight_low, kg	Mutompo – mixed-up system Okamboro – A pastoral system prevailed, where most livestock were Africander, Brahman and Simmental cattle crossbreds Variable_Mean Mutompo _95% interval_ Okamboro_95% interval Age at first calving,m_61.2_49.4-73.0_31.6_28.5-34.6 Calving rate,%_36_60 Liveweight,kg_Mean_Mutompo_Okamboro(+SV): Cows_277±16_333±13 Bulls_395±17_544±6 Oxen_410±12	Siegmund-Schultze *et al.* (2012)
Botswana and Namibia	All parameters for low producing animals: MM_weight, kg MF_weight, kg MF_pregnancy, % MF_DC, % MM_DC, % MF_CP,% MM_CP,% Gr_weight, kg Gr_AWG, kg/d/hd Gr_DC, %	Mature females: Weight – 225 Pregnancy, % - 58.0 DC, % - 57.5 CP, g/kg – 101.4 Mature males: Weight – 300 DC, % - 57.6 CP, g/kg – 99.8 Replacement females: Weight – 120 Daily gain, kg/d – 0.137 DC, % - 57.5 CP, g/kg – 93.0 Replacement males: Weight – 160 Daily gain, kg/d – 0.158	GLEAM (FAO 2017)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
	Gr_CP,% C_weight,kg C_ weight gain, kg/d/hd Cr_DC, % C_CP,%	DC, % - 57.3 CP, g/kg – 99.9 Growing heifers: Weight – 120 Daily gain, kg/d – 0.137 DC, % - 57.8 CP, g/kg – 102.1 Growing steers: Weight – 160 Daily gain, kg/d – 0.185 DC, % - 576 CP, g/kg – 101.9 Birth weight - 16	
Bostwana	Gr_weight_high, kg C_weight_high, kg	Birth weight: Brahman breed – 33.8 kg Tuli – 32.2 kg Weaning weight: Brahman breed – 164.8 kg Tuli – 150.4 kg	Chabo *et al.* (2003)
Botswana	Gr_weight_high, kg C_weight_high, kg	Parameter_Bonsmara_Brahman_Tuli Birth weight_32.1±2.29_26.5±2.38_26.0±0.97 Weaning weight_215±10.9_175±12.4_144±5.0 18mo_323±15.0_303±18.4_221±6.62	Rakwadi *et al.* (2016)
South Africa	MF_milk-protein_low_high, %	Milk Protein, g/kg: Nguni – 32.2 Crossbred – 32.9 Milk fat, g/kg: Nguni – 29.8 Crossbred – 33.5	Mapiye *et al.* (2011)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
Botswana	Gr_weight_high, kg C_weight_high, kg	Botswana: Breed_BW_WW_18MW Tuli_28.8_169.9_283.6 Tswana_30.7_174.6_278.5 Afrikaner_29.9_166.1_269.7 Zimbabwe: Breed_BW_WW_18MW Tuli_32.1_180.0_294.0 Mashona_24.3_156.2_267.2 Nkone_31.4_187.5_278.8 Breed_BW_WW_18MW_ADG1_ADG2 Tswana_32.8_177.6_262.2_0.69_0.25 Composite_33.3_182.7_257.8_0.71_0.24	Raphaka (2008)
South Africa	MF_milk-fat_high, % MF_milk-protein_high, %	Parameter_Boran_Nguni_Tuli_Afrikaner_Bonsmara_Drakensberger Milk fat,%_2.68±0.98_4.18±1.64_2.01±0.82_3.79±1.30_3.76±1.23_3.63±0.49 Milk protein,%_3.61±0.43_2.96±0.82_3.02±0.33_3.16±0.42_3.20±0.40_3.26±0.52	Myburgh *et al.* (2012)
Other countries of African continent		Breed / Population / / MBW Abigar / 548,650 / Agropastoral / 350 Kg Arado / 440,000 / Sedentary / 300 Kg Arsi / 2,011,800 / Sedentary / 250 Kg Barca / 500,000 / Pastoral / 380 Kg; Borana / 1,896,135 / Pastoral / 400, Kg Danakil / 680,000 / Pastoral / 275, Kg Fogera / 868,000 / Sedentary / 280 Kg Goffa / 300,000 / Agropastoral / 280Kg Harar / 1,143,815 / Sedentary / 250 Kg Horro / 3,286,080 / Sedentary / 280 Kg	Tefera (2013)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Jem-Jem 434,000 Sedentary 250 Kg Ogaden 200,000 Pastoral 250 Kg Raya 521,000 Agropastoral 380 Kg Sheko 31,000 Agropastoral 250, Kg	
Benin	Low producing animals: MM_weight, kg MF_weight, kg Gr_weight, kg C_weight, kg MF_pregnancy, %	Sompa cattle: Sub-category / ALBW (kg) / AWG (g/day) / DWPM (%) Growing cattle Female 6-12 m 46.2 93.2 4.5 Male 6-12 m 46.2 93.2 4.8 Heifer 1- 2 y 81.3 96.0 7.9 Young bull 1-2 y 81.3 96.0 2.9 Heifer 2- 3 y 119.0 104.0 4.3 Young bull 2-3 y 119.0 104.0 1.8 Heifer 3- 4 y 149.4 82.2 3.8 Young bull 3-4 y 149.4 82.2 1.3 Cow 4-5 y 158.5 24.7 4.4 Young bull 4 - 5 y 158.5 24.7 0.9 Young bull 5 - 6 y 165.3 18.7 0.8 Other mature cattle Mature cow ≥ 5 y 167.0 0.0 38.2 Bull ≥ 6 y 173.0 0.0 0.3 Borgou cattle Sub-category / ALBW (kg) / AWG (g/day) / DWPM (%) Growing cattle Female 6 -12 m 70.6 160.0 4.5 Male 6 -12 m 70.6 189.0 4.8 Heifer 1- 2 y 126.9 154.3 9.8 Heifer 2 < 4 y 213.8 119.0 15 Young bull 1-2 y 126.9 154.3 5.3 Young bull 2< 4 y 213.8 119.0 3.9 Other mature cattle Mature cow ≥ 4 y 239.4 0.0 31.9 Bull ≥ 4 y 275 0.0 1.0	Kouazounde *et al.* (2015)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		Lagune cattle <table><tr><td>Sub-category</td><td>ALBW (kg)</td><td>AWG (g/day)</td><td>DWPM (%)</td></tr><tr><td>Growing cattle</td><td></td><td></td><td></td></tr><tr><td>Female 6-12 m</td><td>46.2</td><td>93.2</td><td>4.5</td></tr><tr><td>Male 6-12 m</td><td>46.2</td><td>93.2</td><td>4.8</td></tr><tr><td>Heifer 1- 2 y</td><td>96.0</td><td>153.4</td><td>12.4</td></tr><tr><td>Young Bull 1-2 y</td><td>96.0</td><td>153.4</td><td>7.7</td></tr><tr><td>Heifer 2 - 3 y</td><td>111.0</td><td>41.1</td><td>4.3</td></tr><tr><td>Young Bull 2-3 y</td><td>111.0</td><td>41.1</td><td>1.8</td></tr><tr><td>Young Bull 3-4 y</td><td>157.0</td><td>126.0</td><td>1.3</td></tr><tr><td>Heifer 3-4 y</td><td>157.0</td><td>0.0</td><td>3.8</td></tr><tr><td>Other mature cattle</td><td></td><td></td><td></td></tr><tr><td>Mature cow ≥ 4y</td><td>157.0</td><td>0.0</td><td>42.6</td></tr><tr><td>Bull > 4 y</td><td>209.0</td><td>0.0</td><td>2.0</td></tr></table> ALBW : Average live body weight; DWPM = Day weighted population mix <table><tr><td>Breed</td><td>Mature weight (kg)</td><td>ADMP (kg/day)</td><td>Milk fat content (%)</td><td>Calving rate (%)</td></tr><tr><td></td><td>Female</td><td>Male</td><td></td><td></td></tr><tr><td>*Somba* cattle</td><td>167.0</td><td>173.0</td><td>0.8</td><td>6.0</td></tr><tr><td>*Borgou* cattle</td><td>239.5</td><td>275.0</td><td>1.5</td><td>6.7</td></tr><tr><td>*Lagune* cattle</td><td>157.0</td><td>150 – 200</td><td>0.8</td><td>5.8</td></tr></table> ADMP= Average daily milk production	
Uganda	Feeding	Many cattle keepers have adopted sedentary lifestyles, with some of them embracing mixed crop–livestock farming, especially in Burundi, Rwanda and the most western part of Uganda. In these areas, Ankole cattle tend to be kept by smallholder farmers whose livelihoods and income are no longer based exclusively on livestock production but also on crop production or off-farm activities.	Wurzinger *et al.* (2006)
Gambia	MF_weight_high, kg	Cow weight, kg_milk,l/d not supplemented_supplemented	Nouala *et al.* (2003)

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
	MF_milk_high, kg/hd/d	209_1.07,1.36 - N'Dama 292_4.02,4.87 - NDxJ 365_1.36,4.11 - NDxH-F	
Zambia	MF_weight_low, kg MM_weight_low, kg MF_milk_low, kg/hd/d Feeding	Angora_Tonga_Baroste Calving % - 82.5_74.4_78.1 Birth weight, kg – 22.9_25.7_19.8 Weaning weight, kg_147.3_140.8_167.0 Weight at 18 m – 207.7_200.0_235.0 Weight at 3 yr – 238.3_210.3_255.3 Milk yiled/lactation – 990_850_1160	FAO and IAEA (2011)
Cameroon	Feeding	Some characteristics of the dairy production system: <u>High yielding exotic</u> High stall feeding Improved grass Some supplementation Main herd purpose – dairy/manure <u>Exotic or/and crossbreeds</u> Stall feeding Rotational grazing Improved grass Some supplementation Main herd purpose – dairy/manure/beef <u>Local</u> Communal grazing Transhumance of non-lactating adult cattle Main herd purpose – beef/dairy <u>Crossbreeds</u> Communal grazing Main herd purpose – beef/dairy	Bayemi *et al.* (2005)

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
Other countries of African continent	High and low producing animals: MF_milk, kg/hd/d MF_milk-fat, % MF_milk-protein, % Gr_weight, kg C_weight, kg MM_weight, kg MF_weight, kg	<u>Age at first calving</u> Mali, purpose: beef, milk, draft Maure - 42.3 Peul – 44.8 PxM – 43.3 Senegal , Gobra (beef), 45.5±0.8, 31.1±1.5, 39.8±1.8 Uganda, milk breeds Ankole, Small E.A.Zebu- 51.3±1.2, 51.7±1.5 Ngada – 42.0±0.5 Small E.A.Zebu – 42.7±0.6 <u>Milk yield</u> Mali, purpose: beef, milk, draft Maure – 1206 (lactation yield) Peul – 1118 PxM – 1197 Fat – 4.7% Niger, Azaouak (milk) – 1043, fat – 5.1% Uganda Ankole (milk purpose) - 835±31, Small E.A.Zebu (milk purpose) - 613±26 Nganda (milk purpose) - 1032±43 Small E.A.Zebu (milk, beef purpose) – 1319 <u>Birth weight_3moW_6moW</u> Mali, purpose: beef, milk, draft Maure – 21±0.31_54±0.95_82±1.44	International Livestock Centre for Africa (1977)

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TABLE 10B.1-7 **EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4**			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		Peul – 20_49_76 PxM – 20_51_78 Senegal , Gobra (beef), 22±0.30_64±6.8_122±2.4 Niger, Azaouak (milk) – 20_68_98 Botswana: Africaner (beef) – 30_***_150 Tswana (beef) – 31_**_156 Tuli (beef) – 29_***_153 Kenya, Boran (beef) – 28_93_146 12moW_18moW_24moW_30moW Mali, purpose: beef, milk, draft Maure – 122±3.45_175±3.79_221±3.91_264±4.61 Peul – 118_164_206_247 PxM – 125_178_217_262 Senegal , Gobra (beef), 136±2.0_185±2.9_238±2.9_288±4.7 Niger, Azaouak (milk) – 126_168_188_248 Uganda, Ankole breed (milk) – 137_***_196_ Botswana, 18moW Africaner (beef) – 271 Tswana (beef) – 284 Tuli (beef) – 283	

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TABLE 10B.1-7 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4			
Parameter [1] / Country of African region	**Unit / Parameter [1]**	**Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)**	**Reference source**
		Kenya, Boran (beef) – 211_265_299_350 <u>Cow body weight</u> Mali Maure – 322 Peul – 302 PxM – 326 Senegal, Gobra – 380 (selected herd), 350 (unselected herd) Niger, Azaouak breed - 325 Sudan, Baggaga – 272 – 340 Kenya, Boran breed - 372	
Weighted for Africa	All parameters for low-producing animals: MM_weight, kg MF_weight, kg MF_pregnancy, % MF_DC, % MM_DC, % MF_CP,% MM_CP,% Gr_weight, kg Gr_AWG, kg/d/hd Gr_DC, % Gr_CP,% C_weight,kg C_ weight gain, kg/d/hd Gr_DC, % C_CP,%	Mature females: Weight – 240 Pregnancy, % - 58.9 DC, % - 58.0 CP, g/kg – 100.6 Mature males: Weight – 344 Work – 1.1 DC, % - 58.0 CP, g/kg – 96.9 Replacement females: Weight – 150 Daily gain, kg/d – 0.188 DC, % - 57.4 CP, g/kg – 91.0 Replacement males: Weight – 180 Daily gain, kg/d – 0.234	GLEAM (FAO 2017): weighted-average for Africa

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TABLE 10B.1-7
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF AFRICA IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter [1] / Country of African region	Unit / Parameter [1]	Value in Table 10A.1-2 and Table 10A.1-4 / Reference value (±SD)	Reference source
		DC, % - 57.5 CP, g/kg – 96.9 Growing heifers: Weight – 123 Daily gain, kg/d – 0.159 DC, % - 57.7 CP, g/kg – 98.8 Growing steers: Weight – 136 Daily gain, kg/d – 0.234 DC, % - 57.5 CP, g/kg – 99.6 Birth weight - 17	
Other countries of African continent	Day-weighted population structure_low,%	Herd structure,% Mature females – 19 Mature males - 9 Replacement females – 11 Replacement males – 10 Growing heifers – 15 Growing steers – 13 Calves - 23	GLEAM (FAO 2017): weighted-average for Africa
Zimbabwe	MF_milk_low_high, kg/hd/d	Total lactation yield, kg (±SE) Breed: Indigenous – 637.6±372.3_703.9±455.9 Exotic - 1849±192.7_1605.6±310.7 Crossbreds – 1679.3±219.7_1245.4±179.4	Masama *et al.* (2003)

[1] DCA – dairy cattle, MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, Cmilk – Calves on milk, C – Calves on forage; _low and _high subscribt corresponds to low producing systems and high producing systems, accordingly

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TABLE 10B.1-8
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF MIDDLE EAST IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (± SD)	Reference source
Weight_DCA_low	kg/hd	270	200–300 (Yerli Kara) 250-350 (Dogu Anadolu Kirmizisi) 250-350 (Turkish Grey)	Yilmaz *et al.* (2012)
Weight_DCA_low	kg/hd	270	200, Yerli Kara 250, Yerli Kara	Ula (2016)
Weight_DCA_low	kg/hd	270	150-250 200-300 (Yerli Kara) 250-350	MFAL (2011)
Weight_DCA_low	kg/hd	270	275	Kamalzadeh *et al.* (2008)
Weight_DCA_high	kg/hd	510	517±47 (SD)	Fatahnia *et al.* (2010)
Weight_DCA_high	kg/hd	510	485 (470-500)	USDA (2015)
Weight_DCA_high	kg/hd	510	512 (425-600)	Tasdemir *et al.* (2011)
Weight_DCA_high	kg/hd	510	680 (after 3rd calving)	Sadeghi-Sefidmazgi *et al.* (2012)
Feeding_DCA_low		Pasture	Pasture	Karakok (2007)
Feeding_DCA_high		Stall	Stall	Kara *et al.* (2014)
Milk yield_DCA_low	kg/hd/d	3.60	3.60	Turkish Statistical Institute (2017)
Milk yield_DCA _high	kg/hd/d	10.62	10.62	Turkish Statistical Institute (2017)
Milk fat_DCA _low	%	4.5	4 (native black) 3.6 3.6 3.2	Yilmaz *et al.* (2012)
Milk fat_DCA_low	%	4.5	5.1 (4.71-5.45)	Ula (2016)
Milk protein_DCA_low	%	3.7	Fat: 4.41 - 4.60 Protein: 3.6–3.7	Calculated based on: da Cunha *et al.* (2010)
Milk fat_DCA_high	%	3.4	3.5	CBAT (2017)
Milk fat_DCA_high	%	3.4	3.23 (holstein)	Fatahnia *et al.* (2010)
Milk protein_DCA_high	%	3.2	3.3	CBAT (2017)
Milk protein_DCA_high	%	3.2	3.23±0.17 (SEM) (holstein)	Fatahnia *et al.* (2010)
Pregnancy_DCA_low	%	50	50	Calculated based on data of the Turkish Statistical Institute (2017)
Pregnancy_DCA_high	%	55	55	Calculated based on data of the Turkish Statistical Institute (2017)
Pregnancy_DCA_high	%	55	55	Calculated based on Karakok (2007)
DC_DCA_low	%	60		Calculated based on:

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Table 10B.1-8 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other cattle) of Middle East in Table 10A.1-2 and Table 10A.1-4**				
Parameter[1]	**Unit**	**Value in Table 10A.1-2 Table 10A.1-4**	**Reference value (± SD)**	**Reference source**
				FAO *et al.* (2014) Gerber *et al.* (2011)
DC_DCA_high	%	65		Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)
CP_DCA_low	%	12.5	12.0 12.5	Özlütürk *et al.* (2006)
CP_DCA_high	%	15.8	15.8 (Holstein)	Fatahnia *et al.* (2010)
Day weighted population_DCA	%	35/65	High/low	Turkish Statistical Institute (2017)
Weight_MM_low	kg/hd	450	370	Kamalzadeh *et al.* (2008)
Weight_MM_low	kg/hd	450	350-450 550-600 400-600	Yilmaz *et al.* (2012)
Weight_MM_high	kg/hd	600	615.83±7.16	Ustuner *et al.* (2016)
Weight_MM_high	kg/hd	600	743.9±54.06 800.7±57.20 742.5±53.07	Akbaş *et al.* (2006)
Feeding_MM_low		Pasture	Pasture	Karakok (2007)
Feeding_MM_high		Pasture	paddock	Ustuner *et al.* (2016)
Work_MM_low	hr/hd/d	0.55		IPCC 2006
CP_MM_low	%	13.5		The CP,% value of Growing/Replacement animals (low-producing) was applied
CP_MM-high	%	15.5		The CP,% value of Growing/Replacement animals (high-producing) was applied
DC_MM_low	%	55		Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)
DC_MM_high	%	62		Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)
Weight_MF_low	kg/hd	330	350-450 (South Anatolian Red) 270-450 (Zavot)	Yilmaz *et al.* (2012)
Milk_yield_MF_low	kg/hd/d	2.3	900–1000 600–650	Yilmaz *et al.* (2012)
Fat_MF_low	%	3.8	3.5 3.2 3.5-4.5	Yilmaz *et al.* (2012)
Protein_MF_low	%	3.2		Judgement of the IPCC panel
MF_low_high_other				Assumed that other input-

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TABLE 10B.1-8
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF MIDDLE EAST IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (± SD)	Reference source
parameters				parameters (not mentioned above) have the same values as for Dairy cows (low-producing dairy cows and high-producing dairy cows, accordingly)
Weight_C_low	kg/hd	85	0m: 18-20 17-22 15-17 23-27 22-24 17-27	Yilmaz *et al.* (2012)
Weight_Gr_C_low	kg/hd	85 150	205d: 135.48 ± 4.39 0m: 20.60 ± 0.53	Özlütürk *et al.* (2006)
Weight_C_high	kg/hd	150	(0m) 28.69±0.74 (SE) (6m) 141.18±2.48	Koçyiğit *et al.* (2014)
Weight_Gr_C_high	kg/hd	165 350	220 (5.5m) 223 (7.5m) 615 (433d) 615 (490d)	Ustuner *et al.* (2016)
Weight_Gr_C_high	kg/hd	165 350	(175d) 185.5±10 1y: 400.50±17.5 387.00±12.5 349.70±14.0	Chashnidel *et al.* (2007)
Weight_Gr_C_high	kg/hd	165 350	0m: 35 12m: 430 400 460d: 500 520 490	Akbaş *et al.* (2006)
Weight_Gr_C_high	kg/hd	165 350	0d: 25.80 ±0.50 25.59±0.63 205d: 184.97 ± 4.34 (crossbred) 195.68 ± 5.20 (crossbred)	Özlütürk *et al.* (2006)
Weight_C_Gr_high	kg/hd	165 350	144 (6m) 507 (18m)	Yalcin *et al.* (2017)

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TABLE 10B.1-8
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF MIDDLE EAST IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (± SD)	Reference source
Weight_Gr_high	kg/hd	350	500 (Slaughter weight) 519 488 12.35 (SEM)	Akbaş *et al.* (2006)
Weight_gain_C_low	kg/hd/d	0.40		A weight-range between 20 (birth weight) and 150 (MW). The daily weight gain was calculated as 0.40 kg/hd/d.
Weight_gain_C_low_high	kg/hd/d		0.43±0.02 – low 0.60±0.02 – high 0.63±0.02 – high	Özlütürk *et al.* (2006)
Weight_gain_C_high	kg/hd/d	0.70		A weight-range between 30 (birth weight) and 300 (MW).
Weight_gain_C_high	kg/hd/d	0.70	0.62±0.01 (betwen 0 to 160d)	Koçyiğit *et al.* (2014)
Weight_gain_Gr_high	kg/hd/d		between 180 d to 460 d (intensive fattening) 1059 1066 1044 49.35 (SEM)	Akbaş *et al.* (2006)
Weight_gain_Gr_high	kg/hd/d		between 180 d to 460 d (intensive fattening) 1250±35 1060±50 840±30	Chashnidel *et al.* (2007)
Weight_gain_G_low	kg/hd/d	0.25		Expert judjment of the IPCC panel based on the reference sources reported in the reference list
Weight_gain_Gr_high	kg/hd/d	0.50		Expert judjment of the IPCC panel based on Sadeghi-Sefidmazgi *et al.* (2012) and other reference sources reported in the reference list
Feeding_C_Gr_low		Pasture	Pasture	Koçyiğit *et al.* (2014)
Feeding_C_Gr_low		Pasture	Pasture	Karakok (2007)
Feeding_Gr_C_high		Pasture	Paddock	Ustuner *et al.* (2016)
CP_C_Gr_low	%	13.5		The lowest value in CP,%-range reported for high-producing young animals was selected for low-producing young cattle
CP_Gr_high	%	15.5	13.53-13.70	Chashnidel *et al.* (2007)
CP_Gr_high	%	15.5	16.4 =1.11/6.77 16.4 =1.10/6.69 16.4 =1.07/6.53 Crude protein intake, kg:	Akbaş *et al.* (2006)

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TABLE 10B.1-8
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF MIDDLE EAST IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	**Unit**	**Value in Table 10A.1-2 Table 10A.1-4**	**Reference value (± SD)**	**Reference source**
			1.11 1.10 1.07 0.03 (SEM)	
DC_C_Gr_low	%	55		Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)
DC_ C_Gr_high	%	63		Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)
Day weighted population_low	%	41/42/7/10	Of 100%: 41 – calves on forage 42 – growing animals 7 – mature males 10 – mature females	Turkish Statistical Institute (2017)
Day weighted population_high	%	36/42/12/10	Of 100%: 36 – calves on forage 42 – growing animals 12 – mature males 10 – mature females	Turkish Statistical Institute (2017)
Day weighted population	%	70/30_low_high	Of 100%: 35 – high-producing cattle 65 – low producing animals	Turkish Statistical Institute (2017)
Day weighted population	%	70/30_low_high	Of 100%: 42 – high-producing cattle 58 – low producing animals	Statistical Centre of Iran (2011) (Iran)

[1] DCA – dairy cattle, MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, Cmilk – Calves on milk, C – Calves on forage; _low and _high subscribt corresponds to low producing systems and high producing systems, accordingly

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
Weight_DCA_low	kg/hd	265	200-333	Singhal *et al.* (2005)
Weight_DCA_low	kg/hd	265	255 (200-365)	Pathak *et al.* (2013)
Weight_DCA_low	kg/hd	265	175	Dhingra *et al.* (2017)
Weight_DCA_low	kg/hd	265	310 (Gir breed) 295 (Rathi breed) 327 (Sahiwal breed) Population of cattle by breed, % of 25.06% indentified breeds: Hariana - 4.15 Gir - 3.38 (dairy) Sahiwal - 3.23 (dairy) Kankrej - 2.00 Kosali -1.61 Khillar - 1.33 Hallikar - 1.20 Malvi - 1.13 Bachaur - 1.02 Rathi - 0.82 (dairy) All others are dual purpose cattle	National Bureau of Animal Genetic Resources (2017) Department of Animal Husbandry (2013)
Weight_DCA_high	kg/hd	350	260.93±6.28 (crossbred Jersey)	Mahakur *et al.* (2017a)
Weight_DCA_high	kg/hd	350	300-352	Singhal *et al.* (2005)
Weight_DCA_high	kg/hd	350	393.75±15.51 392.92±16.15	Sirohi *et al.* (2012)
Weight_DCA_high	kg/hd	350	300 (210-500)	Pathak *et al.* (2013)
Weight_DCA_high	kg/hd	350	400±15	Sontakke *et al.* (2014)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
Weight_DCA_high	kg/hd	350	375.39±23.43	Saha *et al.* (2012)
Weight_DCA_high	kg/hd	350	275	Dhingra *et al.* (2017)
Weight_DCA_high	kg/hd	350	HF x Sahiwal, Male, Female 0m – 23.75±0.25, 25.01±0.24 3m – 76.25±3.14, 64.98±0.94 6m – 124.1±3.27, 110.83±1.87 9m – 205.46±5.04, 162,50±2.82 12m – 265.90±8.06, 213.49±3.45 15m – 307.12±8.45, 265.76 ±8.45 18m – 309.96±4.19 24m – 371.9±3.03 Jersey x Sahiwal: Male, Female 0m – 19.52±0.34, 19.58±0.37 3m – 60.95±3.59, 59.71±1.46 6m – 105.16±4.90, 106.19±2.92 9m – 165.27±7.44, 156.86±3.92 12m – 210.50±9.39, 198.69±4.52 15m – 256.70±7.63, 241.97±3.77 18m – 278.76±4.03 24m – 332.64±4.29	Khan (2011)
Feeding_DCA_low		Pasture	Pasture	Saha *et al.* (2004)
Feeding_DCA_low		Pasture	Stall fed/pasture	Pathak *et al.* (2013)
Feeding_DCA_low		Pasture	Pasture	Khan *et al.* (2012)
Feeding_DCA_high		Stall	Stall	Deshetti *et al.* (2016)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
Feeding_DCA_high		Stall	Stall fed/pasture	Pathak *et al.* (2013)
Feeding_DCA_high		Stall	Stall	Saha *et al.* (2004)
Milk_DCA_low	kg/hd/yr	4.6	4.8 (calculated value) Sahiwal: 1,400-2,500 kg	Landes *et al.* (2017)
Milk_DCA_low	kg/hd/yr		Gir – 1403 Rathi – 1931 Sahiwal – 1719	Birthal and Parthasarathy Rao (2002)
Milk_DCA_high	kg/hd/yr	7.1	8.4 (calculated value) Karan Swiss: 3,257 kg. Karan Fries: 3,700 kg Frieswal: 2,630-2,730 kg	Landes *et al.* (2017)
Milk_DCA_high	kg/hd/yr		Hayana x Friesian – 3196 Haryana x Brown Swiss – 2785 Haryana x Jersey – 2713 Gir x Jersey – 2713 Gir x Friesian – 2713 Red Sindhi x Friesian – 2326 Rathi x Jersey – 2802 Tharparkar x Friesian – 2600 Sahiwal x Friesian – 2357 Sahiwal x Jersey – 2660	Birthal and Parthasarathy Rao (2002)
Milk fat_DCA_low	%	4.2	4.23±0.18 - Sahiwal	Boro *et al.* (2016)
Milk fat_DCA_low	%	4.2	Sahiwal: 4.9	Landes *et al.* (2017)
Milk fat_DCA_high	%	4.0	Karan Swiss: 4.2-4.4 Karan Fries: 3.8-4.0 Frieswal: 3.5-4.5	Landes *et al.* (2017)

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TABLE 10B.1-9 **EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4**				
Parameter[1]	**Unit**	**Value in Table 10A.1-2 Table 10A.1-4**	**Reference value (±SD)**	**Reference source**
Milk fat_DCA_high	%	4.0	3.91±0.14 – Karan Fries 4.02±0.02 – Karan Fries	Sarkar *et al.* (2006)
Milk fat_DCA_high	%	4.0	3.91±0.14 – Karan Fries 4.02±0.02 – Karan Fries	Boro *et al.* (2016)
Milk fat_DCA_high	%	4.0	4.60 – Karan Fries 4.81 4.79 0.06 SEM	Sontakke *et al.* (2014)
Milk protein_DCA_low	%	3.7	3.60 ±0.03 - Sahiwal	Boro *et al.* (2016)
Milk protein_DCA_high	%	3.6	3.58 ±0.04 - Karan Fries	Sarkar *et al.* (2006)
Milk protein_DCA_high	%		2.98 - Karan Fries 2.93 2.92 0.03 SEM	Sontakke *et al.* (2014)
Pregnancy_DCA_low	%	40	40	Patra (2012)
Pregnancy_DCA_high	%	40	45-50	Pathak *et al.* (2013)
Pregnancy_DCA_high	%	50	50	Patra (2012)
Pregnancy_DCA_high	%	50	45-50	Pathak *et al.* (2013)
DC_DCA_low	%	55	55	Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)
DC_DCA_low	%	55	65(53-78)	Pathak *et al.* (2013)
DC_DCA_low	%	55	55	Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
DC_DCA_high	%	65	60	Calculated based on: FAO *et al.* (2014) Gerber *et al.* (2011)
DC_DCA_high	%	65	65(54-80)	Pathak *et al.* (2013)
DC_DCA_high	%	65	66.98 68.25 67.76 1.16 SEM	Sontakke *et al.* (2014)
DC_DCA_high	%	65	62.5	Patra (2012)
CP_DCA_low	%	14.0	CP intake, g/d: 1390±25.0 391±15.9 1625±21.8 1146±10.0 1930±24.1 1619 ±9.2	Assumed on: Garg *et al.* (2013) Tomar and Sharma (2002)
CP_DCA_high	%	15.5	15.0-15.5 (calculated values) CP intake, kg/100kg BW 0.44 0.44 0.45 SEM- 0.04	Sontakke *et al.* (2014)
CP_DCA_high	%	15.5	18 (14-22)	Yasothai (2014)
Day weighted population	%	77/23	77/23 (low/high)	Landes *et al.* (2017)
Day weighted population	%	77/23	77/23 (low/high)	Patra (2012)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
Weight_MM_low	kg/hd	290	200	Dhingra *et al.* (2017)
Weight_MM_low	kg/hd		499 – Hariana 525 – Kankrej 260 – Kosali 271 – Khilar 340 – Hallikar 499 – Malvi 270 – Bachaur Population of cattle by breed, % of 25.06% indentified breeds: Hariana - 4.15 Gir - 3.38 (dairy) Sahiwal - 3.23 (dairy) Kankrej - 2.00 Kosali -1.61 Khillar - 1.33 Hallikar - 1.20 Malvi - 1.13 Bachaur - 1.02 Rathi - 0.82 (dairy) All others are dual purpose cattle	National Bureau of Animal Genetic Resources (2017) Department of Animal Husbandry (2013)
Weight_MM_low	kg/hd	290	290 (260-320)	Singhal *et al.* (2005)
Weight_MM_high	kg/hd	330	300	Dhingra *et al.* (2017)
Weight_MM_high	kg/hd	330	280-355	Singhal *et al.* (2005)
Work_MM_low	hr/d	1.7	1.7	Patra (2012)
Feeding_all_low		Pasture	Paddock	Chowdhry (2007)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
Feeding_all_high		Stall	Stall	Saha *et al.* (2004)
CP_MM_low	%	10.0		FAO (2017)
CP_MM_high	%	10.0		FAO (2017)
DC_MM_low	%	55	55	Patra (2012)
DC_MM_high	%	62	62.5	Patra (2012)
Weight_MF_low	kg/hd	250	215.63±4.76 (Binjharpuri) 278.79±8.58 (graded Hariana)	Mahakur *et al.* (2017b)
Weight_MF_low	kg/hd	250	330	Chowdhry (2007)
Weight_MF_low	kg/hd	250	175	Dhingra *et al.* (2017)
Weight_MF_low	kg/hd	250	200-330	Singhal *et al.* (2005)
Weight_MF_low	kg/hd	250	325 – Hariana 343 – Kankrej 160 – Kosali 219 – Khilar 227 – Hallikar 340 – Malvi 243 – Bachaur Hariana - 4.15 Gir - 3.38 (dairy) Sahiwal - 3.23 (dairy) Kankrej - 2.00 Kosali -1.61 Khillar - 1.33 Hallikar - 1.20	National Bureau of Animal Genetic Resources (2017) Department of Animal Husbandry (2013)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
			Malvi - 1.13 Bachaur - 1.02 Rathi - 0.82 (dairy) All others are dual purpose cattle	
Weight_MF_high		300	Pakistan: Cattle crossbreeding for beef has also been attempted. Semen of Charolais, Simmental and Angus breeds has been used for experimental purposes. Recently, interest in producing beef crossbreds for special sacrificial occasions has risen. Yet, low price for beef in the local market discourages such adventures by common farmers. Pakistan: Since meat is obtained from the dairy animals, which are genetically modified for milk production, the quality characteristics of produced meat is not ideal. India: Cattle and buffalo are raised mainly for milk and provide meat as an adjunct. Ban on on cow slaughtering in India	Khan *et al.* (2008) Rahman *et al.* (2012) Birthal and Parthasarathy Rao (2002) Khan *et al.* (2016)
Weight_MF_high	kg/hd	300	275	Dhingra *et al.* (2017)
Weight_MF_high	kg/hd	300	400	Bradfield and Ismail (2012)
Weight_MF_high	kg/hd	300	Crosses with Dajal are grown to produce meat in Pakistan. <Local draught breeds can be potentially raised for beef production. The Dhanni, Dajal, and Lohani are basically draught type breeds>	Moaeen-ud-Din and Bilal (2017)
Weight_MF_MM_high	kg/hd	300	304.7±42.1 (SD) – Sahiwal 295.2±42.8 – Jersey 325.6±32.2 – Friesian 221.0±27.3 – Achai 320.4±38.3 – Cholistani 308.3±42.7 – Dajal	Kenyanjui *et al.* (2009)

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TABLE 10B.1-9 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4				
Parameter[1]	**Unit**	**Value in Table 10A.1-2 Table 10A.1-4**	**Reference value (±SD)**	**Reference source**
			315.7±40.1 – Dhanni 306.8±40.6 – Lohani 305.7±36.9 – Rojhani	
Weight_MF_MM_high	kg/hd		Male calves, 18-21 m.o. 226 – Sahiwal 254 – Dajal 245 – Cholistani 257 – Crossbred	Jabbar *et al.* (2009)
Pregnancy_MF_low	%	40	40	IPCC (2006)
Pregnancy_MF_high	%	40	40 – assumed the same rate as for low–producing mature females	
Milk_MF_low	%	1.7	623 –average of 940 600 997 688 572 530 540 384 603 598 400	Sodhi *et al.* (2007)
Milk_MF_low	%	1.7	Haryana -1137 Kankej – 1850 Red Sindhi – 1605 Tharparkar – 1659	Birthal and Parthasarathy Rao (2002)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
Milk_MF_low	%	1.7	Tharparkar: Rajasthan, Gujarat; lactation yield of 1,800-2,600 kg with 5.0 percent milk fat.	Birthal and Parthasarathy Rao (2002)
Milk_FM_high	%	2.5	900 (Milk Yield/305 days)	Bradfield and Ismail (2012)
Milk fat_MF_low	%	4.6	4.6–average of 4.3 5.5 4.9 4.2 4.3 3.9 4.6 4.9	Sodhi *et al.* (2007)
Milk fat_MF_high	%	4.0	The same as for low-producing dairy cattle	
Milk protein_FM_low	%	3.6	3.7	da Cunha *et al.* (2010)
Milk protein_FM_high	%	3.6	The same as for low-producing dairy cattle	
CP_MF_low	%	10	10	Chowdhry (2007)
CP_MF_high	%	13		FAO (2017)
DC_FM_low	%	55	55	Patra (2012)
DC_FM_high	%	62.5	62.5	Patra (2012)
Weight_C_low	kg/hd	65	40 (below 1yr)	Dhingra *et al.* (2017)
Weight_C_low	kg/hd	65	65-80	Singhal *et al.* (2005)
Weight_C_low	kg/hd	65	0d:14 kg	Kayastha *et al.* (2008)
Weight_C_low	kg/hd	65	133 (10-18m)	Sharma *et al.* (2014)
Weight_C_low	kg/hd	65	0d: 20 kg	Manoj (2009)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
			6m: 95 kg 12m: 150 kg 18m: 220 kg 30m: 300 kg	
Weight_C_low	kg/hd	65	0d:15kg 12m: 63kg 18m: 83kg 24m: 105kg	Nahar *et al.* (2016)
Weight_C_low	kg/hd	65	0-3m: 39 4-12m: 82 13-24m:218 25-36m:175	Thombre *et al.* (2015)
Weight_C_low	kg/hd	65	0-3m: 30kg 4-12m: 115kg 13-24m: 230 kg 25-36m: 234 kg	Sambhaji (2013)
Weight_C_low	kg/hd	65	6m: 90 kg 12m: 140 kg	Yadava (2009)
Weight_C_low	kg/hd	65	14m: 96 kg 18m:150 kg	Roy *et al.* (2016)
Weight_C_low	kg/hd		0m; Male, female calves: 23.3, 21.7 – Hariana 22.4, 20.7 – Sahiwal 14.5, 13.2 – Kosali 25.35, 21.9 – Khilar 21.3, 20.2 – Hallikar 21, 19 – Malvi	National Bureau of Animal Genetic Resources (2017) Department of Animal Husbandry (2013)

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Table 10B.1-9 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other Cattle) of Indian subcontinent in Table 10A.1-2 and Table 10A.1-4**				
Parameter[1]	**Unit**	**Value in Table 10A.1-2 Table 10A.1-4**	**Reference value (±SD)**	**Reference source**
			19.7, 18.8 – Bachaur 19.1, 18.9 – Rathi	
Weight_C_Gr_low_high	kg/hd		Birth weight: 18.2±0.18 (SE) – Dhani 16.4±0.21 – Lohani 18.2±0.21 – Red Sindi 20.0±0.37 – Cholistani 19.3±0.49 – Dajal 20.0 ±0.18 – Grossbred Weaning weight: 78.6±1.38 – Dhani 64.0±1.59 – Lohani 70.5±1.58 – Red Sindi 70.7±2.77 – Cholistani 91.3±3.73 – Dajal 69.4±1.33 – Grossbred Yearling weight: 121.4±2.21 – Dhani 99.8±2.55 – Lohani 112.9±2.53 – Red Sindi 111.7±4.43 – Cholistani 148.5±5.97 – Dajal 113.2±2.12 – Grossbred Pre-weaning growth rate: 335.4±7.54 – Dhani 264.2±8.70 – Lohani 290.3±8.63 – Red Sindi	Moaeen-ud-Din and Bilal (2017)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
			281.6±15.12 – Cholistani 399.3±20.38 – Dajal 274.8±7.24 – Grossbred Post-weaning growth rate: 238.3±9.13 – Dhani 198.9±10.54 – Lohani 235.8±10.46 – Red Sindi 227.6±18.31 – Cholistani 317.9±24.68 – Dajal 243.1±8.77 – Grossbred	
Weight gain_C_low	kg/hd/d	0.22	Calculated value based on weight range from 20 to 100 kg	
Weight_Gr_low	kg/hd	140	140 (1-3yr)	Dhingra *et al.* (2017)
Weight_Gr_low	kg/hd	140	136-157 (1-3yr)	Singhal *et al.* (2005)
Weight gain_Gr_low	kg/hd/d	0.15	0.15	Singhal *et al.* (2005)
Weight_C_high	kg/hd	105	60 (below 1yr)	Dhingra *et al.* (2017)
Weight_C_high	kg/hd	105	70-89	Singhal *et al.* (2005)
Weight_C_high	kg/hd	105	0m: 29 kg 3m: 63 kg 6m: 98 kg 12m: 154 kg	Rahman *et al.* (2015)
Weight_C_high	kg/hd	105	0m: 25kg 6m: 127, 74kg 12m: 202, 183, 151kg 18m: 254, 307 kg	Yadava (2009)
Weight gain_C_high	kg/hd/d	0.41	0.41	Yadava (2009)

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Table 10B.1-9 **Explanatory text and references sources used for development of new parameters for Cattle (Dairy and Other Cattle) of Indian subcontinent in Table 10A.1-2 and Table 10A.1-4**				
Parameter[1]	**Unit**	**Value in Table 10A.1-2 Table 10A.1-4**	**Reference value (±SD)**	**Reference source**
Weight_Gr_high	kg/hd	180	180 (1-3 yr)	Dhingra *et al.* (2017)
Weight_Gr_high	kg/hd	180	154-195 (1-3yr) 165-194	Singhal *et al.* (2005)
Weight gain_Gr_high	kg/hd/d	0.33	0.33	Yadava (2009)
Weight gain_Gr_high	kg/hd/d	0.33	892.4 ± 56 (between 12 – 16 m)	Ahmad *et al.* (2013)
CP_C_Gr_low	%	10	10	FAO (2017)
CP_C_low_high	%	10	12	Ahmad *et al.* (2013)
CP_C_Gr_high	%	13	15	Roy *et al.* (2016)
CP_C_Gr_high	%	13	13.7	Ahmad *et al.* (2004)
DC_Gr_C_low	%	55		FAO (2017)
DC_Gr_C_high	%	60	60	Roy *et al.* (2016)
DC_Gr_C_high	%	60	62.5	Patra (2012)
DC_Gr_C_high		60	70	Ahmad *et al.* (2004)
Day weighted population	%		Calculated values: Of 100%: Mature Males – 2 Draft bullocks – 50 Mature Females – 24 Growing/Replacement – 13 Calves on forage – 11	Patra (2012)
Day weighted population	%		Calculated values: Of 100%: Mature Males – 11 Mature Females – 9	Patra (2012)

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TABLE 10B.1-9
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR CATTLE (DAIRY AND OTHER CATTLE) OF INDIAN SUBCONTINENT IN TABLE 10A.1-2 AND TABLE 10A.1-4

Parameter[1]	Unit	Value in Table 10A.1-2 Table 10A.1-4	Reference value (±SD)	Reference source
			Growing/Replacement – 35 Calves on forage – 45	

[1] DCA – dairy cattle, MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, Cmilk – Calves on milk, C – Calves on forage; _low and _high subscribt corresponds to low producing systems and high producing systems, accordingly

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TABLE 10B.1-10
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF WESTERN EUROPE IN TABLE 10A.1-5

Parameter [1]	Unit	Value in Table 10A.1-5	Reference value (±SD)	Reference source
Weight_MF	kg/hd	615	600 (Italy)	FAO (2005)
Weight_MF	kg/hd	615	630	Condor *et al.* (2008)
Weight_MF	kg/hd	615	450 - 650	FAO (2005)
Weight_MF	kg/hd	615	700±11 (non-lactating) 597±20 (lactating) 615±14 (lactating combined)	Neglia *et al.* (2014)
Weight_MF	kg/hd	615	at the first calving 572±12 567±13	Sabia *et al.* (2014)
Weight_MM	kg/hd	700	600 - 800 (Italy)	FAO (2005)
Weight_MM	kg/hd	700	688 (42 m)	Gonzalez Gonzalez (2011)
Weight_Gr	kg/hd	420	405 kg	Condor *et al.* (2008)
Weight_Gr	kg/hd	420	Italy: required male and female young buffalos to be slaughtered at an age of 647 days. Weight at slaughter was 549 kg on average.	Borghese (2013)
Weight_Gr	kg/hd	420	Germany: The buffalo bulls were commonly slaughtered at a weight between 540 and 760 kg	Borghese (2013)
Weight_Gr	kg/hd	420	Greece: The age at slaughter for young stock is 15-17 months and the weight at slaughter is 350-400 kg.	Borghese (2013)
Weight_Gr	kg/hd	420	Slaughtered weight: 550 – Italy (348 th heads) 650 – Germany (5 th heads) 375 – Greece (1.7 th heads)	Borghese (2013) FAO (2017a)
Weight_Gr	kg/hd	420	Bulls 320 kg - 6-12 m 410 – 4-16 m 612 – 18-30 m 685 – 30-42 m	Gonzalez Gonzalez (2011)
Weight_Gr	kg/hd	420	100 kg – 100 d 290 kg – 365 d 500 kg – 600–700 d	Zicarelli *et al.* (2007)
Weight_Gr	kg/hd	420	343±26.5 355±13.8	Gonzalez Gonzalez (2011)
Weight_Gr	kg/hd	420	223 d: 136±40 132±40 372±3 410±3 kg – 630 d	Sabia *et al.* (2014)
Weight_Gr	kg/hd	420	Age at first calving: 28-32 m	FAO (2005)
Weight_Gr	kg/hd	420	Puberty weight: 372 kg (675 d)	Sabia *et al.* (2014)

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TABLE 10B.1-10
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF WESTERN EUROPE IN TABLE 10A.1-5

Parameter [1]	Unit	Value in Table 10A.1-5	Reference value (±SD)	Reference source
			402 kg (667 d) 375 kg (610 d) 462 kg (599 d)	
Weight_Gr	kg/hd	420	Weight range: 290–550 kg/hd	
Weight_Gr	kg/hd	420	400 kg (22 m)	Neglia *et al.* (2014)
Weight_C	kg/hd	170	Germany: 44.7 kg for male buffalo calves and 39.5 kg for female 3 m - 147.0 kg for male calves and 132.4 kg for female calves. 9 m - 351.2 kg (male calves) and 305.7 kg for female calves	Borghese (2013)
Weight_C	kg/hd	170	45-48 – birth weight	Gonzalez Gonzalez (2011)
Weight_C	kg/hd	170	221 kg – 27 weeks (190 d)	Gonzalez Gonzalez (2011)
Weight_C	kg/hd	170	130 kg	Condor et al,. 2008
Weight_C	kg/hd	170	111.0±6.9 116.7±7.6	Gonzalez Gonzalez (2011)
Weight_C	kg/hd	170	Weight range: 43 – 290 (270 kg – replacement heifers and 350 – bulls)	
Weight_gain_MF		0		IPCC (2006)
Weight_gain_MM		0		IPCC (2006)
Weight gain_Gr	kg/hd/d	0.53	0.58 – average of 320 d – 0.6 (0.3-0.85) 374 d – 0.6 (0.2-0.7) 596 d – 0.53 (0.6-0.95)	Zicarelli *et al.* (2007)
Weight gain_Gr		0.53	0.5 (18-30m)	Gonzalez Gonzalez (2011)
Weight gain_Gr		0.53	0.5	Sabia *et al.* (2014)
Weight_gain_C	kg/hd/d	0.68	150 d – 0.8 kg/d (0.6-0.9 kg/d) 220 d – 0.67 (0.45-0.9) 302d – 0.65 (0.45-0.75)	Zicarelli *et al.* (2007)
Weight_gain_C	kg/hd/d	0.68	Calculated based on weight range values	
Weight_gain_C	kg/hd/d	0.68	0.6 (40 kg birth weigh)	Condor *et al.* (2008)
Feeding_MF			Loose in paddock	FAO (2005) Borghese (2013)
Feeding_Gr			Loose in paddocks	Borghese (2013)
Feeding_C			Usually bovine calves are fed milk up to 55-60 days; starting from 30-40 days, the amount of milk is halved and the calves are fed once a day or with diluted milk, in order to encourage the intake of solids	Gonzalez Gonzalez (2011)
Feeding_C			The calves are normally taken off the mothers, they receive colostrum in the biberon (particular bottle) and after reconstituted milk, in single cage 1 or 2 months after birth	Borghese (2013)
Milk_MF	kg/hd/d	2.8	2.8 (Italy, Greece)	Fao (2017b) Accessed on

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TABLE 10B.1-10
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF WESTERN EUROPE IN TABLE 10A.1-5

Parameter [1]	Unit	Value in Table 10A.1-5	Reference value (±SD)	Reference source
				27.11.2017
Milk_fat_MF	%	8.0	8.24	Borghese (2013)
Milk_fat_MF	%	8.0	7.7 – 8.1	Condor *et al.* (2008)
Milk_protein_MF	%	4.6	4.66 %	Borghese (2013)
Milk_protein_MF	%	4.6	8.7 =193.7/2232 9.2 =237.7/2577 Germany: Chursdorf herd over a 305-day lactation period, milk yield was on average 2,232 kg in the first lactation and 2,577 kg in the second lactation. Fat yield was 193.7 kg in the first lactation and 237.7 kg in the second lactation. Protein yield was on average 101.0 kg and 123.7 kg for the first and second lactation respectively. There was found a big variation for these traits 4.5 =101.0/2232 4.8 =123.7/2577	Borghese (2013)
Work_MM			Greece: buffaloes are not used for draught, but only for milk and meat production	Borghese (2013)
Work_MM			Italy: intensive system	Borghese (2013)
Pregnancy rate_MF	%	87	85-89	Condor *et al.* (2008)
DC_MF	%	65	65	Condor *et al.* (2008)
DC_MF	%	65	51.4±5.0 65.6±5.6 56.8±5.1 58.0±2.8	Neglia *et al.* (2014)
DC_MM	%	65	The same as for mature females	
DC_Gr	%	65	61-68	Zicarelli *et al.* (2007)
DC_Gr_C	%	65	OM digestibility: 65±1.3 (free-ranging) 72±1.3	Sabia *et al.* (2014)
CP_MF	%	15.0	14-16	Borghese (2013)
CP_MF		15.0	15.4 (lactating) N intake: 119±5 (non-lactating) 312±30 332±71 314±29 275±29	Neglia *et al.* (2014)
CP_MM	%	14.0	Assumed: DC value is the same as for growing animals	
CP_Gr	%	14.0	15.0	Gonzalez Gonzalez (2011)
CP_Gr	%	14.0	14.0	Zicarelli *et al.* (2007)

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TABLE 10B.1-10
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF WESTERN EUROPE IN TABLE 10A.1-5

Parameter [1]	Unit	Value in Table 10A.1-5	Reference value (±SD)	Reference source
CP_Gr_C	%	14.0	10.8, 14.2, 18.0, 15.3 CP intake, kg: 261.1±14.5 244.1±7.2	Sabia *et al.* (2014)
Day weighted population mix			13 – Calves 25 - Growing 59 – M-Females 3 – M-Males	Gonzalez Gonzalez (2011)

[1]MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, C – Calves

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TABLE 10B.1-11
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF EASTERN EUROPE IN TABLE 10A.1-5

Parameter [1]	Unit	Value in Table 10A.1-5	Reference value	Reference source
Weight_MF	kg/hd	550	545 (Romania)	Borghese (2013)
Weight_MF	kg/hd	550	600 (Bulgaria)	Borghese (2013)
Weight_MF	kg/hd	550	550–600	Peeva *et al.* (2013)
Weight_MF	kg/hd	550	480 – 550 (3-6 yr)	Atanasov *et al.* (2012)
Weight_MM	kg/hd	650	665 (Romania)	Borghese (2013)
Weight_MM	kg/hd	650	800 (Bulgaria)	Borghese (2013)
Weight_MM	kg/hd	650	420 – live weight of breeding bulls	Peeva *et al.* (2011)
Weight_MM	kg/hd	650	800 – of adult bulls	Peeva *et al.* (2011)
Weight_MM	kg/hd	650	700 – 900	Nikolov (2011)
Weight_Gr	kg/hd	350	The most effective slaughter body weight is 400 kg (Bulgaria)	Borghese (2013)
Weight_Gr	kg/hd	350	400 kg , 16m – slaughtered weight (Bulgaria)	FAO (2005)
Weight_Gr	kg/hd	350	720d – age at first conception	Peeva *et al.* (2011)
Weight_Gr	kg/hd	350	390 – 400 – fist insemination – 22-24 m	Peeva *et al.* (2013)
Weight_Gr	kg/hd	350	Weight range: 275 - 420	
Weight_C	kg/hd	155	Male: 6m – 150 12m – 280 18m – 360 24m – 470 36m – 600 Female: 6m – 140 12m – 270 18m – 350 24m – 400 36m – 550	Peeva *et al.* (2013)
Weight_C	kg/hd	155	30 – 40 – birth weight	Nikolov (2011)
Weight_C	kg/hd	155	Weight range: 35 - 275	
Weight_gain_MF	kg/hd/d	0		IPCC (2006)
Weight_gain_MM	kg/hd/d	0		IPCC (2006)
Weight gain_Gr	kg/hd/d	0.55	0.55 – preconception daily gain of heifers	Peeva *et al.* (2011)
Weight gain_Gr	kg/hd/d	0.55	0.7 – of production tested bulls	Peeva *et al.* (2011)
Weight_gain_C	kg/hd/d	0.66	0.6 – of female calves until weaning	Peeva *et al.* (2011)
Weight_gain_C	kg/hd/d	0.66	Male: 6m – 650 12m – 680 18m – 600 24m – 600	Peeva *et al.* (2013)

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TABLE 10B.1-11
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF EASTERN EUROPE IN TABLE 10A.1-5

Parameter [1]	Unit	Value in Table 10A.1-5	Reference value	Reference source
			36m – 520 Female: 6m – 600 12m – 650 18m – 580 24m – 300 36m – 250	
Feeding_MF		Pasture	Tied (Romania) The animals are housed and tied during the winter due to the unfavourable weather conditions and fed with hay, bran, concentrates, silage, grazing on pasture in the warm season	Borghese (2013)
Feeding_MF		Pasture	Buffaloes are still used today on small private farms for draught and the goal of the selection process is to create a dual-purpose type of animal (milk and meat), realizing good daily gains (600-800 g), in order to slaughter the males at 22 months with 460 kg of live weight. At present the calves are also fattened to be slaughtered at four months (100 kg of live weight).	Borghese (2013)
Feeding_MF		Pasture	Milking buffaloes are kept in closed sheds and tied up. During winter, they are allowed outside in paddocks for part of the day, in summer they are allowed to graze.	Borghese (2013)
Feeding_MM		Pasture	Tied - winter (Bulgaria) Pasture - summer Buffaloes were raised on the State farms, kept tied in closed sheds, machine milked and fed maize silage, alfalfa or grass hay, straw and concentrates. The animals were manage in separate groups according to physiological conditions: suckling calves, females four to twelve months, heifers, pregnant heifers, dry cows and milking cows.	Borghese (2013)
Feeding_Gr		Pasture	Assumed: the same feeding situation as for mature females	
Feeding_C		Pasture	Assumed: the same feeding situation as for mature females	
Milk_MF	kg/hd/yr	4.0	4.0	Faostat (2017)
Milk_fat_MF	%	7.5	fat % - 5.2 to 6.2% protein - from 3.5 to 3.9% (Romania)	Borghese (2013)
Milk_fat_MF	%	7.5	7.55	Peeva *et al.* (2011)
Milk_fat_MF	%	7.5	7.0 - minimum	Peeva *et al.* (2013)
Milk_fat_MF	%	7.5	7-9	Nikolov (2011)
Milk_protein_MF	%	4.3	4.0 - minimum	Peeva *et al.* (2013)
Milk_protein_MF	%	4.3	4.6	Nikolov (2011)

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TABLE 10B.1-11
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF EASTERN EUROPE IN TABLE 10A.1-5

Parameter [1]	Unit	Value in Table 10A.1-5	Reference value	Reference source
Pregnancy rate_MF	%		85 (fertility)	
DC_MF	%	71	50/50 – forage/concentrate	Atanasov *et al.* (2012)
DC_MM	%	71	Assumed: the same values as for other categories of buffaloes	
DC_Gr	%	71	71 - 77	Dimov and Tzankova (2003)
DC_C	%	71	71 - 79	Tzankova and Dimov (2003)
CP_MF	%	13.0	12.5	Atanasov *et al.* (2012)
CP_MM	%	13.0	Assumed: the same as for mature females	
CP_C_Gr	%	13.0	12.2-13.7	Tzankova and Dimov (2003)
Day weighted population mix	%		8 – Mature males 62 – Mature females 14 – Growing 16 - Calves	MZH (2016) MZH (2017)

[1] MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, C – Calves

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TABLE 10B.1-12 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF LATIN AMERICA IN TABLE 10A.5				
Parameter [1]	**Unit**	**Value in Table 10A.5**	**Reference value [2]**	**Reference source**
Weight_MF	kg	550	497,16; 564,50; 500 (dairy); 550 527,50 (Murrah); 501,62 (Mediterranean) 400-650	Andrighetto *et al.* (2005) Cardozo *et al.* (2017) Andrade and Garcia (2005) Rezende *et al.* (2017) Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Weight_MM	kg	650	550 (beef) 600 (beef) 750 600-700	Andrighetto *et al.* (2005) dos Santos *et al.* (2016) Andrade and Garcia (2005) Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Weigh_C	kg	90	80 (dairy buffalo) 90 (beef buffalo)	Expert judgement based on personnal communication (Cristiana Andrighetto, UNESP-Dracena)
Weight gain_C	kg/day	0.28	0.22- 0.33 0.35	Santos *et al.* (2014) Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Weight gain_Gr	kg/day	0.4	0.4	Cardoso *et al.* (1997)
Weight gain_Gr	kg/day	0.40	0.22 – 0.33 0.35	Santos *et al.* (2014) Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Weight gain_Gr	kg/day	0.40	0.35	Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Weight gain_C	kg/day	0.40	0.5	Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Feeding		Pasture/Range	Pasture/Range	Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Milk yield_MF	kg/hd/d	4.2	4.2 4.9 (average of: 4.66, 4.52, 4.46, 6.44, 5.10, 3.53, 6.1, 4.6)	Andrighetto *et al.* (2005); Tonhati *et al.* (2000); Macedo *et al.* (2001); Andrighetto *et al.* (2005); Gonçalves (2008); Rassi *et al.* (2009); Tonhati *et al.* (2009); Fruchi and (2009);
Milk yield_MF	kg/hd/d	4.2	3-5	Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Milk yield_MF	kg/hd/d	4.2	7.5 10	Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental) Andrighetto *et al.* (2005)
Milk fat _MF	%	7.1	7.1 (average estimated on different references)	Verruma and Salgado (1994) Tonhati (2001); Macedo *et al.* (2001); Jorge *et al.* (2002); Mesquita *et al.* (2002); Andrighetto *et al.* (2003);

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Table 10B.1-12 Explanatory text and references sources used for development of new parameters for Buffaloes of Latin America in Table 10A.5				
Parameter [1]	**Unit**	**Value in Table 10A.5**	**Reference value [2]**	**Reference source**
				Coelho *et al.* (2004); Oliveira *et al.* (2009); Lopes (2009)
Milk protein _MF	%	4.3	4.3 (average estimated on different references) 4.24	Tonhati (2000); Macedo *et al.* (2001); Jorge *et al.* (2002); Jorge (2005); Mesquita *et al.* (2002); Andrighetto *et al.* (2005); Coelho *et al.* (2004); Oliveira *et al.* (2009); Lopes (2009); Lima *et al.* (2014)
Work	hr/day	0	0	Expert judgement, with consideration of consulted literature
Pregnancy_MF	%	62	62	Expert judgement, with consideration of Cardozo *et al.* (2017)
Pregnancy_MF	%	62	<65	Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
DC_all	%	60	62 60 58.2	Maeda *et al.* (2007); Soares (2011) Zeoula *et al.* (2014) Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
CP_all	%	11	12 10.2 12 13.04	Expert judgement, with consideration of Machado Filho *et al.* (2007); Restle (2003); Maeda *et al.* (2007); Rodrigues *et al.* (2001)
CP_all	%	11	11 (15 for females)	Expert judgement, based on personal communication (Dr. José Ribamar Felipe Marques – Embrapa Amazônia Oriental)
Day weighted population	%	4 - adult male 40 - adult female 26 - growing 30 - calves	4 - adult male 40 - adult female 26 - growing 30 - calves 5 - male 50 - adult female 19 - growing 26 - calves	Expert judgement based on literature and personal communication dos Santos *et al.* (2016)
[1] MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, C – Calves [2] Murrah and its crosses and Mediterranean breeds are the most numerous in Brazil, according to Zava (2013)				

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
Vietnam	MF_weight, kg Pregnancy_MF,%	various provinces: 512 ± 14.4 447 ± 35.0 424 ± 33.6 505 ± 21.1 Age for the first calving 5.01 ± 0.13_5.30 ± 0.18_4.78 ± 0.22_5.17 ± 0.11 Working after calving (month) 3.20 ± 0.24_2.72 ± 0.13_4.47 ± 0.24_4.39 ±1.30 Calving (%): 1 calf/ 1 year _37.6_37.5_53.0_47.6 2 calf/ 3 year_ 42.9_41.7_32.7_20.4 1 calf/>2 year_ 19.5_20.8_14.3_32.0	Nha *et al.* (2008)
Vietnam	MF_weight, kg	various provinces Weight, kg - 458_434_417_358 First conception occurs at an average body weight of 250 to 275 kg, which is usually attained at 24 to 36 months of age. In Vietnam, female buffaloes attain puberty at around 3 years old. Their first calving is at 4 to 5 years of age, and they continue to have calves to the 18 years old.	Tuyen (2009)
Vietnam	MF_weight, kg C_weight,%	cows 6-8 years of age with body weight of about 350 kg weight, kg at birth – 23.2-25.8 1mo – 34.2-41.6 2mo – 46.5-55.9 3mo – 57.3-70.0	Sanh (2007)
Vietnam	MM_weight, kg Working_MM, hr/day	various provinces: 556 ± 10.6 525 ± 10.8 487 ± 12.6 573 ± 8.15 Working hours/day - 7.17 ± 0.19_7.02 ± 0.21_5.78 ± 0.19_6.86 ± 0.17 Working months/year - 3.27 ± 0.27_4.41 ± 0.17_3.37 ± 0.21_4.93 ± 0.16	Nha *et al.* (2008)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
Vietnam	MM_weight, kg Feeding	various provinces Mature males: 494_464_494_428 In Vietnam, farmers have a long traditional and experiences of buffalo raising but techniques are mostly primitive. Management practices are based on extensive systems and buffaloes are freely grazed on natural grasses land, forests, roadsides, canal banks, rice field after harvesting and dikes, etc... They are also fed with rice straw or other crop residues in the dry season and working season.	Tuyen (2009)
Indonesia	MF_weight, kg Gr_weight, kg C_weight,kg	Weight, kg Caracalf - 104.63±38.55 Caraheifer - 343.06±47.74 Caracow - 446.05±45.06	Djaja (2011)
China	Gr_weight, kg C_weight,kg	crosses (the data retrieved from a figure) Birth weight, kg – 40 kg 12mo – 300 kg	Qin *et al.* (2013)
Philippines	Gr_weight, kg C_weight,kg MF_weight, kg MM_weight, kg	Age_Philippine Carabao_Bulgarian Murrah_US Murrah Birth – 32.19_34.70_35.10 1yr – 176.20_232.5_225.6 2yr – 275.15_360.5_363.57 3yr – 360.55_435.75_469.58	
China	Working, hr/day	Field preparation with the help of buffaloes is carried out between January and June on LB farms and between March and June on RB farms. During the field preparation season farmers keep their buffaloes close to the farm or on nearby fields, while the rest of the year they require feeding either through cut and carry, or guidance to proper grazing grounds, mostly in forest areas. Annual working time of a buffalo on different types of crop fields Daily working time (h) – 1.0±0.5 (Livestock-corn based) - 0.3±0.2 (Rubber based) Buffalo keeping households kept 2.5 ±1.80 (n=84) buffaloes with an average herd structure of 47% male and 53%female animals, 23%being younger than 2 years (Table 2). The majority (61.3%) of herds consisted of less than 3 animals.	Riedel *et al.* (2012)
China	MF_milk yield, kg/hd/d MF_weight, kg	Milk yield, kg L – 1092.8±207.44	Cruz, 2012 Cruz (2010)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
	MM_weight, kg Gr_weight, kg C_weight,kg	M – 2132.9±578.3 N – 2262.1±663.0 MLF1 – 1233.3±529.7 MLF2 – 1585.5±620.6 NLF1 – 2041.2±540.9 NLF2 – 2267.6±774.8 NMLF2 – 2294.6±772.1 L = Chinese Swamp buffalo (this represent selected animals); M = Murrah; N = Nili Ravi; MLF1 = F1 cross Murrah x Swamp; MLF2 = F1 Murrah (Backcross); NLF1 = cross Nili Ravi x Swamp; NLF2 = F1 x Nili Ravi (Backcross); NMLF2 = (M x L) crossbred x Nili (triplecross) Age_Swamp Buffalo_F1 Cross(50 : 50) with rivertype_Difference(%) Birth_31.4_31.1_1.0 6 mos_100.3_110.4 _10.1 12 mos _132.5_170.9_29.0 18 mos _196.6_ 244.5_ 24.4 24 mos _213.9_ 255.9_ 19.6 30 mos_ 225.9_ 296.3_ 31.2 36 mos_ 260.9_ 333.6_27.9	
China		305d milk yield, kg 1997 – 864.8±42.0 1998 – 934.2±38.7 1999 – 916.5±41.1 2000 – 944.9±37.9 2001 – 978.4±36.9 2002 – 983.2±34.8	Flores *et al.* (2007)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		2003 – 1068.9±30.3 2004 – 1121.4±31.3 2005 – 1224.0±32.3 2006 – 1244.3±43.3	
Asia	MF_milk yield, kg/hd/d	Breed_milk fat_milk protein Murrah - 6.57±1.21_4.27±0.43 Nili-Ravi – 6.53±1.28_4.16±0.20 Crossbreed buffaloes – 7.56±0.90_4.75±0.53 Crossbreed buffaloes – 7.90±1.30_5.10±0.45 Crossbreed buffaloes – 8.81±1.89_5.23±0.45 Average – 7.59±1.31_4.86±0.44	Han *et al.* (2007)
Indonesia	MM_weight, kg C_weight,kg	average birth weight is 32 kg, carcass percentage is 44%, and slaughtered weight is 300 - 700 kg with age more than 6 years. For funeral ceremony, buffalo is slaughtered at the age of more than 2 years The female water buffaloes reach their sexual maturity at the age of 3 years and age of first calving is 4-5 years.	Batosarnma (2006)
Indonesia	Feeding	Low land – Grazing in community pasture, rice field, under coconut tree High land - Grazing in back yard, rice field, cut and carry	Kusnadi and Praharani (2009)
China	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg	Items_Binhu_Fulin_Guizhou_Murrah_Nili-Ravi_Murrah crossbred_Nili-Ravi crossbred_Crossbred Weight gain at 12 months, (kg per day) male 0.71_0.63_0.62_0.65_0.64_0.63_0.45_0.78 female 0.62_0.60_0.55_ 0.55_0.6_0.51_0.61_0.72 Weight gain at 24 months, (kg per day) male 0.46_0.38_0.43_0.42 _0.45_0.6 female 0.43_0.36_0.48 _0.49_0.58_0.58 Weight of adults (kg) male 547.8_491.7_487.1_888.0_821.1_473.2_922.5 female 485.0_446.5_428.9_ 622.4_659.8_486.7 _642.6_662.1 Meat performance comparison of buffalo bulls.	Qingkun *et al.* (2002)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	**Parameter** [1]	**Reference value (±SD)**	**Reference source**
		Age (months)_Weight before slaughter (kg) Native 19–21_216.0 Murrah crossbred F1 – 24_447 Nili-Ravi crossbred F1 - 18 _398.0 Nili-Ravi crossbred F2 – 26_361.0 Triple-crossbred 18–24_440.7 Triple-crossbred F1 - 19–27 _313.3 Murrah 19–24_292.0 Nili-Ravi 19–24_436.7	
Indonesia	Day weighted population mix,%	Distribution of buffalo by age,% Weaning – 18.91 Yearling – 25.47 Mature – 55.62	Djajanegara and Diwyanto (2002)
Lao PDR	Day weighted population mix,% MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg	the structure of buffalo herd, heads Total male population – 534,500 Total female population – 493,500 Male with >3 year old – 270,600 Female with >3 year old – 271,400 Male 2–3 year old – 160,300 Female 2–3 year old – 148,000 Male 1–2 year old – 62,100 Female 1–2 year old – 48,000 Male 1 year old – 41,500 Female 1 year old – 26,100 Total 1,028,000 Weight at birth, kg - 24–32 Weight at weaning (8 months), kg - 90–120 Weight of cows - 250–340	Phomsouvanh (2002)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Weight of bullocks at maturity - 300–400 Age at first calving, yr - 4.50–5.50 Post weaning daily gain, kg - 0.24–0.30	
Sri Lanka	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg MF_milk yield, kg/hd/d	Indicator_Crossbred buffalo_Local breeds Age at 1st heat (months) 24–30_24–30 Milk yield/day (litres) 5–6_ 2 Length of lactation (days) 280_155 Lactation yield (1000 litres) 1.8–2.1_0.36 Milk fat % 6–8_7–9 Birth weight (kg) 25–30_20–25 Weight at 1st year (kg) 200–240_160–200 Daily gain (g) 450–600_400–500 Mature body weight 500–600_400–450	Phomsouvanh (2002)
Sri Lanka	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg MF_milk yield, kg/hd/d	buffalo females Indicator_Indian crossbreeds_Local breeds Age at 1st heat (months) 24–30_24–30 Milk yield per day (litres) 6–7_2 Length of lactation (days) 300_180 Lactation yield (litres) 1800–2100_360 Birth weight (kg) 25–30_20–25 Weight at 1 year old (kg) 200–240_160–200 Daily gain (g) 450–600_400–500 Mature body weight (kg) 500–600_ 400–500	Somapala (2002)
Indonesia	Pregnancy_MF,%	Calving rate,%: Year-1 – 38.3, 47.9 Year-2 – 48.9, 50.0 Year-3 – 51.1, 52.2 Body weight of cows, kg: 322±5.6, 297±5.9, 348±5.6, 304±6.0	Prabowo (2012)

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TABLE 10B.1-13 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5			
Country of Asian region	**Parameter [1]**	**Reference value (±SD)**	**Reference source**
China	Milk fat_MF,% Milk protein_MF, %	Province_fat,%_protein,% Guangdong - 11.62_ 5.18 Guangdong - 9.14 _5.49 Guangdong - 10.80_ 5.26 Wenzhou - 9.50_ 4.50 Shanghai - 7.40 _5.95 Guangxi - 11.67_ 5.56	Huai and Jun (1995)
China	MM_weight, kg	Swamp buffalo is preferred for draught power in rice cultivation weight, kg, mature males: Nepal _Neapalese - 450 Thailand _Thai - 343 Sri-Lanka : Lankan - 306 The Philippines -- Carabao - 420-500 Lao - Khouay - 400 Indonesia, Sumbawa - 350 100 Tedong - 400 Cambodia: Krabey-beng - 400 Krabey-leu - 350 Malaysia, Kerbau-Sawah - 363 China Binhu - 473 Dechang - 490 Dehong - 500 Dongliu - 500 Enshi Mountainous - 422.4 Fuan - 456 Fuling - 446.5 Fuzhong - 415 Guizhou - 411	Berthouly (2008)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Haizi - 496 Jianghan - 519 Shanghai - 616 Shannan - 399 Taiwan - 389 Wenzhou - 496 Xilin Swamp - 400 Xinfeng Mountainous - 344 Xinlong - 457 Xinyang - 490 Yanjin – 393	
Asia	MF_weight, kg MF_milk yield, kg/hd/d Milk fat_MF,% Milk protein_MF, %	Production of some of the dairy buffalo breeds Breed_Weight at maturity, kg_Age at first calving, m_Milk per lactation, kg_Fat,% Murrah_461 (446-567)_43.8_1805(1276-2272)_6.1-8.3 Nili-Ravi_533 (454-567)_41.2_1833(1585-2164)_6.5 Surti_319-413_50.5_1278(1126-1552)_8.0 Bhadawari_346-467_48.7_1009(976-1040)_7.0 Kundi_320-575_***_1208-2000_7.0 Mehsana_335-567_46.8_1605(1308-1838_7.4 Egyptian_369-535_38.2_1412(1078-2112)_6.1-7.4 Iraqi_***_37.5_1342_7.5-9 Comparative performance of Nili-Ravi breed of Pakistan, Murrah of India and Egyptian Buffalo Indicator_Nili-Ravi_Murrah_Egyptian Weight at first calving,kg_529(499-523)_467(375-557)_432(369-510) Lacation milk,kg_1854(1600-1997)_1654(948-2040)_1185(749-1784) Milk fat,%_6.4(6.1-9.8)_6.6(6.2-7.4)_6.5(5.0-8.4) Milk protein,%_3.9(3.3-4.7)_3.9(3.4-4.1)_3.7(3.3-4.1) Composition of buffalo and cow milk: Breed_fat,%_protein,%	Taneja (1999)

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TABLE 10B.1-13 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5			
Country of Asian region	**Parameter [1]**	**Reference value (±SD)**	**Reference source**
		Egyptian_7.96_4.16 Chinese_12.6_6.04 Carabaos_10.35_5.88 Murrah_7.38_3.60 European cow_3.90_3.47 Zebu cow_4.97_3.18 Crossbred cow_4.0_3.46	
Asia	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg MF_milk yield_MF, kg/hd/d Milk fat_MF,% Milk protein_MF, % Working, hr/day C_Gr_weight gain, kg/hd/d	China – swamp type buffaloes Guizhou breed – most numerous one – raised on natural pasture and varying body size according to environmental conditions Swamp type buffaloes – used only for draught and meat production Average birth weight – 26-30 kg At 8 mo – 125-150 kg 1 yo – 135-205 kg Average daily gain for the period prior to weaning – 340-410g, and after weaning – 340-750 g. Average weight of mature bulls – 450-650 kg Average weight of mature cow – 350-450 kg The average daily working time – 5 hrs and average annual record is between 20 and 146 days Slaughter age – after they lost their work ability – at age of 15-20 years at 380 kg live weight Swamp type buffaloes: Philippines: Male – 500 kg Female – 420 kg Milk yield – 4.45-2.64 kg/day Indonesia: Average body weight – 450-600 kg, can reach up to 800 kg China: Female: 607.8 kg (Haizi), 616.5 kg (Shanghai), 400.5-496.1 kg (hill and mountain type) Lactation milk yield – 441-1031 kg	Mingala *et al.* (2017)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Vietnam: Heifers – 400-420 kg, 370-420 kg, other may reach up to 500-600 kg (buffalo cows) Lactation milk yield – 500 kg Thailand: Males: 450-600 kg <u>River type buffaloes</u> Anatolian Mature male – 200-500 kg Mature female – 200-500 kg Average slaughter weight – 300-350 kg, at the age of 18-20 months Lactation milk yield – 700-1000 kg Milk fat – 6.6-8.1% Milk protein – 4.2-4.6% Azeri: Mature male – 400-600 kg Mature female – 400-600 kg Lactation milk yield – 1200-1300 kg Milk fat – 6.6% Bhadawari (Pakistan): Mature male – 475 kg Mature female – 425 kg Lactation milk yield - 711±25 - 812±23 kg Milk fat – 7.2±0.4 – 13% Bulgarian Murrah Mature male – 700 kg Mature female – 600 kg Slaughter weight – 400 kg, at the age of 16 months Lactation milk yield – 1800 kg Milk fat – 7.04%	

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Egyptian Mature male – 600 kg Mature female – 500 kg Lactation milk yield – 1200-2100 kg Milk fat – 6.5-7.0% Jafarabadi (India) Mature male – 600-1500 kg Mature female – 500 kg, some individuals may reach up to 700-800 kg Lactation milk yield – 1800-2700 kg Milk fat – 8.5% Iraqi buffalo : Mature male – 800 kg Mature female – 600 kg Lactation milk yield – 1300-1400 kg Milk fat – 6.6% Kundi (Pakistan): Mature male – 700 kg Mature female – 600 kg Lactation milk yield – 2000 kg Milk fat – 6.0% Lime (Nepal): Mature female – 399 kg Lactation milk yield – 875kg Milk fat – 7.0% Mediterranean or European : Average body weight – 569 kg (Bulgarian), 550-650 kg (Italian), 487-565 kg (Romanian) Lactation milk yield – 900-4000kg Milk fat – 8.0% Milk protein – 4.2-4.6%	

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Meshana (India): Mature male – 570 kg Mature female – 430 kg Lactation milk yield – 1800-2700 kg Milk fat – 6.6-8.1% Milk protein – 4.2-4.6% Murrah (sub-Indian continent)> Mature male – 750 kg Mature female – 650 kg Lactation milk yield – 1800 kg Milk fat – 7.2% Nagpuri (India): Mature male – 522 kg Mature female – 408 kg Lactation milk yield – 825 kg Milk fat – 7.0% Nili-Ravi: Mature male – 700kg Mature female – 600 kg Lactation milk yield – 2000 kg Milk fat – 6.5% Parkote (Nepal): Mature female – 410 kg Lactation milk yield – 875 kg Milk fat – 7.0% Surti (India): Mature male – 700kg Mature female – 550-650 kg Lactation milk yield – 2090 kg	

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Milk fat – 6.56-8.1% Milk protein – 4.2-4.6% Tapai: Mature male – 375kg Mature female – 325 kg Lactation milk yield – 450 kg Milk fat – 6.6-8.1% Milk protein – 4.2-4.6% Toda : Mature male – 380kg Mature female – 380 kg Lactation milk yield – 500 kg	
China	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg MF_milk yield_MF, kg/hd/d Milk fat_MF,% Milk protein_MF, % C_Gr_weight gain, kg/hd/d	Buffalo breeds: <u>Shanghai</u> The body weight of adult buffalo is 600-650kg, somereach 1000kg. They are mainly used for traclling. In 8 hours they can plough 6-8 Chinese acre field, and the maximum is 10 Chinese acre. The female daily produce 5-10kg milk with 5.5-9% milkfat percentage. The age at mating is 2.5 years for the male and female. The female on the average give birth 2 times in 3 years. <u>Haizi</u> The adult bull weights 586.4kg, and cow 496kg. They have good trailling quality. The age reaching puberty of the cow is 12-16 months and the age for the first mating is 31-36 months. <u>Mountainous</u> The body weight is 447.3kg for the bull and 407.3kg for the cow. Age at puberty 15～18 months, age at first mating 29 months, reproduction phase 13 years. <u>Wenzhou</u> The body weight of calf at birth is 23.6kg for the male, 21.9kg for the female. The body weight and height of adult bull are 517.3kg and 126.5cm as those of adult cow are 496.1kg. The lactation period is 239.9 days, milk production 500-1000kg,	FAO (2003)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		The age at maturation is 2-2.5 years for the male, 2.5-3 years for the cow. The age at first mating is 3-3.5 years for the male, 3.5 years for the female. Dongliu Adult bulls weigh on average 550kg, and cows of 500kg. The lactation period is 9-10 months, with an average daily milk yield of 2kg. The males reach their sex maturity at the age of 17-24 months, and females of 17 months. Cows are managed to breeding at 3 years old with the reproductive rate of 46.1% and the survival rate of 77.8%. Fu'an The adult bulls weigh on average 523kg, and cows 456kg. Their lactation period is 150-300 days, milk yield 375-600 kg, average daily milk yield 2.66kg. The age at first mating is 2.5-3 years for the bull, 3 years for the cow. The reproduction rate and survival rate are 60.1% and 95.1% respectively. Xinfeng Mountainous The bull weights on average 327 kg, cows 344 kg. The cow reaches puberty at 1.5 years, can be mated at 3 years, can managed to breed till 12-14 years, produces 7-8 calfs in whole life with maximum of 16 calfs. The bull reaches sex maturity at 1.5 years old, mates at 3～4 years old, managed to breed till 14 years old. Xinyang The bull weights on average 533.7 kg, cows 490 kg. The age at the first mating is 2.5 years for the bull, 2.5-3 years for the cow. The reproductive rate is 81.2%. Enshi Mountainous The bull weights on average 434.9-524.7 kg, cows 409.9-434.9 kg. The age at first mating is 3 years for the bull, 2.5-3 years for the cow. The reproductive rate is 41.7%. Jianghan The bull weights on average 544.6 kg, cows 519.4 kg. Under the grazing condition, the daily gain is 960.5 g for the bull, 516.5g for the cow. The age at first mating is 3 years for the bull, 2.5-3 years for the cow. The lactation period is 8-12 months, milk yield 800 kg, and daily milk yield 3.5kg. Binhu The bull weights on average 498.8 kg, and cows of 472.8 kg.	

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		The birth weight is 27.5 kg for the bulls, 25.5 kg for the cows. The lactation period is 6-8 months, milk yield 500 kg, milkfat percentage 9.4%-10.6%. The age at first mating is 2.5-3 years for the bull, 3 years for the cow. The birth rate is 58.6%. <u>Xinglong</u> The bull weights on average 503.7 kg, cows 457.1 kg. The cow reaches puberty at 2-3 years. The age at first mating of bull is 3 years. Most of them produce one parity in two years. <u>Fuzhong</u> The bull weights on average 419.9 kg, cows 415 kg. The age to reach sex maturation is 2.5 years for the bull and 2.5-3.5 years for the cow. The age at first mating of cow is 3.5-4.5 years. The reproductive rate is 61.3%. <u>Xilin</u> The bull weights on average 485.4 kg, cows 400.5 kg. The age at reaching sex maturation is 2 years for the bull, 1.5 years for the cow. The age at first mating is 3 years for the bull, 2.5 years for the cow. The average reproductive rate is 54.7%. <u>Fuling</u> The bull weights on average 491.7 kg, cows 446.5 kg. The reproductive rate is 65.3%, the survival rate 95%. The daily gain of calf during the lactation period and at 1 year is 635g and 604g, which shows that the Fuling grows fast before 1 year. <u>Dechang</u> The bull weights on average 527.3 kg, cows 490 kg. The age reaching sex maturation is 1.5-2 years for the bull, 2.5-4.3 years for the cow. The age at first mating is 3 years for bull and cow. The reproductive rate is 37.1%. <u>Guizhou</u> he bull weights 414-483 kg, cows 393-435 kg. The bull reaches sex maturation at 1.5 years and can mate at 3 years.	

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		The cow reaches sex maturation at 10-12 years, mates at 2.5-3 years. Dehong The bull weights 571.3 kg, cows 500.3 kg and the beer steer 627 kg. The bull reaches sex maturation at 1.5 years while the cow at 2-2.5 years. In the rural the reproductive rate is 50%-65%, the survival rate of calf 40%-80%. Yanjin The bull weights on average 406.1 kg, cows 393.1 kg. The bull reaches sex maturation at 1.5-2 years. The age at mating is 3 years for the bull, 2-3 years for the cow. The reproductive rate is 52.6%. Shannan The weight is 442.7kg for the bull. As for the cow they are 398.5kg. The bull reaches sex maturation at 2-2.5 years as the cow at 2 years. They can be managed to mate at 2.5-3 years.	
China	MF_weight, kg MM_weight, kg MF_milk yield_MF, kg/hd/d Milk fat_MF,% Milk protein_MF, %	In China, more than 99.9% indigenous buffalo are swamp type, with lower milk and meat production when compared with river type buffaloes, i.e. Murrah, Nili-Ravi and Mediterranean buffaloes, and were selected for draft purpose in the vast rural area during their long historical cultivation An adult indigenous buffalo cow weighs about 250-400 kg and yields an average of milk for about 500-600 kg per lactation, or up to 800-1,000 kg after selection, with about 7.5% milk fat, 5% protein and 20% dry matter The milk yield of the first and second generation Murrah crossbreds respectively reached 1,240.5 kg and 1,423.3 kg, The milk yield of the triple crossbreds and offspring of triple crossbreds respectively reached 2,294.6 kg and 1,994.9 kg	Yang *et al.* (2013)
Thailand	Working, hr/day	The Thai swamp buffalo can be used to work up to 14 years old without problems. That is very long royal worker life compared to other animals. On average, the buffalo works 5 hours a day. The buffalo is used 122 days a year.	Chang and Huang (2003)
Asia	MF_weight, kg MM_weight, kg	Swamp type buffalo: In most Southeast Asian countries, male dairy and swamp buffalo have not yet been raised for a primary purpose of quality beef production. Item _Dairy _Beef _Buffalo Initial BW, kg _167.13±10.86_211.50±39.14 _153.13±10.95 Final BW, kg_ 413.68±10.16_ 411.51±8.91 _398.88±9.13	Skunmun *et al.* (2002)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Days of feeding _354.17±46.45 _263.42±80.42_ 411.00±49.05	
China	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg MF_milk yield_MF, kg/hd/d Milk fat_MF,% Milk protein_MF, %	Milk production of different breeds Breed _ Lactation length (day), _Milk yield (kg) L _ 280.4 ± 20.2_ 1092.8 ± 207.44 M _324.7 ± 73.6_2132.9 ± 578.3 N _316.8 ± 76.1_2262.1 ± 663.0 MLF1 _ 280.1 ± 76.1_1233.3 ± 529.7 MLF2 _ 303.2 ± 83.1_1585.5 ± 620.6 NLF1_ 326.7 ± 96.4_2041.2 ± 540.9 NLF2 _325.8 ± 93.2_2267.6 ± 774.8 NMLF2 _ 317.6 ± 78.4_2294.6 ± 772.1 L = Chinese Swamp buffalo (this represent selected animals); M = Murrah; N = Nili Ravi; MLF1 = F1 cross Murrah x Swamp; MLF2 = F1 Murrah (Backcross); NLF1 = cross Nili Ravi x Swamp; NLF2 = F1 x Nili Ravi (Backcross); NMLF2 = (M x L) crossbred x Nili (triplecross) Liveweight (kg) from birth to 36 months of age of swamp buffalo and F1 (50 : 50) cross with riverine type Age _Swamp Buffalo_ F1 Cross (50 : 50) Birth _31.4 _31.1 6 mos _100.3_ 110.4 12 mos _132.5_ 170.9 18 mos _196.6 _244.5 24 mos_ 213.9_ 255.9 30 mos _225.9 _296.3	Cruz (2010)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		36 mos _260.9 _333.6 Breed/type _Age, year_ Liveweight, kg Swamp Male _ 4–5 _443 Female _ 4–5 _398 SB x M (50 : 50) Male _ 4–5_ 531 Female _ 4–5 _476 SB x M (25 : 75) Male _ 4–5 _530 Female _ 4–5 _479 SB x Nili (50 : 50) Male _4 _538 Female _ 4 _482	
China	Milk fat_MF,% Milk protein_MF, %	Chemical composition of samples Sample / Fat (% v/v) / Protein (% w/w) Murrah (n = 36) / 6.65±0.08 / 4.65±0.05 FH (n = 36) / 8.16±1.11 / 4.96±0.03 F1 (n = 36) / 8.46±0.26 / 5.13±0.15	Yang *et al.* (2013)
Philippines	MF_weight, kg MM_weight, kg CP_MM_MF,%	Swamp type buffalo: Twenty-four male 1-year old swamp buffaloes with a mean body weight of 202±10 kg obtained from the Mahasarakham Animal Nutrition and Development Station / GG / GGL / GGC1.5 / GGC2.0 Initial weight (kg) / 211.2 / 229.3 / 202.2 / 204.2 Final weight (kg) / 367.3 / 373.8 / 402.5 / 394.8 Fattening period (d) / 494.3 / 414.5 / 349.5 / 349.5 GG – gunea grass GL – Stylosanthes guianensis GGC1.5, 2.0 - gunea grass with 1.5% and 2.0% of concentrate	Lambertz *et al.* (2014)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		Chemical composition of feed, CP,%: Concentrate – 11.5 Grass – 7.7 Legume – 11.6	
Asia	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg	Body weight, kg Country_Breed_Birth_6mo_12mo_18mo_Mature India_Murrah_29_119_212_264_500 India_Nili-Ravi_31_134_219_289_5103 China_Swamp_34_167_250_**_577 Malaysia_Swamp_32_138_204_281_** Thailand_Swamp_29_98_144_**_473 Philippines_Swamp_28_88_121_141_463	Sivarajasingam (1987)
China	MF_weight, kg MM_weight, kg	12-month-old Mediterranean crossbred buffalo body weight (309-325 kg) (P <0.05) were significantly higher than that of Murrah, Nili-Ravi and their crossbred buffalo with Guangxi local swamp type buffalo (211.0-277.0 kg)	Qin *et al.* (2013)
Philippines	Day weighted population mix,%	Item_2015_2016_2017 All ages _2,874,607 _2,888,233 _2,882,954 Backyard 2,862,721 2,876,942 2,872,284 Commercial 11,886 11,291 10,670 Carabulls (Male, 3 years old and above) _784,277 _842,574_ 815,089 Backyard _782,959 _841,344_ 813,787 Commercial _1,318 _1,230_ 1,302 Caracows (Female, 3 years old and above) _1,132,792 1,096,096 1,141,978 Backyard_ 1,127,081 _1,090,779_ 1,137,529 Commercial _5,711_ 5,317 _4,449 Caraheifers (2 to 3 years old)_ 267,834_ 303,845_ 313,719 Backyard _265,737 _301,794_ 311,613	Carabao situation report (2017)

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<table>
<tr><th colspan="4">TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5</th></tr>
<tr><th>Country of Asian region</th><th>Parameter [1]</th><th>Reference value (±SD)</th><th>Reference source</th></tr>
<tr><td></td><td></td><td>Commercial _2,097_ 2,051_ 2,106

Yearlings (0 to 2 years old)_ 505,658 _493,384_ 469,373
Backyard _503,766 _491,454_ 467,317
Commercial _1,892_ 1,930_ 2,056

Others _ 184,046 _152,334_ 142,795
Backyard _183,178 _151,571_ 142,038
Commercial _868 _763_ 757

Distribution of population, %:
Caracows – 39.61
Carabulls – 28.27
Yearlings – 16.28
Caraheifers – 10.88
Others – 4.96</td><td></td></tr>
<tr><td>China</td><td>Working, hr/day</td><td>Field work on own land was the main reason for keeping buffaloes (87.3 %), but lending work buffaloes to neighbours (79.0%) was also important
Buffalo care required 6.2 ±3.00 working hours daily, while annual working time of a buffalo was 294 ±216.6 hours.
Require feeding either through cut and carry, or guidance to proper grazing grounds, mostly in forest areas
Annual working time of a buffalo on different types of crop fields

<table>
<tr><td>Farming System</td><td>Livestock-corn based</td><td></td><td>Rubber based</td><td></td></tr>
<tr><td>Working time (h/yr) in</td><td>Mean</td><td>± SD</td><td>Mean</td><td>± SD</td></tr>
<tr><td>Rice fields</td><td>121.4</td><td>130.70</td><td>37.3</td><td>35.50</td></tr>
<tr><td>Corn fields</td><td>98.3</td><td>56.70</td><td>55.0</td><td>65.90</td></tr>
<tr><td>Hemp fields</td><td>119.3</td><td>80.30</td><td></td><td></td></tr>
<tr><td>Other crops</td><td>11.0</td><td>40.70</td><td></td><td></td></tr>
<tr><td>All plantations</td><td>349.9</td><td>200.10</td><td>92.3</td><td>77.70</td></tr>
<tr><td>Daily working time (h)</td><td>1.0</td><td>0.50</td><td>0.3</td><td>0.20</td></tr>
</table>
Traction was found to be the major reason to raise buffaloes, and selling or self consumption of meat were identified as</td><td>Riedel et al. (2012)</td></tr>
</table>

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		being only additional positive side effects Taking into account the animals required for herd restocking, an average of 2 to 3 animals per household seems reasonable. No preference of sex was found for ploughing animals, which agrees with other reports from Asia	
China	MF_weight, kg MM_weight, kg Feeding	The buffaloes are bred by millions of peasant households in China, each farmer (household) popularly raises 1-3 buffaloes, the forms of buffalo rearing are extensive, buffaloes are grazed in field and fed on agriculture residual products in Spring and Autumn without concentrates, and buffaloes are only raised for farming. In recent years, the dairy buffalo breeding has been rapidly developed in countryside in China. Chinese buffalo is of swamp type, they are small-size and the milk and meat performance are poor. The adult local female buffaloes weigh 250-400kg, the average milk yield in a lactation is 500-600kg According to incomplete statistics, more than 1 million crossbred buffaloes have been born in China in recent 30 years. In recent years, the quantity of hybridized female buffaloes per year is more than 0.55 million, the biggest population distributes in Guangxi and Yunnan and the quantity of buffaloes in these two provinces respectively reached 359,000 and 98,000 in 2005	Yang *et al.* (2007)
China		Swamp type buffalo: The swamp buffalo is usually confined into a sort of mixed farming system within small-holder families, with a reduced number of buffaloes (1–5) per family, primarily used for draft purpose andmeat at the end of their career as work animals. The river buffalo counterpart on the other hand, owing to its inherent higher milk productivity is being capitalized into emerging semi-commercial and commercial-size dairy operations around the peri-urban areas. As for swamp, riverine buffaloes mostly belong to a smallholder system, where animals are a strong asset in the family economy and production drive. Finally, semi-commercial and commercial milk production setups can be seen around urban centers where milk plants are available. Buffalo as a source of meat, has never been a primary productive goal anywhere in the world Males, other than being essential in the buffalo farming system for reproductive purposes and for draft power, are considered more of a burden by the owner and are therefore culled even at young age, not reaching thus the full potentiality as meat producers.	Deb *et al.* (2016)
Asia	Milk fat_MF,% Milk protein_MF, %	Fat _ Protein _Country 7.6±1.3 _4.74±0.2 _ China 7.1±1.0 _ 3.63±0.34 _ Egypt 7.0–7.2 _ 3.60–3.85 _Egypt 8.0±0.6 _ 2.70±0.08 _India 7.7±0.1 _3.81±0.02 _ India	Abd El-Salam and El-Shibiny (2011)

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TABLE 10B.1-13 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5			
Country of Asian region	**Parameter [1]**	**Reference value (±SD)**	**Reference source**
		6.80_ 3.91 _ India 8.1±1.9 _ 4.65±0.48 _ Italy 7.6±0.1 _4.11±0.02 _ Pakistan 7.0±0.6 _4.35±0.34 _ Pakistan 8.4±0.3 _2 3.97±0.06 _ Bangladesh , swamp buffalo 7.3±0.5 _ 3.77±0.26 _ Bangladesh , water buffalo 8.4_ 4.24–4.45 _ Azerbiajan 6.6 _4.13_ Brazil 7.0±1.3 _3.73±0.82 _ Argentina , Murrah 7.6±1.8 _ 3.73±0.88 _ Argentina , cross-bred 8.8±0.3 _ 5.20±0.14 _ Argentina , Jafarabadi 7.9 _ 4.49 _ Bulgaria 7.1±1.4 _ 4.40±0.51 _ Turkey 7.5–9.6 _ 4.90 _ Germany 7.0±0.6 _ 4.35±0.34 _ France	
Indonesia	MF_weight, kg MM_weight, kg	Under good quality grass feeding the body weight of 24 month old buffaloes was 425 kg, and when their feed was supplemented with concentrates their 18-month body weight was reached 360 kg. In Pati District, farmers from several villages raised their buffaloes in communal shelters. As many as 70 farmers, with each 3-10 animals, gathered their buffaloes in one communal shelter located along a tertiary irrigation basin. In villages of Semarang municipality, around 50 buffalo raisers gathered their buffaloes in one communal shelter located on communal village land. While in Pemalang, 75 buffalo raisers, each owning 5-12 animals, gathered their buffaloes in three communal shelters	Suryanto *et al.* (2002)
India	Gr_weight, kg C_weight,kg	Swamp type buffalo (India): Birth weight - 27.81±0.50, 6 mo - 64.06±1.23, 12 mo- 109.14±1.18 kg	Das *et al.* (2004)
Asia		Utility of swamp buffaloes for draft is reported as high as 65% of the 2.3M population in Myanmar (Hlaing, 2001) and about 66% of the population in the Philippines. In Thailand, where 20-30% draft requirement is supplied by buffalo The traditional role of buffalo as source for draft and transport still remains dominant in most of East and Southeast Asia,	Cruz (2007)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		and is usually associated with the small-holder farmers in mixed-farming system In South Asia, small-holder producers have demonstrated success in buffalo dairying by putting huge investment in vertical integration, e.g., linking farm production to agro-processing, value-adding and marketing China, most of Southeast Asia and Sri Lanka are common on the traditional use of water buffaloes – mainly for draft in rice-producing areas In countries such as the Philippines and China where water buffaloes are generally swamp type and mainly used for work, government efforts to transform the huge population of swamp buffalo from being work animals to efficient milk producers were initiated by crossbreeding the riverine animals with the local breed. When buffaloes are used for work and then sent to the slaughterhouse at retirement age, the meat derived is definitely tough and of inferior quality The Asian buffalo will still be a small-holder animal in the foreseeable future, playing an important role in the lives of resource-poor farming families in the developing countries in Asia. Harnessing the full potential of this Asian animal will benefit the majority of the rural farming families and at the same time meet the requirements of the fast-growing Asian economy. In recent years, the swamp buffaloes in the intensively irrigated areas of Southeast Asia as source of draft power are being replaced slowly by farm machineries. In order that the existing huge animal resource can be of benefit to the rural farming families, transformation of these animals to become efficient producers of milk and meat by way of crossbreeding with riverine breeds is now being pursued with good degree of success. The emerging interest in India to harness the enormous population of male buffalo calves as potential sources of good quality meat by way of introducing improved management technologies to dramatically reduce calf mortalities and increase average daily gain in weight will surely reap enormous benefits for millions of small-holder buffalo producers while meeting the growing demand for ruminant-derived meat products.	
India	MF_weight, kg MM_weight, kg	A Swamp buffalo with 592 kg average live weight yields 277 kg carcass and 215 kg meat Calves slaughtered at 18 months of age dress out 50% of the live-weight. India is the world's largest buffalo meat producer having approximately 14 000 buffalo slaughterhouses.	Nanda and Nakao (2003)
Thailand	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg	Thai swamp buffalo Data retrivedfrom fig 1 360 do – 200 kg 720 do – 350 kg 930 do – 400 kg Weaning age: Heifers – 157.5 kg	Meyer *et al.* (2000)

<table>
<tr><th colspan="4">TABLE 10B.1-13
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<tr><th>Country of Asian region</th><th>Parameter [1]</th><th>Reference value (±SD)</th><th>Reference source</th></tr>
<tr><td></td><td></td><td>Bulls – 158 kg
500 days old :
Heifers – 160.9 kg
Bulls – 163.2 kg</td><td></td></tr>
<tr><td>China</td><td>Gr_weight, kg
C_weight,kg</td><td>Binlangjang male buffalo
Weight at age of:
0-3 mo - 53.57 ± 19.22 kg
4-6 mo - 109.7 ± 32.05 kg
12-18 mo - 232.5 ± 29.65 kg
24-36 mo - 390.17 ± 78.49 kg</td><td>Li et al. (2018)</td></tr>
<tr><td>Asia</td><td>Feeding</td><td>Four main categories of feeds are potentially available for use on small mixed farms in Asia: foliages (native & improved grasses, legumes and fodder trees), crop residues, agro-industrial by-products and non-conventional feed resources. Seasonal fluctuation has a great impact on feed resource quantity and quality
In general, farms in tropical production systems include traditional rice cultivation, field crop production, e.g., sugarcane, cassava, sweet potato and raise buffalo or cattle, or both.</td><td>Wanapat and Rowlinson (2007)</td></tr>
<tr><td>Lao</td><td>MF_weight, kg
MM_weight, kg
Gr_weight, kg
C_weight,kg</td><td>Production characteristicsof buffalo in Lao PDR
Weight at birth, kg _24–32
Weight at weaning (8 months), kg_ 90–120
Weight of cows, kg_250–340
Weight of bullocks at maturity, kg_ 300–400
Age at first calving, yr_4.50–5.50
Post weaning daily gain, grass, kg_0.24–0.30</td><td>Phomsouvanh, 2001</td></tr>
<tr><td>Asia</td><td>Gr_weight, kg
C_weight,kg
MF_weight, kg
MM_weight, kg</td><td>Reproductive andproduction performance of some bufffalo
<table>
<tr><th>Items</th><th>Binhu</th><th>Fulin</th><th>Guizhou</th><th>Murrah</th><th>Nili-Ravi</th><th>Murrah crossbred</th><th>Nili-Ravi crossbred</th><th>Crossbred</th></tr>
<tr><td>Weight at 12 m (kg per day)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>male</td><td>0.71</td><td>0.63</td><td>0.62</td><td>0.65</td><td>0.64</td><td>0.63</td><td>0.45</td><td>0.78</td></tr>
<tr><td>female</td><td>0.62</td><td>0.60</td><td>0.55</td><td>0.55</td><td>0.6</td><td>0.51</td><td>0.61</td><td>0.72</td></tr>
<tr><td>Weight at 24 m (kg per day)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td><td>Qingkun et al. (2002)</td></tr>
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<table>
<tr><th colspan="4">TABLE 10B.1-13
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<tr><th>Country of Asian region</th><th>Parameter [1]</th><th>Reference value (±SD)</th><th>Reference source</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>male</td><td>0.46</td><td></td><td>0.38</td><td>0.43</td><td>0.42</td><td></td><td>0.45</td><td>0.6</td></tr>
<tr><td>female</td><td>0.43</td><td></td><td>0.36</td><td>0.48</td><td>0.49</td><td></td><td>0.58</td><td>0.58</td></tr>
<tr><td>Weight of adults (kg)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>male</td><td>547.8</td><td>491.7</td><td>487.1</td><td>888.0</td><td>821.1</td><td>473.2</td><td></td><td>922.5</td></tr>
<tr><td>female</td><td>485.0</td><td>446.5</td><td>428.9</td><td>622.4</td><td>659.8</td><td>486.7</td><td>642.6</td><td>662.1</td></tr>
</table>
</td><td></td></tr>
<tr><td>Indonesia</td><td>MF_weight, kg
MM_weight, kg
Gr_weight, kg
C_weight,kg
Day weighted population mix,%</td><td>
<table>
<tr><td>Criteria</td><td>Bali cattle</td><td>Madura</td><td>Ongole</td><td>Pesisir</td><td>Aceh</td></tr>
<tr><td>Calf crop (%)</td><td>72–92</td><td></td><td>52.6</td><td></td><td></td></tr>
<tr><td>Body Weight (kg)</td><td>12-15</td><td></td><td></td><td>15</td><td></td></tr>
<tr><td>Weight at 1 month (kg)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Weight at 6 months</td><td>84-119</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Weight at 12 months</td><td>158-226</td><td></td><td></td><td>136</td><td></td></tr>
<tr><td>Weight at 18 months</td><td>228-323</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Weight at 24 months</td><td>304-380</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Weight at 36 months</td><td></td><td>350</td><td>340–355</td><td></td><td></td></tr>
<tr><td>Adult weight Male</td><td></td><td></td><td>400</td><td>240</td><td>253</td></tr>
<tr><td>Adult weight Female</td><td></td><td></td><td>310</td><td></td><td>148</td></tr>
<tr><td>ADG, kg</td><td>0.3-0.57</td><td></td><td>0.25</td><td></td><td></td></tr>
</table>
Destribution buffalo by age, %
Age_Male_Female_Total
Weaning_9.03_9.88_18.91
Yearling_10.34_15.13_25.47
Mature_11.93_43.69_55.62
Total_31.30_68.70_100.00
</td><td>Djajanegara and Diwyanto, 2001</td></tr>
<tr><td>Philippines</td><td>Day weighted population mix,%</td><td>Inventory of animals
Breed_Cow _Bull _Heifer _Cull _Total
Philippine Carabao_48_ 27 _37 _10_ 122
Bulgarian Murrah_ 632_ 304_ 575_ 373 _1884
American Murrah _111_ 77 _78 _70_ 336
Indian Murrah_6 _18 _29 _5 _58
Total _797 _426 _719_ 458_ 2400</td><td>Loculan, 2001

Loculan (2002)</td></tr>
</table>

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<table>
<tr><th colspan="4">TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5</th></tr>
<tr><th>Country of Asian region</th><th>Parameter [1]</th><th>Reference value (±SD)</th><th>Reference source</th></tr>
<tr><td>Sri Lanka</td><td>MF_weight, kg
MM_weight, kg
Gr_weight, kg
C_weight,kg</td><td>Productivity and performance information
<table>
<tr><th></th><th>European Crossbreds (Cattle)</th><th>Indian crossbred (cattle)</th><th>Local nondescript (cattle)</th><th>Cross breds (buffalo)</th><th>Local breeds (buffalo)</th></tr>
<tr><td>Age at 1st parturition (months)</td><td>26–32</td><td>28–34</td><td>36–40</td><td>38–42</td><td>38–42</td></tr>
<tr><td>Lactation yield (1000 litres)</td><td>1.8–4.5</td><td>1.08–1.6</td><td>0.18–0.54</td><td>1.8–2.1</td><td>0.36</td></tr>
<tr><td>Milk fat %</td><td>3.2–4.0</td><td>3.5–4.5</td><td>3.5–4.5</td><td>6–8</td><td>7–9</td></tr>
<tr><td>Birth weight (kg)</td><td>25–35</td><td>20–25</td><td>15–18</td><td>25–30</td><td>20–25</td></tr>
<tr><td>Weight at 1st year (kg)</td><td>140–200</td><td>120–160</td><td>80–100</td><td>200–240</td><td>160–200</td></tr>
<tr><td>Daily gain (g)</td><td>300–450</td><td>250–400</td><td>150–250</td><td>450–600</td><td>400–500</td></tr>
<tr><td>Mature body weight</td><td>350–500</td><td>300–400</td><td>200–250</td><td>500–600</td><td>400–450</td></tr>
</table></td><td>Premasundera (2002)</td></tr>
<tr><td>Sri Lanka</td><td>MF_weight, kg
MM_weight, kg
Gr_weight, kg
C_weight,kg</td><td>Production performance of European and Indian breed and crossbreeds and local breed female cattle.
Item_European crossbreeds _Indian crossbreeds _Local breeds
Age at 1st parturition (months) _26–32 _28–34_ 36–40
Lactation yield (litres) _1800–4500 _1080–1620 _180–540
Birth weight (kg) _25–35_ 20–25_ 15–18
Weight at 1 year old (kg)_ 140–200_120–160 _80–100
Daily gain (g) _300–450_ 250–400_ 150–250
Mature body weight (kg) _350–500 _300–400 _200–250</td><td>Somapala (2002)</td></tr>
<tr><td>Vietnam</td><td>MF_weight, kg
MM_weight, kg
Gr_weight, kg
C_weight,kg</td><td>Swamp type buffalo
Body weight of calves (kg) at birth, 3, 6, 12 and 24 months of age
<table>
<tr><th>Age (m)</th><th>Gender</th><th>T1 (LSB+SC) (X±SD)</th><th>T2 (LSB+NSC) (X±SD)</th><th>T3 (SSB+SC) (X±SD)</th><th>CT (SSB+NSC) (X±SD)</th></tr>
<tr><td>At birth</td><td>M</td><td>24.2 ± 1.7</td><td>23.0 ± 1.5</td><td>21.4 ± 1.8</td><td>20.9 ±1. 2</td></tr>
<tr><td></td><td>F</td><td>23.3 ± 1.8</td><td>22.6 ± 1.8</td><td>20.9 ± 1.3</td><td>20.3 ± 1.1</td></tr>
<tr><td>3</td><td>M</td><td>56.6 ± 3.8</td><td>54.4 ± 3.6</td><td>50.6 ± 2.6</td><td>48.7 ± 2.9</td></tr>
<tr><td></td><td>F</td><td>56.0 ± 4.2</td><td>52.6 ± 3.2</td><td>50.0 ± 3.3</td><td>48.4 ± 3.3</td></tr>
<tr><td>6</td><td>M</td><td>88.9 ± 4.6</td><td>84.2 ± 5.2</td><td>80.8 ± 4.7</td><td>77.6 ± 4.5</td></tr>
<tr><td></td><td>F</td><td>87.4 ± 4.4</td><td>82.8 ± 4.4</td><td>78.6 ± 3.9</td><td>77.3 ± 3.6</td></tr>
<tr><td>12</td><td>M</td><td>154.6 ±8.8</td><td>148.9 ±8.9</td><td>139.1 ±10.4</td><td>135.9 ±9.5</td></tr>
<tr><td></td><td>F</td><td>151.0 ±9.5</td><td>147.2 ±9.7</td><td>136.9±10.8</td><td>132.5±10.0</td></tr>
<tr><td>24</td><td>M</td><td>254.8 ±10.5</td><td>246.6±11.8</td><td>234.6 ±10.7</td><td>229.7 ±10.5</td></tr>
<tr><td></td><td>F</td><td>248.4 ±11.5</td><td>244.9 ±9.7</td><td>230.2±10.3</td><td>227.8 ±11.2</td></tr>
</table>
+ Treatment 1 (T1): large bulls and selected cows (LSB+SC), + Treatment 2 (T2): large bulls and non-selected cows (LSB+NSC)</td><td>Van, 2007</td></tr>
</table>

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		+ Treatment 3 (T3): local small bulls and selected cows (SSB+SC), + Control (CT): local small bulls and non-selected cows (SSB+NSC)	
Asia	MF_weight, kg MM_weight, kg Gr_weight, kg C_weight,kg C_Gr_weight gain, kg/hd/d Pregnancy,% Feeding Working, hr/day MF_milk yield_MF, kg/hd/d Milk fat_MF,% Milk protein_MF, % Day weighted population mix,% CP,% DC,%	Weight: 385 – Dairy 381 – Mature females 399 – Mature males 203 – replacement females - the animal are the age at first calving 212 – replacement males 191 – growing heifers - the animals are between the weaned age and the age at first calving 112 – growing steers 24 – birth weight AGW, kg/d 0.245 – replacement females - the animal are the age at first calving 0.257 – replacement males 0.292 – growing heifers - the animals are between the weaned age and the age at first calving 0.259 – growing steers Feeding system: Ranging/grazing Preganancy rate, %: 56.8 – Dairy 57 – Mature females DC,%: 44.1 – Dairy 55.9 – Mature females 55.8 – Mature males 55.9 – replacement females - the animal are the age at first calving 55.8 – replacement males 55.0 – growing heifers - the animals are between the weaned age and the age at first calving 56.8 – growing steers CP, g/kgDM: 91.6 (g/kg DM) – Dairy	FAO (2017)

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TABLE 10B.1-13
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF ASIA IN TABLE 10A.1-5

Country of Asian region	Parameter [1]	Reference value (±SD)	Reference source
		81.9 – Mature females 81.7 – replacement females - the animal are the age at first calving 81.5 – replacement males 81.37– growing heifers - the animals are between the weaned age and the age at first calving 86.3 – growing steers Day weighted population mix, of 100%: 19 – Dairy 24 – Mature females 8 – Mature males 23 – Replacement females 9 – Replacement males 0 – Growing heifers 7 – Growing steers 10 – Calves	

[1] MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, C – Calves

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TABLE 10B.1-14
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF AFRICA IN TABLE 10A.1-5

Parameter[1]	Unit	Value in Table 10A.1-5	Reference value (±SD)	Reference source
Weight_MF	kg/hd	440	Weight at the first calving: 414.9±10.6 376.7±6.6 349.5±9.0	Marai *et al.* (2001)
Weight_MF	kg/hd	440	500	Presicce (201)
Weight_MF	kg/hd	440	570±15 (5-6 years, well-managed)	Morsy *et al.* (2016)
Weight_MM	kg/hd	590	600	Presicce (201)
Weight_MM	kg/hd	590	592.8±4.6 (after 24 m)	Habeeb *et al.* (2016)
Weight_Gr	kg/hd	300	Age at the first calving 34-41 m	FAO (2005)
Weight_Gr	kg/hd	300	Slaughtering weight 398.9±2.6kg (18-24m)	Asheeri and Amal (2012)
Weight_Gr	kg/hd	300	Slaughtering weight 500 kg (18-24m)	Ibrahim (2012)
Weight_Gr	kg/hd	300	450 (meat producing animals)	WAAP (2007)
Weight_Gr	kg/hd	300	live weight at breeding (kg): 312.4±4.2 340.1±3.5	Hussein and Abdel-Raheem (2013)
Weight_Gr	kg/hd	300	Weight range: 200 – 400 kg	
Weight_C	kg/hd	115	118 kg – 6m	Ashour *et al.* (2007)
Weight_C	kg/hd	115	Female calves: 42±0.5 kg – birth weight 134.8±0.4kg – weaning weight (4.5m) 371.2±2.0kg – first service (25 m)	Marai *et al.* (2009)
Weight_C	kg/hd	115	244 buffalo calves (148 females and 96 males): 33.5 – birth 77 – 3-month 114 – 6-month 150 – 9-month 180 – 12-month	Shahin *et al.* (2010)
Weight_C	kg/hd	115	Female calves (overall): birth weight : 28.7±0.4 34.3±0.3 33.2±0.3 weaning weight (4.5m): 133.4±1.0 124.4±0.5 115.2±0.5 379 kg – first calving	Marai *et al.* (2001)
Weight_C	kg/hd	115	Calve males: birth - 31.5±0.4 3-month - 91.1±1.6	Habeeb *et al.* (2016)

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TABLE 10B.1-14
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF AFRICA IN TABLE 10A.1-5

Parameter[1]	**Unit**	**Value in Table 10A.1-5**	**Reference value (±SD)**	**Reference source**
			6-month - 157.5±2.2 12-month - 316.8±3.7 18-month - 472.8±3.3 24-month - 595.8±4.6	
Weight_C	kg/hd	115	Weight range: 32 – 200 kg	
Weight_gain_MF		0		IPCC (2006)
Weight_gain_MM		0		IPCC (2006)
Weight gain_Gr	kg/hd/d	0.40		Assumed based on Habeeb *et al.* (2016)
Weight_gain_C	kg/hd/d	0.45	244 buffalo calves (148 females and 96 males): 0.49 – 0-3 months 0.38 – 3-12 months 0.40 - 0-12 months	Shahin *et al.* (2010)
Weight_gain_C	kg/hd/d	0.45	0-3m - 662.2±16.9 3-6m - 737.7±33.1 6-12m - 885.0±25.5 12-18m - 866.7±18.6 18-24m - 666.7±19.1	Habeeb *et al.* (2016)
Weight_gain_C	kg/hd/d	0.45	Pre-weaning daily weight gain: 0.4±0.009 0.6±0.005 0.8±0.006	Marai *et al.* (2001)
Feeding_MF		Paddock	Tied and paddock (grazing + indoor feeding + cut and carry)	FAO (2005)
Feeding_MM		Paddock		
Feeding_Gr		Paddock	loose in doors day and night and raised under wood roofed shed in one yard	Habeeb *et al.* (2016)
Feeding_C		Paddock	The same as for Growing animals	
Milk_MF	kg/hd/d	4.3		Faostat (2017)
Milk_fat_MF	%	7.2	7.1±0.22 7.5±0.28 7.1±0.18	Radwan (2016)
Milk_protein_MF	%	3.7	4.2±0.15 3.5±0.11 3.5±0.08	Radwan (2016)
Work_MM	hr/day	1.37	Animals are used for draught	FAO (2005)
Work_MM	hr/day	1.37	1.37	IPCC (2006) (Table 10.A.3 - Other continents)
Working_FM	hr/day	0.55	Adult females are used for draught	Soliman (2009)
Working_FM	hr/day	0.55	0.55	IPCC (2006) (Table 10.A.3 - Other continents)
Pregnancy rate_MF	%	44	65.7, 30.3, 69.0, 38.9, 40.9, 18.5	Ali *et al.* (2009)

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TABLE 10B.1-14
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF AFRICA IN TABLE 10A.1-5

Parameter[1]	Unit	Value in Table 10A.1-5	Reference value (±SD)	Reference source
DC_MF	%	58	58.27±0.81 (experimental diet)	Hassan and Abdel-Raheem (2013)
DC_MF	%	58	55	Calculated based on FAO *et al.* (2014) Gerber *et al.* (2011)
DC_MM	%	58		The value of 'Mature females'
DC_Gr	%	58	fattening period: 56.51 70.24 55.64 72.93 SE – 3.120	Abd-Allah *et al.* (2015)
DC_C	%	58	traditional farm system 56.38±2.86 58.61±4.01	Khattab *et al.* (2011)
CP_MF	%	10.0	10.80±0.25 (experimental diet)	Hassan and Abdel-Raheem (2013)
CP_all	%	10.0		Assumed to be the same value as for non-dairy cattle
Day weighted population mix	%		Of 100%: 6 – adult males 42 – adult females 22 – growing 20 – calves	Ibrahim (2012)

[1] MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, C – Calves

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TABLE 10B.1-15
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF MIDDLE EAST IN TABLE 10A.5

Parameter [1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
Weight_MF	kg/hd	520	450-500	Soysal *et al.* (2007)
Weight_MF	kg/hd	520	411±9.07 (minimum) 518±17.2 (maximum)	Soysal *et al.* (2007)
Weight_MF	kg/hd	520	530 (3-6yr)	Calculated based on: Jaayid *et al.* (2011) Tariq *et al.* (2013)
Weight_MF	kg/hd	520	1 yr – 111.8 (Iran) 2yr – 272.2 3 yr – 421 4 yr – 528.3 5 yr – 596.3 6 yr – 710.4	Dezfuli (2010)
Weight_MF	kg/hd	520	438	DAD-IS (2017)
Weight_MF	kg/hd	520	521 – Dairy 548 – Mature females	FAO (2017): input data from literature review and expert opinion
Weight_MM	kg/hd	650	700-800 (Turkey)	Soysal *et al.* (2007)
Weight_MM	kg/hd	650	620 (Iraq)	Calculated based on: Jaayid *et al.* (2011) Tariq *et al.* (2013)
Weight_MM	kg/hd	650	1 yr – 118.1 (Iran) 2yr – 292.2 3 yr – 455.9 4 yr – 572 5 yr – 693.6	Dezfuli (2010)
Weight_MM	kg/hd	650	575 (Turkey)	DAD-IS (2017)
Weight_MM	kg/hd	650	649 – Mature males	GLEAM (FAO 2017): input data from litterature review and expert opinion
Weight_Gr	kg/hd	255	287±3.1 (15m, males) 303±9.91 (18m, males)	Mahmoudzadeh *et al.* (2007)
Weight_Gr	kg/hd	255	150-200 (yearling weight)	Soysal *et al.* (2005)
Weight_Gr	kg/hd	255	300-350 (18-20 m) – slaughtering weight	Porter *et al.* (2016)
Weight_Gr	kg/hd	255	300 – slaughtering weight (Calculated based on carcass weight).	Yavuz and Zulauf (2004)
Weight_Gr	kg/hd	255	310 – slaughtering weight (Calculated based on carcass weight)	Naserian and Saremi (2007)
Weight_Gr	kg/hd	255	slaughtering weight: 336.7 378.7 335.7±12.24 Carcass weight: 168.8 190.8	Mahmoudzadeh and Fazaeli (2009)

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TABLE 10B.1-15
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF MIDDLE EAST IN TABLE 10A.5

Parameter [1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			167.7±10.98	
Weight_Gr	kg/hd	255	Age at the first insemination – 680d ±210.9 (22m)	Soysal *et al.* (2007)
Weight_Gr	kg/hd	255	316.5±25.5– Slaughter weight	Manafiazar *et al.* (2007)
Weight_Gr	kg/hd	255	290 – replacement females - the animal are the age at first calving 340 – replacement males 252 – growing heifers - the animals are between the weaned age and the age at first calving 239 – growing steers 28 – birth weight	FAO (2017)
Weight_Gr	kg/hd	255	Weight range: 180 - 330	
Weight_C	kg/hd	105	208.8±8.0 (1yr) (18m): 400.5±14 393±20.5 377±15.3	Chashnidel *et al.* (2007)
Weight_C	kg/hd	105	15-31 (birth weight)	Soysal *et al.* (2005)
Weight_C	kg/hd	105	(birth weight) 31.79±0.47 31.87±0.08 32.91±0.06 33.16±0.08	Hossein-zadeh *et al.* (2012)
Weight_C	kg/hd	105	30.696±1.043 – birth weight 121.701±5.071– 180d 188.834±8.442– 360 d	Çelikeloğlu *et al.* (2015)
Weight_C	kg/hd	105	201±14 (12 m)	Mahmoudzadeh and Fazaeli (2009)
Weight_C	kg/hd	105	Females: 31 – birth weight 134 – 365 d Males: 31 – birth weight 143 – 365 d	Soysal *et al.* (2015)
Weight_C	kg/hd	105	(1yr): 181.0±10.78 159.8±12.02 164.4±7.18	Şekerden (2013)
Weight_C	kg/hd	105	Weight range: 30 – 180 kg	
Weight_gain_MF	kg/hd/d	0		IPCC (2006)
Weight_gain_MM	kg/hd/d	0		IPCC (2006)
Weight_gain_Gr	kg/hd/d	0.39	0.356 – replacement females - the animal are the age at first calving 0.425 – replacement males	FAO (2017)

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TABLE 10B.1-15
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF MIDDLE EAST IN TABLE 10A.5

Parameter [1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			0.357 – growing heifers - the animals are between the weaned age and the age at first calving 0.426 – growing steers	
Weight_gain_C	kg/hd/d	0.41	Females: 0-3m – 0.456 3-6m – 0.294 6-9m – 0.357 9-12m – 0.360 Males: 0-3m – 0.483 3-6m – 0.305 6-9m – 0.314 9-12m – 0.504	Soysal *et al.* (2007)
Feeding_MF		Pasture/ paddock	'The farmers let their water buffaloes bring to the pasture in each days of year, except extremely harsh conditions. In the evening the village's herd comes back to the village. The lactating water buffaloes are kept in closed barns in the evening. The remaining of herds was kept in simple constructed shelters in the evening.'	Soysal *et al.* (2005)
Feeding_MM		Pasture/ paddock	'In the research area, the buffalo feeding system depended on grazing, but grazing was not sufficient for buffaloes from October to April, and so farmers gave complementary feeding to the buffaloes. Farmers kept their buffaloes mainly under a semi-intensive feeding system in the study areas. '	Işik and Gül (2016)
Feeding_Gr		Pasture		FAO (2017)
Feeding_C		Pasture		FAO (2017)
Feeding_all			Ranging/grazing	GLEAM (FAO 2017): assumption based on FAO (2016)
Milk_MF	kg/hd/d	3.0	2.6	Faostat (2017)
Milk_MF	kg/hd/d	3.0	4.15	GLEAM (FAO 2017): input data from: FAO *et al.* (2014); Borghese (2010)
Milk_fat_MF	%	7.0	5.8 (Iran)	Dezfuli *et al.* (2011)
Milk_fat_MF	%	7.0	6.6±0.68 (minimum) 8.1±0.205 (maximum)	Soysal *et al.* (2007)
Milk_fat_MF	%	7.0	7.0	FAO (2017)
Milk_protein_MF	%	4.2	4.3 (Iran)	Dezfuli *et al.* (2011)
Milk_protein_MF	%	4.2	4.2 4.6	Soysal *et al.* (2007)
Milk_protein_MF	%	4.2	3.5	FAO (2017)
Working_MM	hr/day	1.55	'Buffalo for draught purpose is limited to tree stump hauling in forest area when mechanical	IPCC (2006) Soysal *et al.* (2005)

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TABLE 10B.1-15 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF MIDDLE EAST IN TABLE 10A.5				
Parameter [1]	**Unit**	**Value in Table 10A.5**	**Reference value (±SD)**	**Reference source**
			equipments may not be used.'	Soysal (2013)
Working_FM	hr/day	0.37		IPCC (2006)
Pregnancy rate_MF	%	65	65	Calculated based on Turkish Statistical Institute (2017)
Pregnancy rate_MF	%	65	66.5 – Dairy 68 – Mature females	GLEAM (FAO 2017): input data from litterature review and expert opinion
DC_MF	%	65	62	Calculated based on FAO *et al.* (2014), Gerber *et al.* (2011)
DC_MF	%	65	69.2 – Dairy 59.2 – Mature females	GLEAM FAO (2017)
DC_MM	%	60	59.1	FAO (2017)
DC_Gr	%	62	62	Assumed based on Mahmoudzadeh and Fazaeli (2009), FAO *et al.* (2014) Gerber *et al.* (2011)
DC_Gr	%	62	59.2 – replacement females - the animal are the age at first calving 59.1 – replacement males 62 – growing heifers - the animals are between the weaned age and the age at first calving 62 – growing steers	GLEAM (FAO 2017)
DC_C	%	62		The value of growing/replacement animals
CP_MF	%	11.0		The value of growing/replacement animals
CP_MF	%	11.0	102.1 (g/kg DM) – Dairy 94.1 – Mature females	GLEAM (FAO 2017): calculated with input data from FEEDIPEDIA, 2015
CP_MM	%	11.0		The value of growing/replacement animals
CP_MF	%	11.0	94.0 (g/kg DM)	GLEAM FAO, 2017 #1902}: calculated with input data from FEEDIPEDIA, 2015 GLEAM FAO (2017)
CP_Gr	%	11.0	9.2-11.24	Mahmoudzadeh *et al.* (2007)

TABLE 10B.1-15
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF MIDDLE EAST IN TABLE 10A.5

Parameter [1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
CP_Gr	%	11.0	12.5	Manafiazar *et al.* (2007)
CP_Gr	%	11.0	12.5	Azary *et al.* (2007)
CP_Gr	%		(g/kg DM) 94.0 – replacement females - the animal are the age at first calving 94.0 – replacement males 108.7– growing heifers - the animals are between the weaned age and the age at first calving 108.6 – growing steers	
CP_C	%	11.0	10.2 – 11.2	Mahmoudzadeh and Fazaeli (2009)
Day weighted population mix	%	21 – Calves 22 – Growing/Replacement 52 – Adult females 5 – Adult males	Of 100%: 21 – Calves 22 – Growing/Replacement 52 – Adult females 5 – Adult males	Turkish Statistical Institute (2017)
Day weighted population mix	%	21 – Calves 22 – Growing/Replacement 52 – Adult females 5 – Adult males	Of 100%: 11 – Dairy 25 – Mature females 7 – Mature males 23 – Replacement females 8 – Replacement males 6 – Growing heifers 16 – Growing steers 2 – Calves	FAO (2017)

[1] MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, C – Calves

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TABLE 10B.1-16 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5				
Parameter[1]	**Unit**	**Value in Table 10A.5**	**Reference value (±SD)**	**Reference source**
Weight_MF	kg/hd	480	516 (Murrah, 45% of total population)	AGRI-IS (2017) Breeding survey book (2013)
Weight_MF	kg/hd	480	401 (Surti, 3.5% of total population)	AGRI-IS (2017) Breeding survey book (2013)
Weight_MF	kg/hd	480	484 (Mehsana, 3.5% of total population)	AGRI-IS (2017) Breeding survey book (2013)
Weight_MF	kg/hd	480	568.7±25.4 (Murrah)	Shekhar *et al.* (2010)
Weight_MF	kg/hd	480	448±100.6 (>3 years, Nili-Ravi buffaloes) 529.5±67.5 (>8 years, Nili-Ravi buffaloes)	Tariq *et al.* (2013)
Weight_MF	kg/hd	480	550, Nili-Ravi buffalo	Anjum *et al.* (2012a)
Weight_MF	kg/hd	480	Murrah 554.5±4.66 540.16±5.62 552.9±4.36 542.1±7.26	Khare and Baghel (2010)
Weight_MF	kg/hd	480	Mature males: 300 Mature females: 275 1 to 3 years – 180 Below 1 year – 70	Dhingra *et al.* (2017)
Weight_MF	kg/hd	480	Birth: N - 30±4.6 S - 33±4.9 W - 29±6.3 E - 28±5.2 <u>At heifer stage:</u> N - 180±7.6 S - 161±8.2 W - 142±10.4	Garg *et al.* (2018) Region-wise, the following breeds were considered: northern region: buffalo: Bhadawari, Murrah, Nili Ravi; southern region: buffalo: Toda, non-descript; western region: buffalo: Jaffarabadi, Surti, Mehsana, Nagpuri; eastern region: buffalo: Mehsana-cross, Murrah-cross

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			E – 134±7.6 At lactation: N - 485±5.5 S - 437±4.8 W - 482±11.8 E – 474±20.1 At unproductive stage: N - 465±16.7 S - 380±5.4 W - 500±9.3 E – 410±8.4	
Weight_MM_MF	kg/hd		<1 year old: 70-80, 80-100 (male, female) – 70 (av) 1-3: 160-200, 176-220 (male, female) - 180 (av) Breeding bulls: 475-550 Working bulls: 475-550 Milking: 400–516 (275) Heifers: 276-320	Jha *et al.* (2011)
Weight_MM_MF	kg/hd		India Birth weight and adult body weight for different breeds of cattle	Singh (2002)

Breed	Birth weight			Adult weight	
	Male	Female	Overall	Male	Female
Amritmahal	20.8	19.9		500	318
Bachaur	19.7	18.8		385	318
Bargur	18.9	18.1		340	295
Dangi	18.4	17.5	17.9	363	310
Deoni	23.0	23.4		590	340
Gaolao	19.3	18.5		430	340
Gir	23.1	21.3	23.9	544	309.8
Hallikar	21.3	20.2		340	227
Hariana	23.34	21.73	22.4	499	325
Kangayam	22	21	21	540	380
Kankrej	24	23	23.0	343	
Kenkatha	19.2	18.9		350	300
Kherigarh	20.7	19.9		476	318

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<table>
<tr><th colspan="5">TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5</th></tr>
<tr><th>Parameter[1]</th><th>Unit</th><th>Value in Table 10A.5</th><th>Reference value (±SD)</th><th>Reference source</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><td>Khillari</td><td>22</td><td>21.3</td><td></td><td>499</td><td>334</td></tr>
<tr><td>Malvi</td><td>21</td><td>19</td><td>19.9</td><td>499</td><td>340</td></tr>
<tr><td>Nagori</td><td>17.5</td><td>16.3</td><td>16.9</td><td>362.9</td><td>317.5</td></tr>
<tr><td>Nimari</td><td>19.9</td><td>18.7</td><td></td><td>390</td><td>318</td></tr>
<tr><td>Ongole</td><td>28</td><td>26</td><td>26.8</td><td>570</td><td></td></tr>
<tr><td>Ponwar</td><td>17.6</td><td></td><td></td><td>318</td><td>295</td></tr>
<tr><td>Punganur</td><td>12.8</td><td>11.4</td><td>12.3</td><td>244</td><td>178</td></tr>
<tr><td>Rathi</td><td>19.4</td><td>19.1</td><td>19.2</td><td>294.81</td><td></td></tr>
<tr><td>Red Kandhari</td><td>20.4</td><td>18.7</td><td>20.1</td><td>430</td><td>340</td></tr>
<tr><td>Red Sindhi</td><td>22.5</td><td>21.4</td><td>21.9</td><td>450</td><td>320</td></tr>
<tr><td>Sahiwal</td><td>22.4</td><td>20.9</td><td>21.7</td><td>540</td><td>326.8</td></tr>
<tr><td>Siri</td><td>21.2</td><td>19.9</td><td></td><td>454</td><td>363</td></tr>
<tr><td>Tharparkar</td><td>23.1</td><td>22.4</td><td>22.6</td><td>294.8</td><td></td></tr>
<tr><td>Umbalachery</td><td>18.6</td><td>17.9</td><td></td><td>385</td><td>325</td></tr>
<tr><td>Vechur</td><td>11.2</td><td>10.2</td><td>10.6</td><td>178.43</td><td>132.0</td></tr>
</table>
Birth weight and adult body weight for different breeds of buffalo
<table>
<tr><td>Breed</td><td>Birth weight</td><td></td><td></td><td>Adult weight</td><td></td></tr>
<tr><td></td><td>Male</td><td>Female</td><td>Overall</td><td>Male</td><td>Female</td></tr>
<tr><td>Bhadawari</td><td>27.0</td><td>25.0</td><td>25.3</td><td>475</td><td>425.7</td></tr>
<tr><td>Mehsana</td><td>29.5</td><td>28.5</td><td>29.0</td><td>565.4</td><td>484.2</td></tr>
<tr><td>Murrah</td><td>31.7</td><td>30.0</td><td>30.3</td><td>567</td><td>516</td></tr>
<tr><td>Nagpuri</td><td>29.0</td><td>28.1</td><td>28.6</td><td>520</td><td>363.5</td></tr>
<tr><td>Nili-Ravi</td><td>35.1</td><td>34.5</td><td>34.8</td><td>567</td><td>454</td></tr>
<tr><td>Pandharpuri</td><td>28.0</td><td>25.6</td><td>26.8</td><td>416.2</td><td></td></tr>
<tr><td>Surti</td><td>26.3</td><td>24.5</td><td>25.2</td><td>500</td><td>382.6</td></tr>
<tr><td>Toda</td><td>27.9</td><td>28.0</td><td>27.9</td><td>380</td><td>380</td></tr>
</table>
</td><td></td></tr>
<tr><td>Weight_MF</td><td>kg/hd</td><td>480</td><td>486 – Dairy buffaloes</td><td>FAO (2017)</td></tr>
<tr><td>Weight_MF</td><td>kg/hd</td><td>480</td><td>481 – Mature females</td><td>FAO (2017)</td></tr>
<tr><td>Weight_MM</td><td>kg/hd</td><td>560</td><td>567 (Murrah, 45% of total population)</td><td>AGRI-IS (2017)
Breeding survey book (2013)</td></tr>
<tr><td>Weight_MM</td><td>kg/hd</td><td>560</td><td>432 (Surti, 3.5% of total population)</td><td>AGRI-IS (2017)
Breeding survey book (2013)</td></tr>
<tr><td>Weight_MM</td><td>kg/hd</td><td>560</td><td>565 (Mehsana, 3.5% of total population)</td><td>AGRI-IS (2017)
Breeding survey book (2013)</td></tr>
</table>

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
Weight_MM	kg/hd	560	510	FAO (2017)
Weight_Gr	kg/hd	195	375 kg (puberty age, 887-941 d), India 380.67±6.42 371.50±8.16	Gupta *et al.* (2016)
Weight_Gr	kg/hd	195	270 kg (weight at puberty – 35 months), Bhadawari buffalo 238.90 233.00 237.50 9.11 (pooled SEM)	Singh *et al.* (2015)
Weight_Gr	kg/hd	195	364±12.48 kg (25 months), Nili-Ravi buffalo 380.67±14.00, Murrah (35 months of age)	Anjum *et al.* (2012a)
Weight_Gr	kg/hd	195	162 (20 months) 200 (20 months) 172 (22 months) 190 (21 months)	Singal (2001)
Weight_Gr	kg/hd	195	202 (16 month old), Murrah 300 (21 month old)	Prusty *et al.* (2016)
Weight_Gr	kg/hd	195	150-170 (15-18 month old) 239 (slaughtering weight, 18-21 months old), Nili-Ravi buffalo	Jabbar *et al.* (2009)
Weight_Gr	kg/hd	195	Slaughtering weight: Buffalo slaughtered in India are a by-product of the dairy industry and the average carcass yield per animal varies. Av carcass weight – 103 kg (170 kg)	FICCI (2014)
Weight_Gr	kg/hd	195	(7-14 months), Murrah: 143.41±14.36 143.75±16.89 143.83±16.60 (+90 d):	Gami *et al.* (2017)

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TABLE 10B.1-16 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5				
Parameter[1]	**Unit**	**Value in Table 10A.5**	**Reference value (±SD)**	**Reference source**
			194.00±15.57 189.67±17.98 198.00±16.53	
Weight_Gr	kg/hd	195	140±14 (12-15 months)	Shahzad *et al.* (2011)
Weight_Gr	kg/hd	195	160 (12-15 month old), Nili-Ravi, Pakistan	Basra and Nisa (2003)
Weight_Gr	kg/hd	195	Weight at puberty (33.5-38.3 m) 260 278.5 268.3	Singh *et al.* (2015)
Weight_Gr	kg/hd	195	256 – replacement females - the animal are the age at first calving 270 – replacement males 94 – growing heifers - the animals are between the weaned age and the age at first calving 77 – growing steers 32 – birth weight	FAO (2017)
Weight_Gr	kg/hd	195	Weight range: 140-250	
Weight_C	kg/hd	85	(6-7 months), Pakistan: 77±0.5 (12 months), Pakistan: 106.83 101.83 107.83 106.33 107.67 93.83±4.74	Tauqir *et al.* (2011)
Weight_C	kg/hd	85	71.6±7.6 (8 months), Bhadawari 128-170 (14-15 months): 143.7 129.8	Singh *et al.* (2017)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	**Unit**	**Value in Table 10A.5**	**Reference value (±SD)**	**Reference source**
			146.3±12.9	
Weight_C	kg/hd	85	30-32 (Murrah), birth weight	AGRI-IS (2017)
Weight_C	kg/hd	85	28.5-29.5 (Mehsana), birth weight	AGRI-IS (2017)
Weight_C	kg/hd	85	24.5-26.3 (Surti), birth weight	AGRI-IS (2017)
Weight_C	kg/hd	85	128±4.1 (11-12 months, Murrah)	Kumar et al., 2011
Weight_C	kg/hd	85	77,79 (6 months): Hariana, Murrah 104,135 (12 months): Hariana, Murrah 144,203 (18 months): Hariana, Murrah	Pathak (2005) (p.209)
Weight_C	kg/hd	85	Murrah: 26.8; 31.2 – birth weight 34.9; 38.1 – 1 month 53.7; 59.6 – 3 months 82.4; 90.0 – 6 months 106.7 – 9 months 163.2; 164.3 – 12 months	Pathak (2005)
Weight_C	kg/hd	85	34.857±3.485; 36.6±3.209 (birth weight), Pakistan 140 (12 months) 175 (19 months): 175.0±20.841 170.0±7.106	Afzal *et al.* (2009)
Weight_C	kg/hd	85	88.4±4.37 (9-10 months of age) 150 (14-15 months): 150.0 156.5 148.0±8.19	Kumar and Dass (2006)
Weight_C	kg/hd	85	192±61.8 (1-3 year)	Tariq *et al.* (2013)
Weight_C	kg/hd	85	98.6±5.2 (6-8 months of age)	Anjum *et al.* (2012b)

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TABLE 10B.1-16 EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5				
Parameter[1]	**Unit**	**Value in Table 10A.5**	**Reference value (±SD)**	**Reference source**
Weight_C	kg/hd	85	137 (14 months) 134 (15 months) 143 (13 months) 193 (15 months)	Singal (2001)
Weight_C	kg/hd	85	Wiehgt range: 30-140	
Weight_gain_MF	kg/hd/d		0	IPCC (2006)
Weight_gain_MM	kg/hd/d		0	IPCC (2006)
Weight gain_Gr	kg/hd/d	0.31	564.79±44.45 511.11±44.93 601.85±31.88	Gami *et al.* (2017)
Weight gain_Gr	kg/hd/d	0.31	0.315 (Bhadawari buffalo)	Singh *et al.* (2015)
Weight gain_Gr	kg/hd/d	0.31	500.0 567.5 510.0±37.9	Kumar and Dass (2006)
Weight gain_Gr	kg/hd/d	0.31	Murrah 0.4 0.63±0.02 0.59±0.03	Anjum *et al.* (2012a)
Weight gain_Gr	kg/hd/d	0.31	0.35 (12-36 months), Murrah	Singal (2001)
Weight gain_Gr	kg/hd/d	0.31	0.25	Jha *et al.* (2011)
Weight gain_Gr	kg/hd/d	0.31	0.6-0.7	Basra and Nisa (2003)
Weight gain_Gr	kg/hd/d	0.31	0.308 – replacement females - the animal are the age at first calving 0.328 – replacement males 0.319 – growing heifers - the animals are between the weaned age and the age at first calving 0.336 – growing steers 32 – birth weight	FAO (2017)
Weight_gain_C	kg/hd/d	0.31	0.39-0.40 (Pakistan)	Tauqir *et al.* (2011)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			0.39 0.40 0.37 0.47 0.39 0.32±0.05	
Weight_gain_C	kg/hd/d	0.31	0.35 (at the age of 7-9 months) – average of 0.368 0.298 0.374	Singh *et al.* (2017)
Weight_gain_C	kg/hd/d	0.31	Murrah: 0.27; 0.28 – 1 month 0.313; 0.358 – 3 months 0.319; 0.338 – 6 months 0.186 – 9 months 0.449; 0.640 – 12 months	Pathak (2005)
Weight_gain_C	kg/hd/d	0.31	(3 months) 0.433±0.056 0.415±0.028	Afzal *et al.* (2009)
Weight_gain_C	kg/hd/d	0.31	0.53 (0-12 months)	Singal (2001)
Weight_gain_C	kg/hd/d	0.31	0.23	Jha *et al.* (2011)
Weight_gain_C	kg/hd/d	0.31	0.25-0.45 (Nili Ravi, Pakistan)	Khan *et al.* (2010)
Weight_gain_C	kg/hd/d	0.31	The growth rate from birth to 36 months, in various buffalo breeds was linear. The maximum growth rate was from birth to six months and the rate of relative growth declined with age. The overall average monthly gain from 0-36 months for large breeds was around 12 kg (0.4 per day).	Dhanda (
Weight_gain_C_GR	kg/hd/d	0.31	(from 6-8 months, for 180 d) 0.6±0.03 0.61±0.03	Anjum *et al.* (2012b)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	**Unit**	**Value in Table 10A.5**	**Reference value (±SD)**	**Reference source**
Weight_gain_C_Gr	kg/hd/d	0.31	0.24	Patra (2012)
Feeding_MF			Pasture/Paddock	Singh *et al.* (2012)
Feeding_MF			Ranging/Grazing	FAO (2017)
Feeding_MM			Pasture/Paddock	Singh *et al.* (2012)
Feeding_Gr			Pasture/Paddock	Assumed: the same feeding situation as for other categories of buffalo
Feeding_C			Pasture (Pakistan)	Tauqir *et al.* (2011)
Feeding_all			Ranging/Grazing	FAO (2017)
Milk_yield_MF	kg/hd/d	4.8	4.8	Faostat (2017)
Milk_yield_MF	kg/hd/d	4.8	4.7 – Dairy	FAO (2017)
Milk_fat_MF	%	7.3	7.3 (6.9-8.3), Murrah	AGRI-IS (2017)
Milk_fat_MF	%	7.3	Murrah (fat) 7.7±0.31 7.8±0.21 8.0±0.29 (Protein) 3.8±0.04 3.8±0.03 3.8±0.05	Shekhar *et al.* (2010)
Milk_fat_MF	%	7.3	6.83 (5.2-9.5), Mehsana	AGRI-IS (2017)
Milk_fat_MF	%	7.3	7.02 (3.8-8.7), Surti	AGRI-IS (2017)
Milk_fat_MF	%	7.3	5.82-9.37, Murrah	Anitha *et al.* (2011)
Milk_fat_MF	%	7.3	7.4	Patra (2012)
Milk_fat_MF	%	7.3	6.22±0.21 6.51±0.06	Khan *et al.* (2008)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			6.87±0.25 6.90±0.03 6.34±0.27 6.63±0.03 6.90±0.23 7.10±0.39 6.36±0.36 6.66±0.07 6.93±0.18 7.10±0.33	
Milk_fat_MF	%	7.3	4.7	FAO (2017)
Milk_protein_MF	%	3.5	3.12-3.97, Murrah	Anitha *et al.* (2011)
Milk_protein_MF	%	3.5	4.5	Patra (2012)
Milk_protein_MF	%	3.5	3.41±0.02 3.52±0.03 3.60±0.02 3.60±0.02 3.40±0.03 3.53±0.02 3.61±0.02 3.64±0.03 3.40±0.02 3.55±0.03 3.62±0.03 3.65±0.02	Khan *et al.* (2008)
Milk_protein_MF	%	3.5	3.5	FAO (2017)
Work_MM	hr/day	5.3	3–4 hours during summer time, and 6–8 hours in a day during winter time.	Ranjhan (2007)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
Work_MM	hr/day	5.3	1.7	Patra (2012)
Work_FM	hr/day	0.55	0 (dairy) 1.7 (non-dairy)	Jha *et al.* (2011)
Work_FM	hr/day	0.55		IPCC (2006)
Pregnancy rate_MF	%	50	50-57, Nili-Ravi	Anjum *et al.* (2012a)
Pregnancy rate_MF	%	50	35	Jha *et al.* (2011)
Pregnancy rate_MF	%	50	35	Patra (2012)
Pregnancy rate_MF	%	50	53 – Dairy cattle 51 – Mature Females	FAO (2017)
DC_MF	%	55	55	Calculated based on: FAO, 2014 Gerber *et al.* (2011)
DC_MF	%	55	55.6 (Murrah)	Shekhar *et al.* (2010)
DC_MF	%	55	63.1 – Dairy buffaloes 55.3 – Mature females	FAO (2017)
DC_MM_MF	%	55	50-60	Pathak (2005)
DC_MM_MF	%	55	39.13-71.6 (all age-categories of buffalo livestock)	Singh *et al.* (2012)
DC_MM	%	55	55.2	FAO (2017)
DC_Gr	%	59	g/kg DM 594.4±15.2 603.1±15.4 601.0±9.8	Gami *et al.* (2017)
DC_Gr	%	59	61.87 61.69 61.16±1.25	Kumar and Dass (2006)
DC_Gr	%	59	63.04	Singh *et al.* (2015)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			60.67 64.65±0.905 (pooled SEM)	
DC_Gr	%	59	56.00cd 59.00b 65.50a 55.50cd 56.50 64.50 54.50 58.00 64.50 57.50 59.50 63.50±0.83	Shahzad *et al.* (2011)
DC_Gr	%	59	64	Jabbar *et al.* (2009)
DC_Gr	%	59	58.6±0.69 54.5±2.30 51.0±1.36 59.4±2.24 62.2±1.17 63.4±1.02	Prusty *et al.* (2016)
DC_Gr	%	59	60 (15 months old), Nili-Ravi	Dahiya and Singh (2013)
DC_Gr	%	59	55.3 – Replacement females 55.2 – Replacement males 57.6 – Growing heifers 57.5 – Growing steers	FAO (2017)
DC_C	%	55	63-64 (low nutrient diet) , Pakistan	Tauqir *et al.* (2011)
DC_C	%	55	(Bhadawari buffalo):	Singh *et al.* (2017)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			56.2±2.0 56.0±1.8 56.3±1.0	
DC_all	%		50-60	Jha *et al.* (2011)
DC_all	%		55	Patra (2012)
CP_MF	%	12	11.7 CP intake, kg/day 1.5±0.11 1.6±0.05 1.5±0.06	Shekhar *et al.* (2010)
CP_MF	%	12	14.3-15.4 (calculated values) N intake, g/day 216.4±26.99 200.3±15.00	Garg *et al.* (2018)
CP_MF	%	12	103.7 (g/kgDM) – Dairy 78.8 (g/kgDM) – Mature females	FAO (2017)
CP_MM	%	12	Assumed the same value as for other buffalo categories	
CP_Gr	%	12	10-12 (calculated values) N intake, g/d 108.2±6.54 90.43±4.88 90.82±5.0	Gami *et al.* (2017)
CP_Gr	%	12	12-13 (calculated values) N intake, g/d 101.85 95.06 113.39±3.94 (pooled SEM)	Singh *et al.* (2015)
CP_Gr	%	12	12.36-13.41, Nili-Ravi	Anjum *et al.* (2012a)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
CP_Gr	%	12	10.15-13.8 (12-15 months)	Shahzad *et al.* (2011)
CP_Gr	%	12	12.7	Jabbar *et al.* (2009)
CP_Gr	%	12	12 (10-14), (15 month old), Nili-Ravi	Dahiya and Singh (2013)
CP_Gr	%	12	12-14	Prusty *et al.* (2016)
CP_Gr	%	12	78.8 – Replacement females 78.5 – Replacement males 90.6 – Growing heifers 89.2 – Growing steers	FAO (2017)
CP_C_Gr	%	12	9-14	Basra and Nisa (2003)
CP_C	%	12	9.1-9.5 (Bhadawari buffalo), calculated values CP intake, g 259.0±11.1 239.1±9.2 245.7±9.3	Singh *et al.* (2017)
CP_C	%	12	13 - average of 11.85 11.89 14.22 14.20 (low and medium diets were considered)	Tauqir *et al.* (2011)
CP_C	%	12	16, Nili Ravi	Anjum *et al.* (2012b)
Day weighted population mix	%	26 – Calves 21 – Growing/Replacement 1 – Breeding males 4 – Working males 48 – Mature females	Of 100%: 26 – Calves 21 – Growing/Replacement 1 – Breeding males 4 – Working males 48 – Mature females	Patra (2012)
Day weighted population mix	%		Of 100%: 42 – Dairy 13 – Mature females	FAO (2017)

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TABLE 10B.1-16
EXPLANATORY TEXT AND REFERENCES SOURCES USED FOR DEVELOPMENT OF NEW PARAMETERS FOR BUFFALOES OF INDIAN SUBCONTINENT IN TABLE 10A.5

Parameter[1]	Unit	Value in Table 10A.5	Reference value (±SD)	Reference source
			4 – Mature males 13 – Replacement females 5 – Replacement males 0 – Growing heifers 1 – Growing steers 22 – Calves	

[1] MF – Mature Females, MM – Mature Males, Gr – Growing/Replacement animals, C – Calves

Annex 10B.2 Estimation of Default Emission Factor(s) for Goat Tier 2 parameters

A database was compiled from peer-reviewed articles that studied in-vivo methane (CH_4) production from goat enteric fermentation. These studies were identified through a comprehensive literature search performed in Goggle scholar and researchgate and from sources that carried out review work such as a recent study attempting to derive statistical models for prediction of enteric CH_4 from goats (Patra & Lalhriatpuii 2016) and a New Zealand technical report for CH_4 and N excretion rates for goats (Lassey 2012). Data were directly extracted from the individual studies identified. Authors were contacted in order to fill in gaps of information from the studies.

Overall, 63 publications were obtained from a varied sample of countries and 18 different goat breeds (Aguilera *et al.* 1990; Prieto *et al.* 1990; Shibata *et al.* 1992; Haque *et al.* 1997; AFRC 1998; Haque *et al.* 1998; Islam *et al.* 2000; Islam *et al.* 2001; Rapetti *et al.* 2002; Puchala *et al.* 2005; Rapetti *et al.* 2005; Tovar-Luna *et al.* 2007b; Tovar-Luna *et al.* 2007c; Tovar-Luna *et al.* 2007a; Animut *et al.* 2008; Bhatta *et al.* 2008; Haque *et al.* 2008; Vermorel *et al.* 2008; Li *et al.* 2010; López *et al.* 2010a; López *et al.* 2010b; Tovar-Luna *et al.* 2010b; Tovar-Luna *et al.* 2010a; Gerber *et al.* 2011; Lassey 2011; López *et al.* 2011; Tovar-Luna *et al.* 2011; Abecia *et al.* 2012; Jeong *et al.* 2012; López *et al.* 2012; Mitsumori *et al.* 2012; Puchala *et al.* 2012a; Puchala *et al.* 2012b; Romero-Huelva *et al.* 2012; Yang *et al.* 2012; Bhatta *et al.* 2013; Chethan *et al.* 2013; López & Fernández 2013; Martínez-Fernández *et al.* 2013; Miri *et al.* 2013; López *et al.* 2014; Martínez-Fernández *et al.* 2014; Nielsen *et al.* 2014; Romero-Huelva & Molina-Alcaide 2014; Ibáñez *et al.* 2015a; Ibáñez *et al.* 2015b; Lu *et al.* 2015; Wang & Xue 2015; Arif *et al.* 2016; Castro-Lima *et al.* 2016; Criscioni & Fernández 2016; Lu *et al.* 2016; Patra & Lalhriatpuii 2016; Wang *et al.* 2016a; Wang *et al.* 2016b; Arco-Pérez *et al.* 2017; Barbosa *et al.* 2017; Keli *et al.* 2017; Kumar *et al.* 2017; Na *et al.* 2017; Romero-Huelva *et al.* 2017; Tovar-Luna *et al.* 2017; Azlan *et al.* 2018; Fernández *et al.* 2018; Li *et al.* 2018; Na *et al.* 2018a; Na *et al.* 2018b; Puchala *et al.* 2018)

Although there was a total of 290 treatment means, treatments that were using substances with antimethanogenic properties were excluded before analysis. The minimum prerequisite for a study to be included in the data set was that Ym values (or gross energy and CH_4 output energy) were reported.

Information on feed and diet characteristics, feed intake, breed, animal type, digestibility, and rumen were collected in the final data set. Table 10B.2-17 shows the mean and the range of some of the diet and animal variables for the different studies. Values were quite heterogeneous. For example, dry matter intake ranged between 0.14 and 2.51 kg DM intake/day animal (0.93 on average).

The concentrations of crude protein (CP), neutral detergent fibre (NDF) and starch were within the range of 6-26% (mean value of 15%), 18-74% (mean value of 42%) and 1-42% (mean value of 19%), respectively.

Methane production was expressed as grams per day, liters per day, megajoules per day, or as a proportion of GE or DE; therefore, the following factors were used in converting units: 1 g = 1.40 L =55.5 kJ; 1 L = 0.716 g = 39.54 kJ.

TABLE 10B.2-1
MEAN, MEDIAN, MAXIMUM, MINIMUM AND QUARTILE 1 AND 3 (Q1 AND Q3) VALUES FOR A SELECTION FEED DIET COMPOSITION, FEED INTAKE, BODY WEIGHT AND MILK PRODUCTIVITY.

	Digestibility (%)					Feed intake			***body weight***	Milk yield
	DM	OM	N	NDF	GE	DM (kg/day)	GE (MJ/day)	DE (MJ/day)	kg/animal	(kg/day animal)
mean	68%	69%	72%	54%	71%	0.94	18.77	12.18	39.82	1.90
median	69%	71%	73%	53%	72%	0.78	15.20	9.44	40.05	1.59
max	83%	91%	84%	82%	83%	2.59	46.68	29.90	64.00	3.69
min	49%	40%	44%	18%	52%	0.14	4.64	6.02	14.53	0.81
Q1	64%	65%	67%	46%	67%	0.62	11.80	8.44	33.45	1.31
Q3	74%	76%	78%	60%	76%	1.14	26.12	11.09	47.55	2.28

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The CH_4 emissions also varied greatly in the dataset. Table 10B.2-18 shows the methane emissions expressed in different units and metrics.

Table X. Mean, median, maximum, minimum and quartile 1 and 3 (Q1 and Q3) values for CH_4 production results referred as a proportion of gross energy intake (CH_4 conversion factor: Ym), per day, per kg DM intake, per kg of milk produced and per kg of body weight

TABLE 10B.2-2

MEAN, MEDIAN, MAXIMUM, MINIMUM AND QUARTILE 1 AND 3 (Q1 AND Q3) VALUES FOR CH_4 PRODUCTION RESULTS REFERRED AS A PROPORTION OF GROSS ENERGY INTAKE (CH^4 CONVERSION FACTOR: YM), DAY^{-1}, KG DM INTAKE^{-1}, KG OF MILK PRODUCED^{-1} AND KG OF BODY WEIGHT^{-1}

	CH_4				
	Ym	*MJ/day*	*MJ/kg DM*	*MJ/kg milk*	*J/kg BW*
mean value	5.3%	0.9	1.0	0.8	23.1
median	5.3%	0.8	1.0	0.8	20.5
max	10.3%	3.8	4.7	1.7	73.6
min	1.2%	0.2	0.3	0.2	5.3
Q1	4.3%	0.6	0.8	0.6	15.8
Q3	6.3%	1.0	1.2	1.1	27.4

The average methane emission was 16.2 g CH_4/animal day, 18.3 g CH_4/kg DM intake, 0.42 g CH_4/ kg BW (*data not shown*). Average/median methane conversion factor (Ym) was 5.3%, which is in the range of the recent value obtained by the study by Patra & Lalhriatpuii (2016), which included 42 studies.
We analyzed the relationship between methane output and diet type (e.g. diet digestibility, % forage use) but there were not any clear statistical relationships between diet type and enteric methane output (*data not shown*).
In general increased body weight and milk yield resulted in greater CH_4 output but body weight and milk yield did not show any statistical relationship with Ym (*data not shown*).
Methane output per animal were positively correlated with dry matter (Fig 1) and gross energy (Fig 2) intake (R2=0.60; P<0.00001).

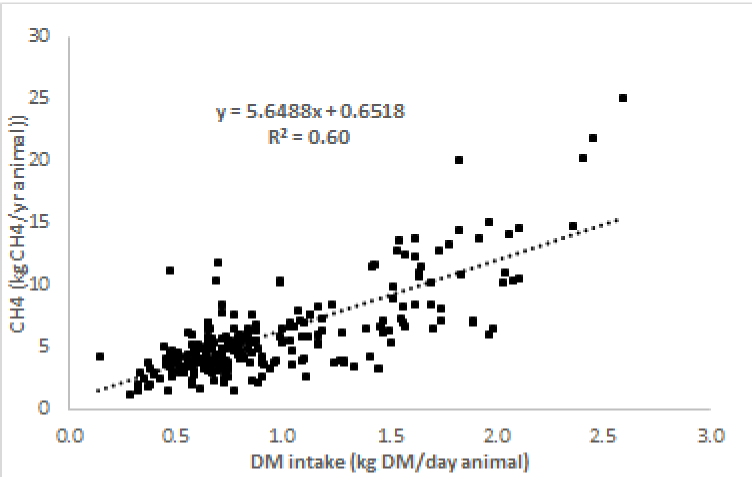

Fig 10B.1-1. Annual enteric methane output per animal expressed in mass in relation to daily dry matter (DM) intake.

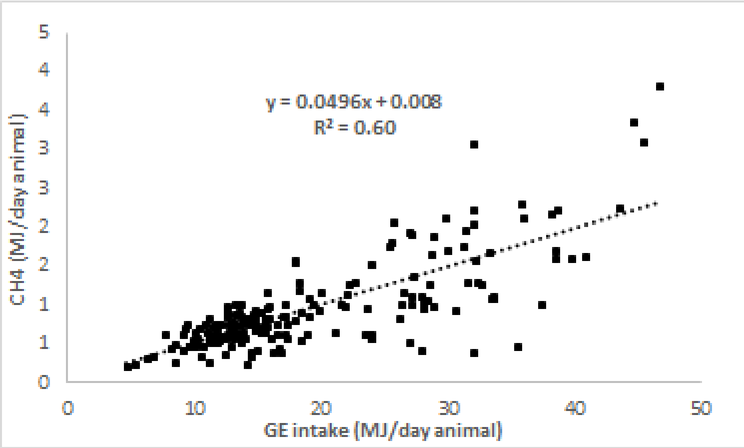

Fig 10B.2-2. Daily enteric methane output per animal expressed in energy in relation to daily gross energy (GE) intake.

In order to develop Tier 1 EF for enteric CH_4 from goats for both low and high production systems the following steps were followed:

- Average goat weight (LW) for high and low production systems were estimated using global world information from Gerber et al. (2013). For high and low production systems it was estimated average weight values of 50 kg and 28 kg, respectively.
- Daily dry matter intake per animal was estimated as a function of animal weight using the equation from AFRC (1998).
- Using the equation from Fig 1 we obtained kg CH_4/animal yr as a function of the previously estimated value of daily dry matter intake.

EF for Tier 1 resulted in 8.7 and 4.9 kg CH_4/head yr for high and low production systems, respectively. These values are both lower than that estimated than Vermorel *et al.* (2008) from French systems (11.9 kg CH_4/head yr^{-1}) and that from high production systems is similar to that proposed for Lassey (2012) for New Zealand goat herd.

Considering the data analysed, a Ym methane conversion factor a 5.5 % has been chosen. No clear evidence was found to develop Ym factors separately as a function of diet quality or production system.

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Annex 10B.3 Feed intake estimates using a simplified Tier 2 method

Prediction of DMI for cattle based on body weight and estimated dietary net energy concentration (NE_{ma}) or digestible energy values (DC%):

Several studies have shown that dry matter intake (DMI) is highly and positively related to methane emissions. In some cases it has been reported that up to 92% of the variability in enteric methane emissions could be explained by DMI alone (Charmley *et al.* 2016). Most models developed to predict enteric methane emissions usually include either DMI or some form of feed intake. There are a number of models already developed with the objective of predicting DMI and these could be used in conjunction with emission factors to estimate enteric methane emissions in a Tier 2 approach. Appuhamy *et al.* (2016) evaluated 40 prediction equations using data that included measured DMI and feed quality attributes from North America, Europe and Australia/New Zealand. The best performing models in each region were then re-evaluated using calculated DMI and compared with estimates that used measured DMI. They evaluated several DMI prediction equations including the Cornell Net Carbohydrate and Protein System (CNCPS, Fox *et al.* 1992) as modified by Arnerdal (2005), National Research Council (NRC 2001) (developed based on North America cows), Lindgren *et al.* (2001) and Arnerdal (2005) (developed using data from cows in Europe), and Vazquez and Smith (2000) model (developed from Australia/New Zealand data). Appuhamy *et al.* (2016) reported that models using estimated DMI predicted enteric methane emissions just as good as the measured data and concluded that enteric methane emissions from dairy cows can be predicted successfully with estimated DMI, particularly using the modified CNCPS model. Appuhamy *et al.* (2017) further evaluated the comprehensive (IPCC-CMP) and simplified (IPCC-SMP) IPCC models (IPCC 2006) to predict DMI as well as the modified CNCPS and NRC (2001) models to predict DMI using an independent data. The modified CNCPS relying on BW and fat corrected milk yield (Eq. 1) more accurately predicted DMI (RMSPE = 14.1%) than NRC (RMSPE = 19.4%), IPCC-SMP (RMSPE = 16.9%), and IPCC-CMP (RMSPE = 23.4%). Overall, the results demonstrated that DMI of dairy cows can be predicted successfully using information such as milk yield, milk fat content, and body weight (BW) that are routinely available in dairy farms.

DMI (kg/d) = 0.0185 x BW (kg) + 0.305 x fat corrected milk (kg/d) Eq [1]

A simplified approach can also be used to estimate DMI of beef cattle, as described by NASEM (2017). For growing and finishing cattle, equations are:

Calves

$$DMI\ (kg/d) = (BW^{0.75} \times (0.2435 \times NEm - 0.0466 \times NEm^2 - 0.1128)) / NEm \qquad \text{Eq. [2]}$$

Yearlings

$$DMI\ (kg/d) = (BW^{0.75} \times (0.2435 \times NEm - 0.0466 \times NEm^2 - 0.0869)) / NEm \qquad \text{Eq. [3]}$$

Feedlot cattle (high grain diets)

Steers: DMI (kg/d) = 3.830 + 0.0143 x BW x 0.96 Eq. [4]

Heifers: DMI (kg/d) = 3.184 + 0.01536 x BW x 0.96 Eq. [5]

Where: BW = body weight (kg), NEm = Mcal/kg feed DM Eq. [6]

Mature Cows

Forage type	Digestibility	Forage DMI Capacity (kg/day), % of BW (kg)	
		Non-lactating	Lactating
Low quality	<52	1.8	2.2
Average quality	52-59	2.2	2.5
High quality	>59	2.5	2.7

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Annex 10B.4 Estimation Cattle/Buffalo CH4 conversion factors (Ym)

Dairy Yms were developed considering values from Appuhamy *et al.* (2016) , Hellwing *et al.* (2016) and Niu *et al.* (2018) according to the summaries peresnted in these publications methodology outlined in that publication. The cutoffs of milk productivity were intended to represent high, medium and low levels of productivity in these publications for which there was definitive data. A lack of literature was available for very low production systems and as a result, the 2006 default value of 6.5 was proposed for all other production systems.

In the case of beef cattle, a total of 78 measurements were compiled from 27 studies. Studies were divided by their dominant diet type into three categories, high forage diets, mixed diets (mixed forage and concentrate) and feedlot diets. No statistical analysis was carried out, with the exception of the development of group averages. An overall average was developed for the feedlot and non-feedlot diets. Non feedlot diets were differentiated between dominantly forage based diets and mixed concentrate diets. Though there is important variability in the results of scientific studies numerous empirical and biochemical modelling studies demonstrate both statistical significance and the biochemical processes that impact methane production with the introduction of concentrates to ruminant diets (Mills *et al.* 2001; Mills *et al.* 2003; Ellis *et al.* 2006; Ellis *et al.* 2007; Ellis *et al.* 2009; Ellis *et al.* 2010; Alemu *et al.* 2011; Bannink *et al.* 2011; Ellis *et al.* 2014; Escobar-Bahamondes *et al.* 2016; Kebreab *et al.* 2016). At present it was not considered possible to introduce additional categories for differentiation between low and high quality forages, due to a lack of data, particularly for low quality feed conditions.

TABLE A10.B.4-1
DATA COMPILED FOR THE COMPILATION OF YM VALUES FOR CATTLE AND BUFFALO

Author	Measurement method	BW (kg)	Category	Methane (g/kg DMI)	Ym
Baron *et al.* (2017)	Micro-meteorological	690	High forage	23.73	7.16
Baron *et al.* (2017)	Micro-meteorological	690	High forage	17.72	5.34
(Beauchemin & McGinn 2006)	Chambers	260	High forage	25.50	7.93
(Beauchemin & McGinn 2006)	Chambers	328	High forage	21.60	6.43
Beauchemin and McGinn (2005)	Chambers	306	High forage	24.80	7.55
Beauchemin and McGinn (2005)	Chambers	306	High forage	24.80	7.55
Beauchemin and McGinn (2005)	Chambers	344	High forage	24.30	7.28
Boadi and Wittenberg (2002)	SF6	310	High forage	19.40	6.00
Boadi and Wittenberg (2002)	SF6	310	High forage	21.45	7.10
Boadi and Wittenberg (2002)	SF6	310	High forage	21.12	6.90
Boadi and Wittenberg (2002)	SF6	310	High forage	23.17	7.60
Boadi and Wittenberg (2002)	SF6	310	High forage	20.86	7.10
Boadi and Wittenberg (2002)	SF6	310	High forage	21.12	7.10
Chaves *et al.* (2006)	SF6	380	High forage	23.30	7.30
Chaves *et al.* (2006)	SF6	380	High forage	31.00	9.60
Chaves *et al.* (2006)	SF6	380	High forage	37.40	11.80
Chaves *et al.* (2006)	SF6	380	High forage	18.70	5.80
Chaves *et al.* (2006)	SF6	380	High forage	21.60	6.90
Chaves *et al.* (2006)	SF6	380	High forage	25.70	7.90

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Chung *et al.* (2013)	Chambers	630	High forage	26.60	8.60
Chung *et al.* (2013)	Chambers	630	High forage	24.80	8.20
Chung *et al.* (2013)	Chambers	630	High forage	28.20	9.10
Chung *et al.* (2013)	Chambers	630	High forage	24.00	8.00
Chung *et al.* (2013)	Chambers	614	High forage	22.30	7.10
Chung *et al.* (2013)	Chambers	614	High forage	22.50	7.10
Hart *et al.* (2009)	SF6	470	High forage	25.60	9.80
Hart *et al.* (2009)	SF6	470	High forage	25.70	9.90
Kennedy and Charmley (2012)	Chambers	326	High forage	18.60	5.80
Kennedy and Charmley (2012)	Chambers	326	High forage	21.70	6.93
Kennedy and Charmley (2012)	Chambers	326	High forage	20.25	6.40
Kennedy and Charmley (2012)	Chambers	326	High forage	18.60	5.50
Kennedy and Charmley (2012)	Chambers	326	High forage	19.00	6.00
Kennedy and Charmley (2012)	Chambers	326	High forage	15.80	5.00
Kennedy and Charmley (2012)	Chambers	326	High forage	18.50	5.40
Kennedy and Charmley (2012)	Chambers	326	High forage	21.40	6.50
Mc Geough *et al.* (2010a)	SF6	531	High forage	29.40	8.40
Mc Geough *et al.* (2010a)	SF6	531	High forage	25.80	7.70
Mc Geough *et al.* (2010a)	SF6	531	High forage	27.70	8.10
Mc Geough *et al.* (2010a)	SF6	531	High forage	26.20	7.30
Mc Geough *et al.* (2010b)	SF6	539	High forage	30.10	8.90
Mc Geough *et al.* (2010b)	SF6	539	High forage	27.50	8.24
Mc Geough *et al.* (2010b)	SF6	538	High forage	28.00	8.52
Mc Geough *et al.* (2010b)	SF6	538	High forage	25.90	6.79
Mc Geough *et al.* (2010b)	SF6	539	High forage	35.60	9.72
Nascimento *et al.* (2016)	SF6	402	High forage	17.38	6.18
Nascimento *et al.* (2016)	SF6	402	High forage	23.41	9.02
Nascimento *et al.* (2016)	SF6	402	High forage	20.02	7.42
Pinares-Patiño *et al.* (2003)	SF6	712	High forage	21.07	5.90
Pinares-Patiño *et al.* (2003)	SF6	712	High forage	22.66	6.70
Pinares-Patiño *et al.* (2003)	SF6	712	High forage	21.84	6.60
Pinares-Patiño *et al.* (2003)	SF6	712	High forage	22.03	6.50
Staerfl *et al.* (2012)	Chambers	310	High forage	16.57	5.28
Staerfl *et al.* (2012)	Chambers	310	High forage	15.53	4.72
Staerfl *et al.* (2012)	Chambers	480	High forage	16.46	5.13
Staerfl *et al.* (2012)	Chambers	493	High forage	18.94	5.73
Staerfl *et al.* (2012)	Chambers	498	High forage	16.87	5.12
Vyas *et al.* (2014)	Chambers	406	High forage	25.69	7.80
MEAN (±SD)				23.0±4.6	7.2±1.5
(Beauchemin & McGinn 2006)	Chambers	328	Intermediate forage	19.90	5.92
(Beauchemin & McGinn 2006)	Chambers	328	Intermediate forage	21.10	6.26
(Beauchemin & McGinn 2006)	Chambers	328	Intermediate forage	20.50	6.09

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(Beauchemin *et al.* 2007)	Chambers	324	Intermediate forage	20.00	6.67
Doreau *et al.* (2011)	SF6	417	Intermediate forage	20.20	6.20
Doreau *et al.* (2011)	SF6	417	Intermediate forage	22.60	6.70
Fiorentini *et al.* (2014)	SF6	419	Intermediate forage	16.55	4.81
Hünerberg *et al.* (2013b)	Chambers	388	Intermediate forage	25.30	7.80
Hünerberg *et al.* (2013b)	Chambers	388	Intermediate forage	21.50	6.60
Hünerberg *et al.* (2013b)	Chambers	388	Intermediate forage	23.90	7.30
Jordan *et al.* (2006)	SF6	474	Intermediate forage	25.46	7.90
Lovett *et al.* (2003)	SF6	462	Intermediate forage	20.40	6.60
McGinn *et al.* (2009)	SF6	381	Intermediate forage	23.80	7.10
McGinn *et al.* (2009)	SF6	381	Intermediate forage	19.90	5.40
Romero-Perez *et al.* (2014)	Chambers	549	Intermediate forage	24.62	6.49
Romero–Perez *et al.* (2015)	Chambers	666	Intermediate forage	22.46	6.46
Staerfl *et al.* (2012)	Chambers	107	Intermediate forage	15.06	4.57
Staerfl *et al.* (2012)	Chambers	107	Intermediate forage	13.73	4.18
Staerfl *et al.* (2012)	Chambers	304	Intermediate forage	15.02	4.59
Staerfl *et al.* (2012)	Chambers	107	Intermediate forage	14.54	4.42
Troy *et al.* (2015)	Chambers	696	Intermediate forage	24.90	7.52
Troy *et al.* (2015)	Chambers	696	Intermediate forage	25.20	7.61
Vyas *et al.* (2016a)	Chambers	602	Intermediate forage	20.00	6.38
Vyas *et al.* (2016b)	Chambers	377	Intermediate forage	26.40	8.18
MEAN (±SD)				21.0±3.8	6.3±1.2
Beauchemin and McGinn (2005)	Chambers	439	Feedlot	9.20	2.81
Beauchemin and McGinn (2005)	Chambers	427	Feedlot	13.1	4.03
Doreau *et al.* (2011)	SF6	417	Feedlot	10.20	3.00
Hales *et al.* (2012)	Head boxes	223	Feedlot	8.26	2.47
Hales *et al.* (2012)	Head boxes	223	Feedlot	9.94	3.04
Hales *et al.* (2013)	Head boxes	322	Feedlot	7.63	2.40
Hales *et al.* (2013)	Head boxes	322	Feedlot	8.00	2.50
Hales *et al.* (2013)	Head boxes	322	Feedlot	9.43	2.90
Hales *et al.* (2013)	Head boxes	322	Feedlot	12.44	3.70
Hales *et al.* (2014)	Head boxes	362	Feedlot	10.84	3.07
Hales *et al.* (2014)	Head boxes	362	Feedlot	11.78	3.35

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Hales *et al.* (2014)	Head boxes	362	Feedlot	13.35	3.80
Hales *et al.* (2014)	Head boxes	362	Feedlot	14.73	4.18
Hales *et al.* (2015b)	Head boxes	503	Feedlot	13.01	3.94
Hales *et al.* (2015a)	Head boxes	NA	Feedlot	10.92	3.27
Hales *et al.* (2015a)	Head boxes	NA	Feedlot	10.88	3.08
Hales *et al.* (2015a)	Head boxes	NA	Feedlot	10.74	3.21
Hales *et al.* (2015a)	Head boxes	NA	Feedlot	10.80	3.13
Hales *et al.* (2017)	Head boxes	397	Feedlot	11.05	3.39
Hegarty *et al.* (2007)	SF6	541	Feedlot	16.30	5.09
Hegarty *et al.* (2007)	SF6	541	Feedlot	14.70	4.59
Hünerberg *et al.* (2013a)	Chambers	529	Feedlot	16.60	5.00
Hünerberg *et al.* (2013a)	Chambers	529	Feedlot	13.60	4.00
Hünerberg *et al.* (2013a)	Chambers	529	Feedlot	18.40	5.50
Hünerberg *et al.* (2013a)	Chambers	529	Feedlot	14.50	4.20
Jordan et al. 2006a	SF6	338	Feedlot	11.81	3.90
Lee *et al.* (2017)	Chambers	553	Feedlot	18.30	5.47
Mc Geough *et al.* (2010a)	SF6	531	Feedlot	22.10	6.30
Mc Geough *et al.* (2010b)	SF6	537	Feedlot	15.30	3.71
Troy *et al.* (2015)	Chambers	696	Feedlot	13.50	4.12
Troy *et al.* (2015)	Chambers	696	Feedlot	15.80	4.79
Vyas *et al.* (2014)	Chambers	581	Feedlot	15.30	4.40
Vyas *et al.* (2016b)	Chambers	549	Feedlot	16.10	4.45
MEAN (±SD)				12.99±3.3	3.84±1.0

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Annex 10B.5 Description and Discussion of Proposed Changes to MCF Calculations for Liquid/Slurry.

The following briefly summarizes the 2006 approach and improvements included in the current approach.

IPCC 2006 Model for Liquid/Slurry:

The IPCC 2006 MCF for liquid slurry was based on the following relationship:

MCF = *f*

where *f* was calculated with the following temperature-dependent Arrhenius function, derived from Mangino et al., 2001, which is based on Safley and Westerman (1990):

$f = \text{EXP}[(\text{Ea}\times(T_2-T_1))/(R\times T_2\times T_1)]$

where,

f is a unitless fraction (0 to 1). Originally, Safley and Westerman (1990) used *f* to design an anaerobic digestion system at a lower temperature (T_2) based on known performance of a digester at a warmer temperature (T_1).

Ea is the activation energy. Originally, Safley and Westerman used Ea = 15175 cal/mol, based on an earlier study. Mangino et al. 2001 continued to use 15175 cal/mol.

T_2 is the variable temperature (K). Defined by Safley and Westerman (1990) as the unknown anaerobic digester temperature. Mangino et al. 2001 defined T2 as the monthly temperature of the anaerobic lagoon (assuming equality with monthly average air temperature). IPCC (2006) defined T2 as the annual average temperature of a region.

T_1 is the reference temperature (K). Defined by Safley and Westerman (1990) as 30 °C (303.16 K). Mangino et al. 2001 and IPCC 2006 use the same value.

R is the gas constant 1.987 cal k^{-1} mol^{-1}.

The reasons for modification of MCF though the Methane conversion factor (MCF) remains an uncertain parameter.

First and foremost, in the IPCC 2006 , the MCF parameter violates a first-principle of inventory development: comparability. The use of an annual average temperature to calculate MCF systematically underestimates the annual MCF due to the mathematical principle known as Jensen's Inequality which applies to non-linear functions such as the Arrhenius equation (VanderZaag *et al.* 2018). Using this mathematical principle it can be shown that for a 1-month retention time, the annual average MCF calculated based on monthly temperature will always exceed the MCF calculated from the annual average temperature. Therefore, the IPCC 2006 MCF values are underestimates, and the level of underestimation is greatest for countries with large seasonal temperature extremes.

The 2006 model also used an MDP factor which reduced the mass of VS entering the manure storage or lagoon. Since VS cannot simply vanish, there needs to be justification for altering the VS loading rate. In the modified method, the MCF calculation used an MDP = 1.0, which means we are assuming the VS Excretion rates are correct, and that VS Excreted enters the liquid manure storage. MDP factors may be used in specific cases such as when solid-liquid separation systems are used, whereby VS is removed from the liquid system and transferred to a solid system. However in most cases the use of MDP factor is indicative of an inaccurate B0 or VS input into the manure storage system.

For the sake of completeness, it is worth pointing out that the quantity of VS entering liquid storage could be greater than VS excreted (implied MDP >1.0). For instance, the use of straw bedding results in additional VS entering the liquid storage. Another example is waste milk (from treated cows, or from cleaning milking systems) on dairy farms which adds VS to the storage. Secondly, it is well known that the retention time of liquid manure in storage is a critical parameter in determining MCF, and the IPCC 2006 guidelines state "both temperature and retention time play an important role in the calculation of MCF". However, the IPCC 2006 calculations of MCF (Table 1), give very little focus to retention time. Previous IPCC Good Practice Guide recommended that future MCFs be modeled accounting for the storage period (Zeeman & Gerbens 2000).

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Furthermore, the work of Safley and Westerman (1990) showed that the same amount of VS destruction can be achieved by longer retention time at lower temperature compared with shorter retention time at higher temperature. Furthermore the suggestion to use equation 1 for batch-fed storage/digesters that is currently in 2006 guidelines would not result in a value that is comparable to the default annual temperature values, because this equation would inherently require inclusion of retention time.

Recent year-round field studies in climates where the annual average air temperature was <10° C have reported MCFs in the range of 0.61 (Wightman & Woodbury 2016) , ⩾0.57 (Balde *et al.* 2016a) at liquid dairy manure storages, and greater for anaerobic lagoons (Leytem *et al.* 2017). Controlled studies at or around 20° C without added inoculum reported MCF of 55% over 165 d (VanderZaag *et al.* 2010) and 32% over 150-d (Masse *et al.* 2008). Another study showed the MCF increased non-linearly with the duration of storage (Le Riche *et al.* 2016). Previous IPCC Guidance reported an MCF of 39%, 45%, and 72% for liquid/slurry for Cool, Temperate, and Warm climates, respectively (Zeeman & Gerbens 2000). They also stated that liquid/slurry storage tanks were considered to have ⩾6 month retention time. Therefore, the interaction between retention time and temperature has long been recognized, but the calculation of MCFs has not been fully transparent about how this important interaction has been handled (or how it should be handled by practitioners) and therefore has made comparability with measurements challenging.

Thirdly, the single temperature time step given in the IPCC guidelines suggests a level of certainty that is simply not supported by the experimental results, considering the approach being used.

Table 10A-26. IPCC 2006 Table of MCF values for Liquid/Slurry (Table 10.17)

TABLE 10.17
MCF VALUES BY TEMPERATURE FOR MANURE MANAGEMENT SYSTEMS

System[a]		MCFs by average annual temperature (°C)																			Source and comments
		Cool					Temperate											Warm			
		≤ 10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	≥ 28	
Liquid/Slurry	With natural crust cover	10%	11%	13%	14%	15%	17%	18%	20%	22%	24%	26%	29%	31%	34%	37%	41%	44%	48%	50%	Judgement of IPCC Expert Group in combination with Mangino *et al.* (2001) and Sommer (2000). The estimated reduction due to the crust cover (40%) is an annual average value based on a limited data set and can be highly variable dependent on temperature, rainfall, and composition. When slurry tanks are used as fed-batch storage/digesters, MCF should be calculated according to Formula 1.
	Without natural crust cover	17%	19%	20%	22%	25%	27%	29%	32%	35%	39%	42%	46%	50%	55%	60%	65%	71%	78%	80%	Judgement of IPCC Expert Group in combination with Mangino *et al.* (2001). When slurry tanks are used as fed-batch storage/digesters, MCF should be calculated according to Formula 1.

Proposed Changes:

The proposed change is to use a spreadsheet model to calculate MCF using monthly temperature in each IPCC climate region, and for a specific liquid manure retention time (e.g. the Table below). Therefore, this approach produces MCF values that account for both temperature and retention time, while leaving the users to decide which retention time is appropriate for their manure management systems. The spreadsheet model will be made available as well.

	Tropical Montane	Tropica l Wet	Tropical Moist	Tropica l Dry	Warm Temperate Moist	Warm Temperate Dry	Cool Temperate Moist	Cool Temperate Dry
RETENTI ON TIME	**N_TM**	**N_T W**	**N_TMs t**	**N_TD**	**N_WTM**	**N_WTD**	**N_CTM**	**N_CTD**
1 Month	0.25	0.38	0.36	0.42	0.13	0.15	0.06	0.08
3 Month	0.43	0.61	0.57	0.62	0.24	0.28	0.12	0.16
4 Month	0.50	0.67	0.64	0.68	0.29	0.32	0.15	0.19
6 Month	0.59	0.76	0.73	0.74	0.37	0.41	0.21	0.26
12 Month	0.73	0.80	0.80	0.80	0.55	0.64	0.31	0.42
Tavg C	21.5	25.9	25.2	25.6	13.9	14.0	4.6	5.8

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Figure A10.B.5-1. MCFs calculated for each retention time and climate. (selected IPCC Climate regions shown) Note that an upper limit MCF of 80% has been imposed for consistency with the Anaerobic Lagoon MCFs at high temperatures and long retention times

Changes in liquid/slurry Mcf, compared to the IPCC 2006 are summarized below:

#1 – Timestep:
Monthly temperature (proposed) instead of annual average temperature (IPCC 2006)

Methane emissions are non-linearly related to temperature, therefore Jensen's inequality states that the use of the average temperature will lead to systematic underestimation. As a result, monthly average air temperature is proposed for the calculation of MCF, rather than annual average temperature. Therefore, it is proposed that MCF for liquid/slurry be calculated using the Mangino *et al.* (2001) spreadsheet model, with the regional climate data from the IPCC defined climate regions. Additional details below.

#2 – Retention Time:
Several retention times (proposed) instead of 1-month implied retention time (IPCC 2006).

Retention time is a crucial parameter determining the extent of methane emissions and the quantity of VS in storage at any given time, therefore affecting the MCF. The IPCC 2006 used a 1-month retention time for all liquid/slurry systems by using MCF = *f*, based on an annual average temperature. Using a 1-month retention time is unrealistic, since the majority of liquid/slurry storages are meant for storage over several months or more. Therefore, it is proposed to calculate MCF based on five retention times: **1 month, 3 months, 4 months, 6 months, and 12 months.**

Proposed "Good Practice" in the case of countries that do not know have information on retention times is to use the six month retention time.

#3 – Activation Energy (Ea):
Updated Ea value (19347 cal/mol proposed) instead of 15175 cal/mol (IPCC 2006).

Recent research from Petersen *et al.* (2016) and Elsgaard *et al.* (2016) propose a new Ea value of 81 kJ/mol = 19347 cal/mol. It is proposed to use this updated value.

#4 – Reference Temperature (T_1):
Updated T1 value (308.16 proposed) instead of 303.16 K (IPCC 2006).

The value of T_1 used by IPCC 2006 and Mangino *et al.* (2001) is directly taken from Safley and Westerman (1990). The original intent of Safley and Westerman was comparing performance of a known and unknown anaerobic digester performance. In Mangino *et al.* (2001) and IPCC (2006) the value of T1 defines the temperature at which *f* = 1.0, therefore T1 defines the temperature at which the B_0 will be reached in one month. There is considerable literature on laboratory methods for incubating manure to measure methane potential (e.g. BMP, B_0) and it is customary for the temperature of these incubations to be ca. 35°C, rather than 30°C. With a temperature of 35°C it would be reasonable to expect the B_0 to nearly be reached in 30 days (i.e. one month) (e.g. Owen *et al.* 1979; Pham *et al.* 2013). Therefore, it is proposed to change T1 to 308.16 K (=35 + 273.16).

#5 – Manure Temperature (T_2):
Manure temperature lagging behind T_{air} (proposed) instead of equal T_{air} (IPCC 2006)

Most of the time, manure temperature does not equal air temperature. The temperature of liquid manure tends to lag behind air temperature. While models for manure temperature do exist (Rennie *et al.* 2017) this is too complex for the general guidelines. As a pragmatic alternative, a 1-month lag is proposed, i.e., set $T_2 = T_{air}$ from the previous month. It has also been shown (Rennie *et al.* 2018) that manure storages which are emptied once per year at the end of the growing season before winter stay cooler than air temperature during the summer. Therefore, only in the case of once per year emptying (i.e. 12 month retention time), a downward temperature shift of 3°C has also been applied.

#6 – VS carryover after emptying:
After manure is removed, 5% remains (proposed), instead of complete emptying (IPCC 2006)

It has been shown in several studies that farms do not completely empty liquid/slurry storages due to the practical challenge of doing so at the farm-scale (Balde *et al.* 2016b). Therefore, it is proposed that 5% of VS is retained in storage after emptying, rather than 0% (i.e. completely clean) assumption implied in the IPCC 2006 calculations. It is noteworthy that the IPCC 2000 Good Practice Guide (Zeeman & Gerbens 2000) mention approximately 15% of the manure storage cannot be emptied.

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Annex 10B.6 Revision of methane from dung deposited onto pasture range and paddocks (Table 10.17)

Dataset

Cai *et al.* (2017) included 26 data, however some of these were omitted due to incomplete information to allow an estimation of methane conversion factor (MCF) and/or emission factors on the basis of volatile solids (VS) content. Therefore, the number of values retained was 20. Our review of the literature identified a further 25 suitable values (Carran *et al.* 2003; Saggar *et al.* 2003; Sherlock *et al.* 2003b; Sherlock *et al.* 2003a; Kelly *et al.* 2016), resulting in a total of 45 data values spanning six countries (Table 1). Data were available for dairy cattle (25), beef cattle (9), sheep (8) and yaks (3). Data was assessed for suitability, in terms of length of study, sufficient replication and inclusion of key manure characteristics to allow estimation of the emission factors (g CH_4/kg VS; Table 10.14B) and MCF (%; Table 10.17). Some studies also presented emissions on the basis of mass of CH_4 emitted per unit of faecal dry matter (FDM). Therefore, we have also supplied emission factors using these units (g CH_4/kg FDM) for countries with access to total FDM.

TABLE A10.B.6-1
SOURCE OF METHANE FROM PRP EXCRETION DATA.

Country	**Cattle**	**Sheep**	**Total**
Australia	13		13
Brazil	4		4
China	3	2	5
Japan	5		5
New Zealand	6	6	12
UK	6		6
Total	**37**	**8**	**45**

Emission factors

Methane conversion factors (MCF) and emission factors were estimated for both cattle and sheep, where yaks were grouped with cattle (Table 2). For estimating MCFs and emission factors based on VS content, ash content of dung is required. We estimated dung ash content to be 17.9% for pasture-fed sheep, beef cattle and dairy cattle (Fries *et al.* 1982; Karn 1991; Waghorn *et al.* 1999; Andueza *et al.* 2017). Data from a UK study (Defra, 2014) suggested that the IPCC Bo values were appropriate for cattle, we therefore assumed the IPCC values for sheep were also reasonable estimates. For yaks, we used the IPCC default Bo value for buffalo (0.100).

There was no significant difference in values for cattle and sheep regardless of the method of representing methane emissions ($P > 0.05$). For the refinement of the 2006 guidelines we therefore suggest an aggregated value is used. We also explored the possibility of disaggregating EF values by climatic zones, however the limited size of the dataset did not support this. Therefore, an aggregated value regardless of temperature is suggested for the refinement.

When adopting a Tier 2 approach, the MCF must be used in conjunction with a single B_0 value of 0.19 m^3 CH_4 kg^{-1} of VS excreted to ensure consistency with the Tier 1 Emission Factor provided in Table 10.14B.

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TABLE A10B.6-2:
METHANE CONVERSION FACTOR (MCF) AND METHANE EMISSION FACTORS (PER KG FAECAL DRY MATTER (FDM)) AND VOLATILE SOLIDS (VS) FOR CATTLE AND SHEEP.

N source	MCF (%) Average, (Std Dev)	EF (g CH_4/kg FDM) Average, (Std Dev)	EF (g CH_4/kg VS) Average, (Std Dev)
Cattle	0.46 (0.38)	0.49 (0.42)	0.59 (0.51)
Sheep	0.52 (0.40)	0.53 (0.42)	0.65 (0.51)
Average	**0.47 (0.38)**	**0.50 (0.42)**	**0.60 (0.51)**

References

Andueza D, Picard F, Dozias D, & Aufrère J. (2017). Fecal Near-Infrared Reflectance Spectroscopy Prediction of the Feed Value of Temperate Forages for Ruminants and Some Parameters of the Chemical Composition of Feces: Efficiency of Four Calibration Strategies. Applied Spectroscopy, 71: 2164-2176. doi: 10.1177/0003702817712740

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Annex 10B.7. Estimation of default emission factors for MCF CH_4 values, EF for direct N_2O emissions, NH_3, NO_3 leaching and N_2 emissions from solid storage and composting systems

Methodologies

The estimation of updated MCF values, EF for direct N_2O emissions and NO_3 leaching and N_2 from both (i) solid storage and (i) two composting systems (static pile and passive windrow) are based on an extensive meta-analysis of 50 peer-reviewed research articles involving 304 observations and published in open access by Pardo *et al.* (2015). In this study it was quantified the response of GHG emissions, NH_3 emissions, and total N losses to different solid waste management strategies (conventional solid storage, turned composting, forced aerated composting, covering, compacting, addition/substitution of bulking agents and the use of additives).

For solid storage, new treatments have been proposed to be incorporated in the 2019 Refinement: covering/compacted (both treatments had similar effects on GHG emissions), addition/substitution of bulking agents and the use of additives. In the 2006 IPCC Guidelines for National GHG inventories default emission factors for solid storage were based on expert IPCC judgement and a single study (Amon et al. 2001). In Pardo *et al.* (2015) the estimation of MCF values and EF for direct N_2O emissions from solid storage (without treatment) is based on data from 30 studies at the farm level.

For the new treatments, MCF values and EF for direct N_2O emissions have been based on:

- 9 studies for compacting and covering
- 11 studies for addition/substitution of bulking agents
- 6 studies for use of additives

For the rest of the management systems, MCF values and EF for direct N_2O emissions have been based on:

- 22 studies for solid storage
- 6 studies for composting-static piles (Forced aeration)
- 11 studies for composting-Passive windrow (infrequent turning)

Based on the IPCC (2006) climate zone classification two factors were defined: Temperature, which involved two categories (i) Warm temperate and (ii) Cool temperate; and annual rainfall rate, including (i) Dry, (ii) Moist and (iii) Wet conditions.

CH_4 MCF

For the absolute values of CH_4 values, Pardo *et al.* (2015) used untreated solid storage as a reference system. They compared estimated % C lost as CH_4 using the IPCC (2006) method (IPCC 2006 MCF) with the values obtained at the different studies (Figure A.10B.7-1).

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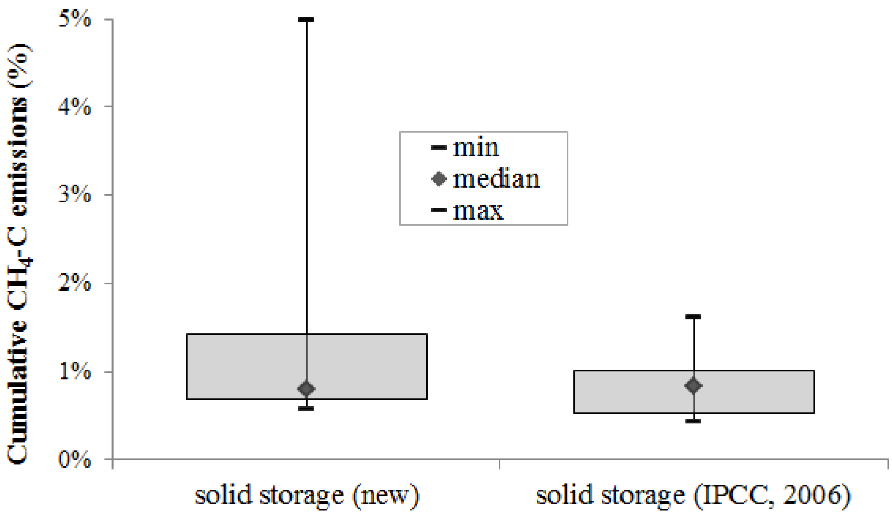

Figure A.10B.7-1. Comparison between ranges of CH_4-C emissions observed in collected studies in Pardo *et al.* (2015) (new) with estimations for the same studies according to IPCC (2006) methodology. Figure adapted from Pardo *et al.* (2015).

For untreated solid storage systems Pardo *et al.* (2015) showed that overall values were within the IPCC (2006) range for CH_4 emissions (Figure A.10B.7-1) and confirmed that the differences between cold and temperate conditions were in agreement with those indicated by IPCC (2006) not shown here, Figure S3b in Pardo *et al.* (2015). There were not enough studies under warm conditions and therefore, the assumption is to keep the same values indicated by IPCC (2006).

Values for new solid storage treatments and composting (static pile and passive windrow) are estimated using the reference value from the untreated solid storage system and the relative differences observed in Pardo et al. (2015).

For the new treatments, covering or compacted solid storage resulted in emissions in the same range as in solid storage not shown here, Figure 2b in Pardo *et al.* (2015) and estimated reduction of 75% and 50% was observed due to bulking agent addition and additives, respectively not shown here, Figure 2b in Pardo *et al.* (2015). The differences amongst climatic zones were assumed to be in the same proportion as that found for untreated solid storage systems.

Both composted static piles and static windrows were estimated to produce 50% of the CH_4 coming from solid storage not shown here, Figure 2b in Pardo *et al.* (2015), which results in consistently greater values than those indicated by IPCC (2006). As a difference to IPCC (2006), CH_4 emissions were found to be temperature dependent for both composting systems (IPCC, 2006 did not indicate temperature differences for static piles).

N_2O EF3 (Table 10.21)

According to the data examined in Pardo *et al.* (2015), there was no evidence to assume a lower EF for solid storage systems (0.005 kg N_2O–N kg^{-1} N excreted) than for passive windrow composting (0.01 kg N_2O–N kg−1N excreted). In fact, an EF of 0.5% (0.005kg N_2O-N kg initial N^{-1}) and 1% (0.01kg N_2O-N kg initial N^{-1}) were found for composting-passive windrow and solid storage, respectively.

Composting static pile, in contrast to IPCC (2006), was found to emit greater N_2O emissions than passive windrows (not shown here, Fig. 3a in Pardo et al., 2015).

For the different treatments of solid storage, whereas Pardo *et al.* (2015) found no different effect on N_2O after compaction or covering, for both the addition of bulking agents or additives, a reduction of about 50% compared with conventional solid storage was observed not shown here, Figure 2a in Pardo *et al.* (2015).

NH_3 losses

For solid storage and composting relative values compared to solid storage are trying to reflect results obtained from meta-analysis by Pardo *et al.* (2015) (Fig X2)

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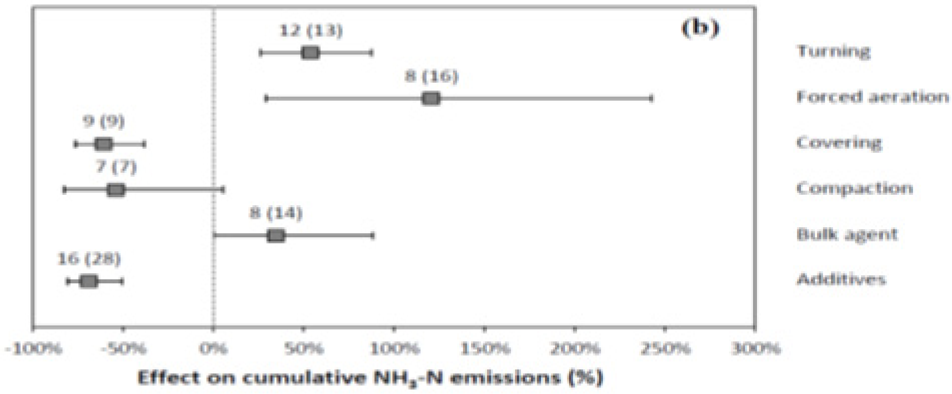

Figure A.10B.7-2. Effect on cumulative NH_3-N emissions of different solid storage and composting methods compared with conventional solid storage. Figure adapted from Pardo et al. (2015)

NO_3 leaching and N_2 losses

Nitrate leaching/run-off has been estimated from the database from Pardo *et al.* (2015). For solid storage and composting some of the studies included measurements of N leaching (15), some of which estimated N_2 from the total N balance, but only one included measurements of N_2 (Moral *et al.* 2012). As a median value about 3% is estimated to be lost as NO_3 leaching/run-off (range: 0-38%). This value is subject to large uncertainty. In fact these trials may not represent common practices where the efficiency of collection of excreta N is much lower and can lead to as great as 50% losses (e.g. Lekasi *et al.* 2001; Rufino *et al.* 2007). Nitrogen (N_2) losses, have only been, to our knowledge, measured by Moral *et al.* (2012) (12%) and even though they could be estimated as a result of an N balance from trials where all N flows expept N_2 have been measured, the results are very uncertain (0-55%). For N_2, an estimated median value of 12% was found; coinciding with the measured value by Moral *et al.* (2012), Systems that do not percolate but are subject to large water input will have greater N_2 losses and lower NO_3 leaching-runoff. The opposite effect will be expected with rainy areas with no containment and large possibilities for run-off/leaching. Values must be considered with large caution.

A further summary review was carried out to identify run-off/leaching values from dry lots and manure pack. As observed in the 2006 IPCC Guidelines runoff and leaching values varied greatly citing ranges of 3 to 6% of N excreted (Eghball and Power, 1994) or 5 to 19% (Bierman et al. 1999). In humid environments losses can be significant reaching 22-25% (Uusi-Kämppä, 2002). However, uncovered holding and feeding pens without runoff containment tend to be in drier climates simply due to challenges in moisture control in more humid environments. Furthermore, considerable numbers of cattle are raised in drier climates and as a result considerably more studies exist looking at runoff from feedlots and drylots. Likewise recent attempts have been made to attempt to model these losses to the environment (Kizil et al., 2006; Williams et al., 2006). These studies tend to place the range of runoff loss between 1% and roughly 7% (Erickson and Klopfenstein, 2001; Kizil et al., 2006; Vadas and Powell, 2013; Williams et al., 2006). It is proposed the value of 3.5% with an uncertain range of 0 to 7% be considered as a default leaching factor for open, uncovered, uncontained drylots and bedded pack to provide a Tier 1 estimate of the fraction of N excreted lost to the environment.

Inventory compilers must be careful to consider that this refers to N lost to the environment surrounding the pens or leached into the soil. If runoff is captured and returned to agricultural fields these losses must not be considered. In humid environments, in cases where manure is left exposed to rainfall, inventory compilers should consider the use of the upper bounds of the leaching fraction and furthermore to consider the development of a country specific leaching fraction.

Review on the effect of slurry store solid covers and natural crust in emissions of CH_4 and N_2O

The review found 18 papers dealing with the impact of solid covers or natural crusts on CH4 and/or N2O emissions from slurry stores.11 of them were suitable to be included here to deduce emission factors (Amon et al.

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2006; Clemens et al. 2006; Guarino et al. 2006; Amon et al. 2007; VanderZaag et al. 2008; VanderZaag et al. 2009; Aguerre et al. 2012; Nielsen et al. 2013; Hou et al. 2015; Matulaitis et al. 2015; Misselbrook et al. 2016)

For CH_4 emissions from Liquid/Slurry, the IPCC 2006 guidelines state that by judgement of the IPCC Expert Group, a reduction of 40% due to crust cover (40%) may be applied when a thick, dry, crust is present. The new review carried our within the 2019 refinement confirms this judgement (VanderZaag *et al.* 2008; Aguerre *et al.* 2012; Nielsen *et al.* 2013). A solid cover reduces CH4 emissions by 25 to 50% (range: 0 to 90%) (Amon *et al.* 2006; Clemens *et al.* 2006; Guarino *et al.* 2006; Amon *et al.* 2007; VanderZaag *et al.* 2008; VanderZaag *et al.* 2009; Hou *et al.* 2015; Matulaitis *et al.* 2015; Misselbrook *et al.* 2016).

For N2O emissions from Liquid/Slurry with natural crust cover a detailed literature review carried out during the 2019 refinement revealed only very few new datasets on the measurement of N2O emissions from manure stores and the influence of crusting. These datasets agree that N2O emissions increase when a crust is formed, but do not give concrete numbers on the level of increase (VanderZaag *et al.* 2008; Aguerre *et al.* 2012).

For N2O emissions from Liquid/Slurry with a cover a detailed literature review carried out during the 2019 refinement revealed only few new datasets on the measurement of N2O emissions from manure stores. These datasets emcompass a large range of N2O emissions from a 50% reduction to a 100 % increase in N2O emissions when slurry stores are covered. The 2019 refinement therefore suggest to use the emission factor of crust cover (Amon *et al.* 2006; Clemens *et al.* 2006; Guarino *et al.* 2006; Amon *et al.* 2007; VanderZaag *et al.* 2009; Hou *et al.* 2015; Misselbrook *et al.* 2016).

References

Solid storage

(Sommer & Dahl 1999; Sommer & MØLler 2000; Amon *et al.* 2001; Osada *et al.* 2001; Sommer & Hutchings 2001; Tiquia *et al.* 2002; Wolter *et al.* 2002; Wolter *et al.* 2004; Chadwick 2005; Paillat *et al.* 2005; Hansen *et al.* 2006; Sagoo *et al.* 2006; El Kader *et al.* 2007; Espagnol *et al.* 2007; Gichangi *et al.* 2007; Szanto *et al.* 2007; Hassouna *et al.* 2008; Ahn *et al.* 2011; Moral *et al.* 2012; Shah *et al.* 2012; Jiang *et al.* 2013)

Solid storage (covered/compacted)

(Sommer & Dahl 1999; Sommer & Hutchings 2001; Chadwick 2005; Hansen *et al.* 2006; Sagoo *et al.* 2006; El Kader *et al.* 2007; Gichangi *et al.* 2007; Shah *et al.* 2012; Jiang *et al.* 2013)

Solid storage (bulking agents)

(Eklind & Kirchmann 2000; Sommer & MØLler 2000; Barrington *et al.* 2002; Hao *et al.* 2004; Sagoo *et al.* 2006; Tamura & Osada 2006; Yamulki 2006; Gichangi *et al.* 2007; Dias *et al.* 2010; Maeda *et al.* 2013; Yang *et al.* 2013)

Solid storage (additives)

(Hao *et al.* 2005; Fukumoto *et al.* 2006; Fukumoto & Inubushi 2009; Fukumoto *et al.* 2011; Xie *et al.* 2012; Luo *et al.* 2013)

Composting (static pile)

(Hao *et al.* 2001; Wolter *et al.* 2002; de Guardia *et al.* 2008; de Guardia *et al.* 2010; Jiang *et al.* 2011; Shen *et al.* 2011)

Composting (passive windrow)

(Sommer & Dahl 1999; Amon *et al.* 2001; Hao *et al.* 2001; Tiquia *et al.* 2002; Sagoo *et al.* 2006; El Kader *et al.* 2007; Espagnol *et al.* 2007; Szanto *et al.* 2007; Hassouna *et al.* 2008; Ahn *et al.* 2011; Jiang *et al.* 2013)

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References for the Annexes

Annex 10A.1 Data underlying methane default emission factors for Enteric Fermentation

Annex 10A.2 Additional data and information for the calculation of methane from Manure Management

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MacLeod, M. J., Vellinga, T., Opio, C., Falcucci, A., Tempio, G., Henderson, B., Makkar, H., Mottet, A., Robinson, T., Steinfeld, H. & Gerber, P. J. (2017) Invited review: A position on the Global Livestock Environmental Assessment Model (GLEAM). animal: 1-15.

Annex 10A.3. MCF Spreadsheet example for the calculation of a country or regions specific MCF

IPCC. (2006) 2006 IPCC Guidelines. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme 12.

Annex 10A.4. Equations relating all direct and indirect N_2O emissions from manure along all stages in agricultural production for livestock.

Annex 10A.5 Additional data and information for the calculation of N_2O from Manure Management of other animal

Annex10B.1 Raw data used to compile Annex A.1 enteric fermentation Tier 1 emission factors, volatile solids and nitrogen excretion for cattle and buffalo

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Annex 10B.2 Estimation of Default Emission Factor(s) for Goat Tier 2 parameters

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Annex 10B.5 Description and Discussion of Proposed Changes to MCF Calculations for Liquid/Slurry.

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Annex 10B.7. Estimation of default emission factors for MCF CH_4 values, EF for direct N_2O emissions, NH_3, NO_3 leaching and N_2 emissions from solid storage and composting systems

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