New CVB Table ‘Standardized ileal digestibility of amino acids in feedstuffs for pigs’

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Wageningen Livestock Research

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Preface

In 1990 CVB introduced the first (preliminary) Table with ileal amino acid digestibility values of feedstuffs for pigs. This first Table was included in the CVB Feed Table 1991.
In 1998 the table was considerably updated and extended, using a report of an extensive literature survey, executed by ILOB-TNO (1996). This desk study was subsidized by Degussa AG (now Evonic) and made available to CVB.

Till 2016, when CVB for the first-time published guidelines for pig diets based on standardized ileal digestible amino acids, an apparent ileal digestible amino acid requirement system was used. In the 2020 edition of the 'Booklet of Feeding Tables for Pigs, Nutrient requirements and feed ingredient composition for pigs' standardized amino acid requirements for growing pigs and sows were published, based on desk studies of Van der Peet-Schwering and Bikker (2018 and 2019). From then on only guidelines based on standardized ileal digestibility values were published in this booklet. Also, the number of amino acids for which guidelines were published was increased from the four first limiting amino acids (lysine, methionine + cystine, threonine and tryptophan) to all essential amino acids.

In this report a new Table on the standardized ileal digestibility of crude protein and amino acids is published, based on an extensive dataset of digestibility studies (330 publications and 1,675 observations) published in the scientific literature in the period 1970 – 2020.

Some valuable studies did not completely fulfil the criteria that were defined for insertion the data in the database of CVB. Therefore, we asked to corresponding author if he could provide us with the information that was missing in the publication. We wish to thank Prof. Dr O. Adeola (Purdue University, USA), Dr. S.M. Hodgkinson (Massey University, New Zealand), Prof. Dr. T.A.T.G. van Kempen (North Carolina State University, USA), Prof. Dr. B.J. Kerr (University Minnesota, USA), Dr. J.V. Nørgaard (Aarhus University, Denmark), Prof. Dr. H.H. Stein (University Illinois, USA) and Prof. Dr. R.T. Zijlstra (University Alberta, Canada) for sending the additional information needed. We especially wish to thank Prof. Dr. Hans H. Stein for his very kind and valuable collaboration, not only in sending us much information, but also by acting as sparring partner with respect to several project themes.

This project was guided and assessed by the Technical Committee of CVB and the Ad hoc group 'CVB amino acids in pigs'.

Wageningen, October 2022
M.C. Blok

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List of abbreviations

Abbreviation	Unit	Explanation
AA		Amino acid(s)
AIA		Acid insoluble ash
AID		Apparent ileal digestibility
AIDC	%	Apparent ileal digestibility coefficient
ALA		Alanine
ARG		Arginine
ASP		Aspartic acid
BEL	g/kg DM	Basal endogenous loss (of CP or amino acids at the terminal ileum)
CASH	g/kg	Crude ash
CFAT	g/kg	Crude fat
CFIBER	g/kg	Crude fiber
CP	g/kg	Crude protein
CYS		Cystine
DC-AA	%	Digestibility coefficient amino acid
DM	g/kg	Dry matter
DMI	g	Dry matter intake
GLY		Glycine
GLU		Glutamic acid
HIS		Histidine
ILE		Isoleucine
LEU		Leucine
LYS		Lysine
MET		Methionine
PHE		Phenylalanine
PRO		Proline
SER		Serine
STDEV		Standard deviation
SID		Standardized ileal digestibility
SIDC	%	Standardized ileal digestibility coefficient
SIDC-AA	%	Standardized ileal digestibility coefficient of an Amino acid
STA	g/kg	Starch
SUG	g/kg	Sugars
THR		Threonine
TRP		Tryptophan
TYR		Tyrosine
VAL		Valine

1. Introduction

1.1 Current table

The current Table is largely based on a desk study, subsidized by Degussa AG (now Evonic), executed by ILOB-TNO and published in 1996. This desk study was made available to CVB for implementing the results in the CVB Feed Table. In the ILOB-TNO report both apparent and standardized ileal digestibility values were published.
This updated table on the ileal digestibility of crude protein and amino acids in feedstuffs for pigs was integrated in the CVB Feed Table of 1998. In the Introduction of this Feed Table a table with standardized ileal digestibility values were incorporated. As in the Netherlands the system 'Apparent ileal digestibility of crude protein and amino acids' was used in practice, recalculated apparent digestibility coefficients were published on the product sheets.

1.2 Update of the current Table

In this Documentation report a new Table on the standardized ileal digestibility of crude protein and amino acids is published, based on an extensive search of the scientific literature. Publications were collected that were published in the 1970 – 2020, with some incidental publications that appeared in 2021 for feedstuffs for which not sufficient data could be gathered in the period mentioned.
Each study was checked whether it fulfilled the set of criteria that were set for inclusion of the data in the database on ileal digestibility of feedstuffs in pigs (see paragraph 2.1).
Depending on the way the ileal digestibility was determined and published the publications accepted for inclusion in the database were inserted in one of the 5 sub databases (see paragraph 2.2).
Recalculation of apparent digestibility coefficients into standardized digestibility coefficients was done by using a uniform pattern for the basal endogenous loss (see paragraph 2.4).
After combining all observations of a particular feedstuff in one dataset, an outlier test was executed first for the amino acid pattern and subsequently for the standardized ileal digestibility coefficients. It was also checked whether there were significant correlations between the SIDC's of crude protein and the amino acids on the one hand and gross chemical nutrients like crude protein, crude fiber, NDF and ADF in the other hand.
After the outlier procedure a proposal was developed for the SIDC evaluation of crude protein and amino acids of the feedstuff concerned.
For each feedstuff a separate note was written to provide transparent insight how the new evaluation came about. In this report the key information of these notes has been copied.

2. Literature survey, data collection and data processing

2.1 Procedure

The first step in the development of an 'New CVB Table 'Standardized ileal digestibility of amino acids in feedstuffs for pigs' was a literature survey. Papers published till 2020 covering the ileal amino acid digestibility of feedstuffs for pigs, mainly piglets and growing/finishing pigs, were collected. From all publications a PDF file was downloaded. The following basic data were gathered in a spreadsheet (below it is mentioned if data were considered obligatory for insertion of a study in one of the databases):

- Peer-reviewed publications (obligatory)
- Author(s), scientific journal and year of publication (obligatory)
- Chemical composition of the test ingredient(s):
    - Dry matter (DM) (obligatory, unless a reliable estimation was possible)
    - Crude protein (CP) (obligatory)
    - Crude fiber (CFIBER), NDF and/or ADF
    - Crude ash (CASH)
    - Starch (STA)
    - Sugars (SUG)
    - Separate run for S-containing amino acids: yes/no
    - Separate run for the amino acid Tryptophan: yes/no
- Animal data:
    - Genotype
    - Sex
    - Body weight or age (obligatory)
    - Housing system
    - Experimental set up
    - Number of animals per replicate
    - Number of replicates
- Chyme collection
- Method to determine ileal digestibility: direct or indirect method (obligatory)
    - Direct:
        - Percentage of ingredient incorporated in diet
        - Protein-rich ingredients; CP-level
        - Digestibility as published: in the diet or in test ingredient?
    - Indirect: Percentage of test ingredient in test diet
- Experimental aspects:
    - Diets: incorporation rate of the test ingredient (obligatory)
    - Feeding method: ad lib / crop intubation / restricted
    - Experiments or treatments where enzymes were added to the feed have been excluded from the database (except control treatments without added enzymes)
    - Diet: mash / pellets
    - Marker: Cr_2O_3 / Acid insoluble Ash (AIA) / TiO_2
- Chyme collection:
    - Collection technique (obligatory):
        - Cannulation (and type of cannula)
        - Ileal rectal Anastomosis
        - Slaughter technique
    - Adaptation period before chyme collection
    - Duration and number of chyme collections (obligatory)

2.2 Databases

In the original publications different ways were used to express the digestibility data. Therefore, data were at first gathered in five separate databases:

Database 1.

Contains publications where the *direct method* is applied and where the apparent digestibility of the diet is recalculated into the *standardized ileal amino acid digestibility and in which the test product* is the sole protein source in the diet.

This database is by far the largest of all databases. It was split in three parts, depending on the BEL values used to convert the AIDC-AA of the test diet to the SIDC-AA of the test product:

a. The BEL pattern used is determined in the same study (mostly with a N-free diet, sometimes with a low casein diet and incidentally with the regression method using a highly digestible protein source) and the values for BEL are (in g/kg DMI) are also mentioned.
b. As a. but without explicitly mentioning the BEL pattern.
c. A BEL pattern published in the literature (mostly A.J.M. Jansman et al. (2002), or a BEL pattern of the own institute (based on several studies) is used.

In the Materials and Methods section of the publications the way of calculating SIDC is mentioned as follows:

- *Calculation of the AIDC-AA (%) using the following (or an – essentially – identical) formula:*

  $$AIDC\text{-}AA_{diet}\ (\%) = \frac{(AA/Marker)_{diet} - (AA/Marker)_{chyme} * 100}{(AA/Marker)_{diet}}$$

  With this formula the AIDC-AA (%) of the diet is calculated.
- *From the AIDC-AA of the diet the SIDC-AA (%) of the test product is calculated using the following (or an essentially identical) formula:*

  $$SIDC\text{-}AA_{test\ product}\ (\%) = AIDC\text{-}AA_{diet}\ (\%) + [(BEL\text{-}AA;\ g/kg\ DMI)/(AA_{\mathbf{diet}};\ g/kg\ DM) * 100]$$

Database 2.

Contains publications where the *direct method* (with the test product as sole protein source) is applied and where the *apparent ileal amino acid digestibility* (AID-AA) *of the experimental diet* is given, as can be concluded from the way the digestibility is calculated.

This database is the second largest.

In the Materials and Methods section of the papers the calculation of the apparent ileal digestibility coefficient of the amino acid, AIDC-AA (%) is specified. Mostly one of the following formulas are mentioned:

- $AIDC\text{-}AA\ (\%) = [1 - (AA_{chyme} * marker_{diet})/(AA_{diet} * marker_{chyme})] * 100$
- $$AIDC\text{-}AA\ (\%) = \frac{(AA/Marker)_{diet} - (AA/Marker)_{chyme}}{(AA/Marker)_{diet}} * 100$$

In fact, both formulas yield the same result, but the result is not the AIDC of the test ingredient but of the test diet.

From the published data the SIDC-AA (%) was calculated as follows:

- *Using the AA content in the test ingredient, the inclusion rate of the test product in the diet, and the AIDC-AA, the amount of apparent ileal digestible AA is calculated*
- *Subsequently this amount is converted to the amount of standardized ileal digestible AA by adding the basal endogenous loss of the AA*

- *Finally, the SIDC is calculated: SIDC (%) = (amount standardized ileal digestible AA)/(amount of AA in test product)*100*

Database 3.
Contains publications where the *indirect method* is applied and where the *standardized ileal amino acid digestibility of the test product* is given.

In the Materials and Methods section of the publications the way of calculating SIDC is mentioned as follows:

- *First the AIDC (%) of the diet is calculated in the same way as mentioned for Database 2.*
- *Then the SIDC-AA$_{test\ product}$ (%) is calculated using one of the two options:*
  - *In option 1, first the AIDC-AA(%) of both the test diet and the basal diet is converted to the SIDC-AA (%) of the diet with the formula:*

    *SIDC-AA$_{diet}$ (%) = AIDC-AA$_{diet}$ (%) + [(BEL-AA; g/kg DMI)/(AA$_{\mathbf{diet}}$; g/kg DM) * 100].*

    Then the SIDC-AA$_{test\ product}$ (%) is calculated by difference calculation using the formula:

    $$SIDC\text{-}AA_{test\ ingredient}\ (\%) = \frac{\{(\text{amount SID-AA}_{test\ diet}) - (1-y)*(\text{amount SID-AA}_{basal\ diet})\}}{(\text{amount AA}_{test\ product})} * 100$$

    where y = fractional incorporation rate of test product in test diet and (1-y) that of the basal diet
  - *In option 2, first the AIDC-AA of the test ingredient is calculated with the formula:*

    $$AIDC\text{-}AA_{test\ ingredient}\ (\%) = \frac{\{(\text{amount AID-AA}_{test\ diet}) - (1-y)*(\text{amount AID-AA}_{basal\ diet})\}}{(\text{amount AA}_{test\ product})} * 100$$

    where y = fractional incorporation rate of test product in test diet and (1-y) that of the basal diet
    Then the SIDC-AA$_{test\ product}$ (%) is calculated with the formula:

    *SIDC-AA$_{test\ product}$ (%) = AIDC-AA$_{diet}$ (%) + [(BEL-AA; g/kg DMI)/(AA$_{\mathbf{diet}}$; g/kg DM) * 100]*

For BEL-AA either a pattern is used determined in the same study or a pattern from the literature or a pattern determined in several experiments in the own institute.

Database 4.
Contains publications where the *apparent ileal amino acid digestibility of the test product* is determined with the *indirect method* (i.e., the digestibility is determined of a basal diet and of an experimental diet containing y of the basal diet and (1 - y) of the test product; the digestibility of the test product is calculated from the difference).

In the Materials and Methods section of the papers the calculation of the apparent ileal digestibility coefficient of the amino acid, AIDC-AA (%) is specified.

- *First the AIDC (%) of the diet is calculated in the same way as mentioned for Database 2.*
- *Then the AIDC-AA$_{test\ ingredient}$ (%) is calculated with the same formulas as mentioned in Option 2 for Database 3.*

Database 5.
Contains publications where the *regression method* is used to calculate the *ileal amino acid digestibility of the test product.* The slope of the regression line represents the *standardized ileal digestibility*.

In cases where both the apparent and the standardized ileal amino acid digestibility were published, both data were inserted in the relevant database. This was often the case for publications inserted in Database 1.

In the list with References all publications are mentioned of which one or more (sometimes >20) observations are included in one of these five databases.

2.3 Recalculation of published data

In the publications the analyzed contents of amino acids and other nutrients of the test products were also expressed in various ways: g/kg DM, g/kg product, g/16 g N (or g per 100 g protein). The analyzed amino acid composition of the test product was recalculated to amino acid contents in g/kg DM, and by using the information in the paper the amino acid pattern was calculated in g amino acid/16 g N, before entering the data in the database.
Ileal digestibility's were published both in %-units and as fractional digestibility's. All data were recalculated into %-units.

2.4 Basal endogenous losses of CP and amino acids

In database 2 and 4, a standard basal endogenous loss (BEL) was applied for the conversion of apparent ileal digestibility data into standardized ileal digestibility data. The basis for the calculation of the BEL pattern used was a large database in which a great number of BEL patterns from scientific publications were collected and processed (see for

Table 1. Basal endogenous losses (BEL) of CP and amino acid loss (g/kg DM intake) at the terminal ileal of growing pigs.

Amino acid	Basal endogenous loss (g/kg DM intake)
CP	14.85
ARG	0.52
HIS	0.23
ILE	0.35
LEU	0.56
LYS	0.43
MET	0.11
PHE	0.34
THR	0.58
TRP	0.12
VAL	0.49
ALA	0.59
ASP	0.79
CYS	0.20
GLU	1.07
GLY	1.29
PRO	3.40
SER	0.59
TYR	0.28

more information ANNEX I). The standard BEL pattern calculated and agreed by the Ad hoc group and the Technical Committee of the CVB is represented in Table 1.
The formulas used for this conversion have been described above.

2.5 Outlier procedure

2.5.1 Outliers with respect to amino acid pattern

For each feed ingredient the available observations were collected in an ingredient-specific dataset. For the available observations of each ingredient, the (calculated) amino acid profile (expressed in g/16 g N), the average value, the standard deviation (STDEV), the minimum and maximum value and the number of observations were calculated. Per amino acid, all values deviating more than 2.0*STDEV from the average value were removed from the dataset, and the standardized digestibility of the deleted amino acids was highlighted. If five or more outliers were detected in the amino acid profile of one observation, the observation was completely deleted from the dataset.

2.5.2 Outliers with respect to standardized amino acid digestibility

Subsequently, for each feedstuff in the ingredient-specific dataset the average SIDC value, the standard deviation (STDEV), the minimum and maximum value and the number of observations were calculated. For the individual observations values deviating more than 2.0 *STDEV from the average value were removed from the database. For small datasets, it sometimes was decided to remove values deviating more than 1.5*STDEV from the average value.[1] In cases where the number of standardized amino acid digestibility values of an ingredient (including the values highlighted based on deviating amino acid contents from the amino acid profile) was $\geq$ 5 all data of this observation were deleted from the database. In some cases, with datasets in which more than 5 AA had STDEV > 7%, a second outlier procedure was applied if useful.

It is well known that often the basal endogenous loss of PRO is much higher than of other amino acids. As the magnitude of the basal endogenous loss is experiment specific (Annex II) and directly determines the level of the apparent digestibility, the inaccuracy in the determined endogenous PRO loss, often results in large variations in the SIDC values of PRO between studies. Therefore, the average SIDC of PRO in the dataset of a specific feedstuff often deviates from that of other amino acids, with high STDEV, very low minimum and very high maximum SIDC's. So, it was decided to set the SIDC of PRO on the average SIDC of the average SIDC of the 17 other amino acids.
In smaller datasets incidentally no (average) SIDC value or a strongly deviating SIDC, based on one observation, was observed. Also, in such cases the average SIDC of the average SIDC of the remaining amino acids was used.

[1] When the number of observations is limited, the criterion '≥ 2.0*STDEV' yields hardly any outlier, while visual inspection of the data reveals good reasons for the elimination of certain data. With a limited number of observations, an outlier has a major influence on the average value and on the magnitude of the STDEV. By applying the stricter criterion ('$\geq$ 1.5*STDEV'), subjective removal of data as outlier is prevented. When executing this procedure, it was realized that the less the number of observations is, the less values are detected as outlier.

3. Proposed standardized ileal digestibility of crude protein and amino acids of individual feed ingredients for pigs

Introduction

In this chapter, the results of the examination of the datasets of the individual feed ingredients included in the CVB Feed Table with a nutritional evaluation for pigs are briefly reviewed.
For each feed ingredient, separate proposals have been worked out and submitted to the 'Ad hoc Group Ileal CVB amino acids pigs' – installed by the Technical Committee of the CVB – for a critical evaluation. The comments of this group have been processed in the final proposals. The updated standardized ileal digestibility of the individual feed ingredients is presented in alphabetical order below.

For most ingredients, two Tables are presented. In these Tables the data are mentioned after executing the outlier procedure. In the first Table an overview is given of the amino acid pattern of the dataset (number of observations, average values and STDEV).

For several feedstuff, there was a substantial variation in CP content and/or fiber contents such as crude fiber, NDF and ADF. In such cases correlation matrices were made, and – if there were significant correlations between one of these parameters and the SIDC's for CP and several AA – regression analysis was performed. For several feedstuffs this resulted in a proposal to calculate the SIDC of CP and AA with a regression equation. These regression equations are not presented in this report, but they were truly us to calculate the SIDC's for (the qualities of) the feedstuff as published in the CVB Feed Table.

Not for all feedstuffs with a nutritional evaluation for pigs additional observations were found in the literature. Most of these ingredients have (very) low protein contents and/or are of little practical importance and/or are only locally available (e.g., certain high moisture feed materials). For these feedstuffs the current amino acid evaluation will be maintained. An overview of these feed ingredients is given in ANNEX III.

3.1 Barley.

For barley there was a large dataset of 61 observations. In approximately 60% of the observations the apparent ileal digestibility was published without any information about the basal endogenous loss, or a BEL pattern from the literature was used to correct the AIDC values into SIDC values. These observations also showed a large variation in the AIDC values and the SIDC values, using a fixed BEL pattern agreed within the CVB that is based on a very large dataset.
In a special study, presented by Machiel Blok, Wouter Spek and Paul Bikker as poster at the 15th International Symposium Digestive Physiology in Pigs (DPP 2022) in Rotterdam (17-20 May 2022), with observations for corn, where AIDC and SIDC values plus an experiment specific BEL pattern was published, it was shown that for this low protein feedstuff the AIDC decreases with increasing (experiment specific) BEL values (see also Annex II). This difference disappeared after converting AIDC values into SIDC values. We assume that this phenomenon also plays a role in the observations for barley where the AIDC values were not corrected into SIDC values with an experiment specific BEL pattern.
Therefore, it was decided to base the new evaluation of barley on a subset of 19 observations, where in all cases the SIDC values were obtained by correcting the AIDC values with an experiment specific BEL pattern. The average crude protein of this subset content was 128 ± 20.6 g/kg DM, with a minimum and maximum value of 95 and 156 g/kg DM, respectively.

Table 3.1.1. Amino acid pattern of all observations for barley, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	17	18	17	17	18	15	18	17	13	18	16	16	14	16	15	13	15	16
Average *	4.6	2.1	3.4	7.0	3.7	1.6	5.1	3.3	1.0	4.9	4.1	5.8	2.2	22.6	4.0	10.2	4.1	**2.4**
STDEV	0.52	0.28	0.25	0.56	0.4	0.16	0.49	0.28	0.14	0.49	0.51	0.62	0.37	1.83	0.34	1.05	0.33	0.75
Min	3.7	1.6	2.9	6.1	3	1.2	4.4	2.7	0.8	3.9	3.3	4.7	1.7	19.9	3.5	8.5	3.3	1
Max	5.5	2.5	3.9	7.9	4.4	1.8	6.1	3.8	1.3	5.6	5.1	6.8	2.9	26.1	4.6	11.9	4.5	3.4
CVB Feed Table 2021																		
Average	4.9	2.2	3.5	6.9	3.6	1.7	5.0	3.4	1.2	4.9	4.1	6.0	2.2	23.5	4.0	10.8	4.2	3.1
STDEV	0.3	0.2	0.2	0.3	0.3	0.1	0.3	0.2	0.1	0.3	0.3	0.5	0.2	1.7	0.2	0.9	0.2	0.2

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.1.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for barley, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of barley in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	16	15	16	16	16	16	16	16	16	13	16	14	16	14	15	15	10	15	15
Average SIDC	78.0	83.0	82.4	81.2	82.9	76.6	82.4	81.6	76.4	80.6	79.5	72.7	75.1	83.5	87.8	75.5	93.2	80.8	77.0
STDEV *	2.92	3.95	4.04	3.34	3.44	4.03	3.75	4.33	5.96	5.22	4.93	3.62	4.78	4.36	2.18	5.87	10.47	3.32	9.87
Min	74.5	73.5	74	75.6	77	69.9	76.7	72.2	67.7	69.4	69.9	63.9	66.7	74.1	84	63.2	82.2	75.3	58.9
Max	84.7	88.3	89.1	87.3	89.6	83.4	87.4	90	87.5	89.2	87.4	79.6	83.5	89.3	91.8	83.8	112	88.8	95.5
	After conversion to an integral number																		
SIDC	78	83	82	81	83	77	82	82	76	81	80	73	75	84	88	76	80 **	81	77
	SIDC values in the CVB Feed Table 2021																		
SIDC	80	84	82	82	82	76	82	84	79	77	80	72	75	80	89	77	91	85	83

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.2 Biscuit, ground and bread remains, dried

The SIDC evaluation of biscuit, ground and bread remains, dried is based on an initial dataset with 4 observations for 'bakery products'. From the literature it is not clear which bakery products were studied. The average crude protein content of these four observations was 145 ± 24.3 g/kg DM, with a minimum and maximum value of 121 and 173 g/kg DM, respectively.

Table 3.2.1. Amino acid pattern of the 4 observations for bakery products: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	3	4	3
Average **	4.3	2.7	3.6	**7.9**	2.8	1.5	4.6	3.1	1.0	4.6	**4.4**	5.7	**1.7**	**23.7**	3.8	**7.8**	4.3	2.9
STDEV	0.5	1.3	0.3	1.4	0.5	0.1	0.2	0.3	0.1	0.2	1.1	1.6	0.3	6.3	0.2	0.6	0.5	0.4
Min	3.8	1.7	3.3	6.5	2.4	1.4	4.3	2.8	0.9	4.4	3.2	3.8	1.3	17.8	3.5	7.3	3.8	2.5
Max	5.0	4.5	4.0	9.7	3.4	1.6	4.9	3.4	1.1	4.8	5.8	7.7	1.9	32.5	4.0	8.4	4.8	3.2
CVB Feed Table 2021																		
Average	4.1	2.4	3.6	6.6	2.5	1.5	4.6	3.3	1.0	4.5	3.7	5.8	2.1	27.7	3.9	9.7	4.7	2.8
STDEV	0.6	0.2	0.1	0.1	0.3	0.2	0.5	0.4	-	0.4	0.3	0.5	0.1	1.3	0.3	0.2	0.3	-

*: In this small dataset no outliers were identified.

**: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.2.2 shows that the evaluation in the current CVB Feed Table 2021 is substantially higher than the values in the new dataset. Considering that bakery products have been heat treated for longer times, it is assumed that the new evaluation is more realistic than that in the current CVB Feed Table 2021.

Further, the table shows that the SIDC of LYS in the dataset is very low and has a large STDEV. Therefore, it is decided to use for LYS the same SIDC as for poultry. For the SIDC of PRO the average SIDC of the other 16 AA is used.

The SIDC evaluation of CP and AA for bakery products will be used for the following feedstuffs in the CVB Feed Table: biscuit, ground (two qualities differing in crude fat content) and for bread remains, dried.

Table 3.2.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for bakery products, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of bakery products in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	3	4	2
Average SIDC	78.3	86.9	80.4	79.0	83.9	62.5	82.7	83.8	72.4	75.3	77.6	75.9	72.5	74.7	87.5	79.4	106.7	80.6	83.4
STDEV *	11.5	7.5	10.1	10.3	8.4	17.5	8.5	9.2	11.9	13.4	10.2	11.0	12.7	14.2	8.8	16.2	58.4	9.4	9.1
Min	65.0	75.7	71.1	69.2	75.2	46.6	74.5	74.2	62.1	59.8	67.7	61.6	61.8	57.4	78.3	55.1	43.3	70.0	77.0
Max	89.2	91.5	91.4	88.4	91.8	80.8	92.0	92.8	83.9	83.1	87.2	84.9	87.6	88.1	96.8	88.7	158.2	90.4	89.8
	After conversion to an integral number																		
SIDC	78	87	80	79	84	70	83	84	72	75	78	76	73	75	88	79	79 **	81	83
	SIDC values in the CVB Feed Table 2021																		
SIDC	93	94	93	94	94	92	93	90	91	91	93	93	91	88	95	92	92	94	95

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.3 Blood meal

Generally, blood meal is considered a protein source with a high digestibility. In the initial dataset there were 6 publications with an average SIDC of all AA (except PRO) >85%, and 8 with an average SIDC of all AA (except PRO) <80%.
It was decided to use only observations of blood meal with a digestibility >85%, and to identify these as 'good quality blood meal'. The average crude protein content of these 6 samples was 969 ± 11.6 g/kg DM, with a minimum and maximum value of 950 and 982 g/kg DM, respectively.

Table 3.3.1. Amino acid pattern of all observations for blood meal (good quality), after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference. *

Item	Amino acid pattern (g/16g N) *																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	6	6	5	6	6	3	6	6	6	6	3	3	3	3	3	1	3	3
Average **	4.2	6.1	0.7	12.7	9.3	1.1	7.0	4.6	1.3	8.9	7.5	**9.2**	0.9	**7.7**	**3.9**	4.2	**3.6**	2.5
STDEV	0.67	0.51	0.18	1.29	1.11	0.40	0.76	1.14	0.32	1.39	0.44	0.83	0.50	1.54	0.30		0.42	0.80
Min	3.4	5.2	0.4	10.3	7.9	0.7	6.0	2.5	1.0	6.3	7.2	8.4	0.6	6.8	3.6		3.1	1.8
Max	5.3	6.8	0.8	13.8	10.4	1.3	7.6	5.7	1.8	10.2	8.0	10.0	1.5	9.5	4.2		3.9	3.4
CVB Feed Table 2021																		
Average	4.3	6.4	1.2	12.8	8.9	1.2	6.9	4.4	1.5	8.6	7.9	11.0	1.2	9.3	4.5	3.9	5.0	2.9
STDEV	0.3	0.4	0.3	0.6	0.4	0.2	0.4	0.5	0.2	0.6	0.4	0.4	0.2	0.5	0.2	0.4	0.3	0.4

*: In this outlier analysis the difference in amino acid pattern between blood meals from different origin is ignored.
**: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.3.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for blood meal (good quality), after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of blood meal (good quality) in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	5	5	5	5	5	3	5	6	5	6	3	3	3	3	3	0	3	3
Average SIDC	84.5	89.9	92.5	82.1	88.3	89.9	88.4	91.4	86.1	86.9	89.2	90.7	89.5	81.4	87.7	84.5		87.7	89.0
STDEV *	0.78	1.17	2.35	5.86	2.94	1.03	3.64	2.72	2.56	2.75	3.83	4.64	4.69	9.28	1.25	2.84		1.41	1.10
Min	83.6	88.1	90.4	71.9	83.6	88.8	84.3	89.5	83.1	82.7	83.5	85.9	84.6	70.7	86.7	81.3		86.4	88.2
Max	85.5	91.3	96.0	86.3	91.6	91.4	91.2	96.0	89.9	89.6	95.0	95.2	93.9	87.2	89.1	86.8		89.2	90.2
	After conversion to an integral number																		
SIDC	85	90	93	82	88	90	88	91	86	87	89	91	90	81	88	85	88 **	88	89
	SIDC values in the CVB Feed Table 2021																		
SIDC	88	95	95	75	93	94	88	92	88	91	93	88	88	88	88	88	88	88	88

*: STDEV > 7% are marked red. **: SIDC-PRO = average SIDC of the other 17 AA.

It was decided to publish also a SIDC evaluation of CP and AA if the quality of blood meal is not known, based on the combined analysis of both good quality and lower quality blood meals. This proposal is presented in Table 3.3.3.

Table 3.3.3. Standardized ileal digestibility (SIDC; %) of crude protein and amino acids for blood meal for which the quality is not known.

SIDC values (in %-units) for blood meal for which quality is not known																		
CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
78.7	83.0	82.6	74.3	79.7	84.0	82.1	81.6	79.0	83.3	79.2	77.2	77.9	59.8	78.3	74.6		77.8	85.4
After conversion to an integral number																		
70	83	80	74	80	84	82	82	79	83	79	77	78	60	78	75	79 *	78	85

*: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.4 Brewer's yeast and other yeasts

The SIDC evaluation of yeasts (brewer's yeast, Torula yeast, yeast cultured on n-alkanes, molasses, sulphite waste) is based on an initial dataset with 10 observations, in which the average crude protein content was 513 ± 88.0 g/kg DM, with a minimum and maximum value of 381 and 661 g/kg DM, respectively.

Table 3.4.1. Amino acid pattern of all observations for yeasts, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	9	9	10	9	9	8	9	9	7	9	10	10	8	10	10	8	10	10
Average *	4.7	1.9	**5.8**	7.5	7.4	1.5	4.4	4.9	1.2	5.3	6.2	9.6	1.0	13.5	4.5	3.8	4.7	3.0
STDEV	0.34	0.15	1.39	0.80	0.99	0.24	0.52	0.33	0.07	0.20	0.73	0.93	0.12	1.93	0.36	0.81	0.65	0.75
Min	4.0	1.8	4.5	6.6	6.5	1.1	3.8	4.5	1.1	5.0	4.8	8.3	0.8	10.7	3.9	3.0	3.8	2.0
Max	5.2	2.2	8.4	9.3	9.7	1.8	5.4	5.5	1.3	5.7	7.7	10.9	1.2	16.1	5.2	5.0	5.8	4.5
CVB Feed Table 2021																		
Average	4.4	2.1	4.6	6.8	6.7	1.6	4.2	4.8	1.2	5.3	6.3	9.0	1.1	12.6	4.5	4.1	5.0	3.3
STDEV	0.7	0.2	0.4	0.4	0.8	0.1	0.3	0.5	0.1	0.4	0.5	1.0	0.2	1.3	0.3	0.7	0.4	0.4

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.4.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for yeasts, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of yeasts in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	9	10	10	10	10	8	10	10	8	10	10	10	8	9	10	6	10	10
Average SIDC	86.7	93.2	87.1	86.8	87.4	89.6	85.7	87.2	81.9	87.5	85.5	86.5	86.5	73.6	90.6	86.6	98.1	83.7	88.2
STDEV *	6.13	3.59	6.93	5.71	5.93	4.73	8.46	6.06	4.57	7.97	6.28	5.78	4.7	15.5	3.71	6.57	9.74	5.12	7.02
Min	77.6	87.2	76.2	77.4	79.1	82.1	73.8	75.3	74.6	73.8	76.7	75.7	78.7	44.6	84.2	79.3	80.1	76.1	75.1
Max	94.6	99.4	96.3	93.9	95.3	95.2	94.5	94.8	88.8	97	93.2	94.4	92.1	87.9	94.9	99.5	106.2	90.8	95
	After conversion to an integral number																		
SIDC	87	93	87	87	87	90	86	87	82	88	86	87	87	78 **	91	87	87 ***	84	88
	SIDC values in the CVB Feed Table 2021																		
SIDC	85	92	84	84	85	88	82	86	83	85	85	86	86	69	89	85	90	85	89

*: STDEV > 7% are marked red. **: In the dataset with 8 observations there is 1 extreme low SIDC value (44.6); after removal of this value the SIDC becomes 78%.
***: For the SIDC of PRO the average SIDC of the other 17 AA is used.

The new SIDC evaluation of CP and AA for yeasts (as described above) will be used for brewers' yeast, dried and for (the three qualities of) brewers, yeast, liquid as published in the CVB Feed Table.

3.5 Casein

This SIDC evaluation is based on an initial dataset with 20 observations, in which the average crude protein content was 958 ± 41.4 g/kg DM, with a minimum and maximum value of 871 and 1000 g/kg DM, respectively.

Table 3.5.1. Amino acid pattern of all observations for casein, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last rows the pattern from the CVB Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	18	19	19	19	19	17	18	19	12	18	19	19	16	19	18	18	19	14
Average *	3.6	2.9	5.5	9.8	7.9	3.0	5.2	4.4	1.3	7.0	3.1	7.2	0.5	22.6	1.9	11.2	5.4	5.4
STDEV	0.37	0.28	0.31	0.54	0.63	0.16	0.37	0.26	0.15	0.28	0.29	0.48	0.17	1.50	0.19	1.25	0.67	0.43
Min	3.1	2.4	4.8	8.5	6.7	2.6	4.4	3.8	1.0	6.4	2.4	6.1	0.3	19.6	1.6	8.8	4.5	4.6
Max	4.4	3.3	5.9	10.6	8.8	3.2	5.8	4.9	1.6	7.4	3.7	7.9	0.8	25.1	2.1	13.2	6.8	6.3
CVB Feed Table 2021																		
Average	3.6	3.1	5.2	9.7	8.0	3.0	5.2	4.3	1.3	6.7	3.2	7.3	0.4	22.0	2.0	11.2	5.7	5.6
STDEV	0.3	0.1	0.2	0.3	0.4	0.1	0.1	0.2	0.1	0.4	0.3	0.4	0.1	0.9	0.2	1.1	0.3	0.5

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.5.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for casein, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of casein in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	18	18	18	17	18	18	17	17	18	11	18	18	18	14	17	17	15	18	13
Average SIDC	96.9	98.3	97.8	97.2	98.2	98.6	97.9	98.9	95.2	96.7	97.3	96.0	96.9	86.1	98.5	98.4	105.4	95.5	98.4
STDEV	3.40	3.21	2.23	2.15	1.49	2.14	1.94	2.26	3.67	4.07	1.68	5.15	2.61	11.62	5.34	13.36	8.04	3.26	1.37
Min	89.8	92	93	92.7	95.9	95.5	94.5	95	89	88.2	94.2	87.2	91.7	61	94.2	75.2	96.8	91.2	95.6
Max	101.1	103.1	101	101.1	100.3	103.2	100.7	104	100.7	101.2	100.5	106.9	101	99.5	117.9	123.8	124.9	101.2	100.1
	After conversion to an integral number																		
SIDC	97	98	98	97	98	99	98	99	95	97	97	96	97	86	99	98	97**	96	98
	SIDC values in the CVB Feed Table 2021																		
SIDC	97	99	99	96	99	98	99	99	96	98	96	97	98	92	97	99	99	92	100

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.6 Coconut (Copra) expeller and meal

The SIDC evaluation of copra meal and expeller is based on a small initial dataset with 4 observations (3 meals and 1 expeller), in which the average crude protein content was 222 ± 25.0 g/kg DM, with a minimum and maximum value of 187 and 242 g/kg DM, respectively.
Before starting the data processing, it was decided to remove completely one observation for copra meal; this observation had a very low digestibility with an average SIDC of all AA, except PRO, of 44.3 ± 11.0%.

Table 3.6.1. Amino acid pattern of all observations for copra meal and expeller, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2
Average *	10.5	1.7	3.1	6.0	2.2	1.4	4.0	3.0	0.7	4.9	4.1	7.9	1.4	18.3	4.2	3.3	4.1	2.5
STDEV	2.78	0.41	0.19	0.69	0.48	0.29	0.48	0.68	0.04	0.72	0.41	1.38	0.22	3.88	0.57	0.71	0.98	0.89
Min	8.4	1.4	3.0	5.5	1.9	1.2	3.6	2.5	0.7	4.4	3.9	6.8	1.3	15.2	3.7	2.7	3.2	1.9
Max	13.7	2.2	3.3	6.8	2.8	1.7	4.5	3.8	0.7	5.7	4.6	9.4	1.7	22.6	4.8	4.1	5.1	3.1
CVB Feed Table 2021																		
Average	10.9	1.8	3.2	6.2	2.5	1.5	4.2	3.0	0.7	4.8	4.2	7.9	1.5	18.2	4.2	3.5	4.2	2.4
STDEV	0.7	0.1	0.2	0.2	0.3	0.1	0.3	0.1	0.1	0.2	0.2	0.3	0.1	0.8	0.2	0.2	0.2	0.1

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.6.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for copra meal and expeller, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of copra meal and expeller in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2
Average SIDC	73.8	85.8	80.9	79.8	80.2	65.2	83.6	81.7	72.4	77.4	76.9	76.8	70.3	63.0	75.5	75.4	150.2	76.0	84.5
STDEV **	8.70	8.40	7.08	2.70	1.57	22.13	1.75	2.66	6.90	15.63	2.67	3.14	7.44	8.53	7.10	14.49	40.43	5.77	2.35
Min	67.6	76.1	73.2	76.7	78.5	40.3	82.1	79.2	64.4	66.3	73.9	73.2	65.6	53.1	67.3	60.6	125.0	70.5	82.8
Max	79.9	91.2	87.1	81.6	81.6	82.6	85.5	84.5	76.7	88.4	79.0	79.0	78.9	68.0	79.9	89.5	196.9	82.0	86.1
	After conversion to an integral number																		
SIDC	74	86	81	80	80	65	84	82	72	77	77	77	70	63	76	75	77 ***	76	85
	SIDC values in the CVB Feed Table 2021																		
SIDC	57	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58

*: The evaluation is used for copra expeller (2 qualities) and copra meal in the CVB table. **: STDEV > 7% are marked red. ***: SIDC-PRO = average SIDC of the other 17 AA.

3.7 Cotton seed expeller and meal

3.7.1 Cotton seed meal, solvent extracted

This SIDC evaluation of cottonseed meal, solvent extracted is based on an initial dataset with 48 observations, in which the average crude protein content was 478 ± 65.9 g/kg DM, with a minimum and maximum value of 350 and 627 g/kg DM, respectively.

Table 3.7.1.1. Amino acid pattern of all observations for cottonseed meal, solvent extracted, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	42	46	44	43	45	41	47	46	36	44	38	41	36	41	40	40	40	40
Average *	10.7	2.7	3.0	5.6	4.1	1.4	5.3	3.1	1.1	4.2	3.7	8.8	1.6	18.5	3.9	3.4	4.0	2.5
STDEV	0.68	0.25	0.20	0.29	0.26	0.16	0.40	0.21	0.14	0.28	0.23	0.53	0.16	0.90	0.22	0.71	0.35	0.21
Min	9.6	2.3	2.6	5.0	3.7	0.9	4.7	2.6	0.9	3.7	3.0	7.9	1.2	17.0	3.5	2.0	3.3	2.0
Max	12.2	3.3	3.3	6.2	4.8	1.6	6.2	3.6	1.4	4.8	4.1	10.0	2.1	20.4	4.3	4.9	5.0	2.9
CVB Feed Table 2021																		
Average	10.7	2.7	3.1	5.9	4.1	1.6	5.2	3.2	1.2	4.4	4.1	9.3	1.7	18.9	4.2	3.7	4.3	2.9
STDEV	0.6	0.2	0.2	0.3	0.3	0.1	0.3	0.2	0.1	0.3	0.3	0.4	0.1	0.8	0.2	0.3	0.2	0.3

*: If averages values deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

For cottonseed meal, solvent extracted it was observed that the SIDC's of CP and most AA are significantly correlated with the CP content. In the Table 3.7.1.2 a correlation matrix is presented, showing the number of observations, correlation coefficients and the significance of the correlation.

Based on the results in Table 3.7.1.2 prediction equations were developed by performing regression analysis with the model: SID level of CP or AA = a*Crude Protein + c (results not shown).

Table 3.7.1.2. Correlation matrix showing the correlation of the standardized ileal digestible CP and Amino Acid contents (g/kg DM) to Crude Protein (g/kg DM): number of observations, correlation coefficient (r) and significance (p).

Item	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	44	44	47	47	47	47	41	47	47	41	47	42	42	37	42	42	36	42	40
Corr. Coeff. (r)	0.897	0.884	0.861	0.839	0.834	0.759	0.314	0.888	0.760	0.693	0.738	0.351	0.851	0.627	0.893	0.760	0.606	0.595	0.799
Signific. (p) *	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.046	<.0001	<.0001	<.0001	<.0001	0.023	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

*: All correlations are significant.

Using these prediction equations, the SIDC's have been calculated for the three qualities of cottonseed meal that are published in the CVB Feed Table (see Table 3.7.1.3).

Table 3.7.1.3. New SIDC values for the three qualities of cottonseed meal, solvent extracted as published in the CVB Table, using the regression equations that were developed. For comparison the SIDC values of the CVB Feed Table 2021 are depicted too.

Cottonseed meal, solvent extracted	**CP**	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Cottonseed meal, extracted-dehulled, CF < 140 g/kg																			
New SIDC values, with one decimal	78.4	96.3	85.7	76.2	75.3	70.3	69.1	90.6	73.1	77.1	75.0	72.0	78.0	73.9	88.5	74.7	77.9	76.6	71.8
New SIDC values, converted to an integer	78	96	86	76	75	70	69	91	73	77	75	72	78	74	88	75	78	77	72
SIDC values in CVB Feed Table 2021	*81*	*92*	*81*	*79*	*78*	*70*	*80*	*86*	*76*	*82*	*83*	*79*	*83*	*80*	*90*	*85*	*89*	*86*	*82*
Cottonseed meal, extracted-partly dehulled, CF 140 - 200 g/kg																			
New SIDC values, with one decimal	69.9	85.5	72.7	69.5	66.5	59.2	66.5	80.9	63.4	64.5	71.4	68.4	66.9	70.5	79.5	62.0	**69.4**	67.5	64.2
New SIDC values, converted to an integer	70	86	73	69	66	59	67	81	63	65	71	68	67	70	79	62	**69**	68	64
SIDC values in CVB Feed Table 2021	*81*	*92*	*81*	*79*	*78*	*70*	*80*	*86*	*76*	*82*	*83*	*79*	*83*	*80*	*90*	*85*	*89*	*86*	*82*
Cottonseed meal, solvent extracted	**CP**	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Cottonseed meal, extracted -non-dehulled																			
New SIDC values, with one decimal	54.6	71.0	54.4	60.4	54.7	43.9	64.0	69.0	49.8	47.6	68.8	65.8	51.1	68.3	67.8	42.7	*58.1*	55.0	53.3
New SIDC values, converted to an integer	55	71	54	60	55	44	64	69	50	48	69	66	51	68	68	43	*58*	55	53
SIDC values in CVB Feed Table 2021	*No SIDC values in current CVB Table*																		

3.7.2 Cotton seed expeller

The SIDC evaluation of cotton seed expeller is based on an initial dataset with 4 observations, in which the average crude protein content was 425 ± 58.6 g/kg DM, with a minimum and maximum value of 379 and 505 g/kg DM, respectively.

Table 3.7.2.1. Amino acid pattern of all observations for cotton seed expeller, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	4	4	4	4	3	4	4	2	3	3	4	2	4	4	4	4	4
Average *	10.0	2.8	3.2	**5.2**	3.7	1.5	5.1	3.1	1.2	4.3	3.6	**8.0**	1.5	17.6	**3.6**	3.9	**3.8**	2.7
STDEV	0.88	0.42	0.43	0.57	0.56	0.11	0.32	0.32	0.01	0.17	0.41	1.08	0.13	2.52	0.44	0.71	0.28	0.40
Min	9.3	2.3	2.8	4.6	3.2	1.4	4.7	2.7	1.2	4.1	3.1	6.7	1.4	14.4	3.1	3.3	3.5	2.2
Max	11.3	3.3	3.8	5.8	4.4	1.6	5.4	3.5	1.2	4.5	3.9	9.1	1.6	20.1	4.1	4.8	4.2	3.2
CVB Feed Table 2021																		
Average	10.7	2.7	3.1	5.9	4.1	1.6	5.2	3.2	1.2	4.4	4.1	9.3	1.7	18.9	4.2	3.7	4.3	2.9
STDEV	0.6	0.2	0.2	0.3	0.3	0.1	0.3	0.2	0.1	0.3	0.3	0.4	0.1	0.8	0.2	0.3	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.7.2.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for cotton seed expeller: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of cotton seed expeller in the CVB Feed Table 2021 is mentioned as a reference. * **

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	3	4	4	4	4	4	2	4	4	3	4	4	4	2	4	4	4	4	4
Average SIDC	81.9	91.9	76.8	77.7	80.1	67.3	80.7	85.6	79.0	79.0	77.8	78.4	79.9	83.3	89.7	89.3	113.6	82.2	82.9
STDEV ***	7.93	2.57	15.41	4.34	3.29	10.99	2.40	4.65	3.01	6.59	4.58	5.63	3.66	4.60	5.80	8.33	19.38	3.69	3.90
Min	73.0	89.5	60.0	72.0	76.0	51.3	79.0	81.1	75.0	75.0	72.8	70.6	75.8	80.0	82.0	77.0	90.0	78.2	79.0
Max	88.1	94.7	91.7	82.6	84.0	76.1	82.4	91.7	82.3	86.6	83.8	83.7	83.9	86.5	95.9	95.2	134.4	85.5	88.2
	After conversion to an integral number																		
SIDC	82	92	77	78	80	67	81	86	79	79	78	78	80	83	90	89	81 ****	82	83
	SIDC values in the CVB Feed Table 2021																		
SIDC	81	92	81	79	78	70	80	86	76	82	83	79	82	80	90	85	89	86	82

*: There were no outliers identified for the SIDC's. **: The SIDC evaluation will be used for cotton seed expeller, dehulled and cottonseed, partly dehulled as published in the CVB Feed Table. ***: STDEV > 7% are marked red. ****: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.8 DDGS, Maize

This SIDC evaluation of DDGS, Maize is based on an initial dataset with 92 observations, in which the average crude protein content was 308 ± 25.5 g/kg DM, with a minimum and maximum value of 272 and 489 g/kg DM, respectively.

Table 3.8.1. Amino acid pattern of all observations for DDGS, Maize, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	86	86	84	86	86	88	85	85	78	88	87	84	85	87	87	72	79	59
Average	4.3	2.7	3.7	11.3	3.1	2.0	4.8	3.6	0.7	5.0	6.9	6.3	1.9	14.6	3.8	7.6	4.2	3.4
STDEV	0.31	0.22	0.17	0.56	0.42	0.20	0.22	0.13	0.08	0.30	0.40	0.36	0.29	2.02	0.21	0.40	0.40	0.30
Min	3.6	2.2	3.3	10.1	2.3	1.6	4.2	3.3	0.6	4.3	6.2	5.6	1.3	11.2	3.3	6.6	3.4	2.9
Max	4.9	3.1	4.1	12.8	3.9	2.5	5.4	4.1	0.9	5.6	7.9	7.2	2.6	18.8	4.2	8.4	4.9	4.3
CVB Feed Table 2021																		
Average	4.1	2.5	4	11.9	2.4	1.0	5.0	3.6	0.7	5.0	7.2	6.8	1.8	18.1	3.9	7.9	4.6	4.1
STDEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3.8.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for DDGS, Maize, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of DDGS, Maize in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	75	82	83	83	80	80	83	82	82	79	81	78	82	82	79	79	68	74	56
Average SIDC	73.9	83.6	77.9	76.3	84.7	62.6	82.4	81.8	70.7	73.8	75.8	80	69.2	73.2	81.5	66.6	75.5	77.1	82.5
STDEV *	4.8	4.47	4.31	4.11	2.84	6.94	3.34	3.17	4.34	8.45	4.08	3.51	4.58	4.11	3.72	8.69	11.8	4.3	3.14
Min	63.5	74.1	69.8	66.5	77.8	46.5	73.9	74.4	60.6	53.2	67.3	71.7	59.4	65.9	71.2	51	51.5	63.4	74.6
Max	82.9	92	85.9	84.2	91.3	75.4	89.2	88.7	81.9	86.9	86.2	86.4	79.1	80.6	88.7	87	109.1	86.6	90.1
	After conversion to an integral number																		
SIDC	74	84	78	76	85	63	83	82	71	74	76	80	69	73	82	67	76**	77	83
	SIDC values in the CVB Feed Table 2021																		
SIDC	73	84	78	79	86	58	86	85	73	77	80	82	67	66	84	60	67	84	-

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.9 DDGS, Wheat

This SIDC evaluation of DDGS, Wheat is based on an initial dataset with 10 observations, in which the average crude protein content was 363 ± 43.1 g/kg DM, with a minimum and maximum value of 318 and 445 g/kg DM, respectively.

Table 3.9.1. Amino acid pattern of all observations for DDGS, Wheat, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	10	10	10	10	9	10	9	10	8	10	9	9	9	9	9	9	9	1
Average	3.8	2.0	3.4	6.8	1.8	1.4	4.5	3.0	1.0	4.3	3.8	5.0	1.8	25.5	4.0	9.0	4.4	2.6
STDEV	0.33	0.17	0.31	0.40	0.27	0.21	0.10	0.11	0.06	0.15	0.38	0.26	0.23	1.95	0.08	0.73	0.20	
Min	3.3	1.8	2.8	6.3	1.5	1.0	4.3	2.8	0.8	4.1	3.5	4.7	1.4	22.2	3.9	8.1	4.2	
Max	4.4	2.3	3.9	7.6	2.3	1.9	4.7	3.2	1.0	4.6	4.5	5.5	2.2	27.9	4.1	10.2	4.6	
CVB Feed Table 2021																		
Average	4.0	2.0	3.6	7.5	2.1	1.5	4.5	3.2	0.9	4.3	4.3	5.4	1.7	23.7	3.9	8.5	4.4	-
STDEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

It was observed that the SIDC's of CP and several AA correlated well with the NDF content in DDGS, Wheat. This is illustrated in Table 3.9.2.

Table 3.9.2. Correlation matrix showing the correlation of the standardized ileal digestible (SID) of CP and Amino Acid contents (g/kg DM) to Crude Protein, crude fiber, NDF and ADF (all in g/kg DM).

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	8	9	9	9	9	9	9	9	9	8	9	8	8	9	8	8	4	8	
Corr. coeff. (r)	-0.834	-0.777	-0.811	-0.739	-0.703	-0.779	-0.835	-0.677	-0.707	-0.572	-0.710	-0.802	-0.792	-0.307	-0.572	-0.810	-0.127	-0.638	
Significance (p)	**0.010**	**0.014**	**0.008**	**0.023**	**0.035**	**0.013**	**0.005**	**0.045**	**0.033**	0.138	**0.032**	**0.017**	**0.019**	0.421	0.139	**0.015**	0.873	0.089	

Based on the results in Table 3.9.2 regression analysis has been performed to develop prediction equations with the model: (Standardized ileal digestible level of CP or AA) = a*Crude Protein + c Results not shown). These equations were used only to calculate the SIDC values of CP and AA for DDGS, Wheat, using the CP content and the AA pattern as published in the CVB Feed Table (2021). The results are shown in Table 3.9.3.

Table 3.9.3. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for DDGS, Wheat, calculated with internal equations. The SIDC's of DDGS, Wheat in the CVB Feed Table 2021 is mentioned as a reference.

SIDC (%)																		
CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
70.7	81.4	74.0	76.7	80.4	44.7	76.4	83.7	68.4	70.7	77.7	66.4	58.1	68.3	90.4	61.7	72.8 *	76.7	81.6
After conversion to an integral number																		
71	81	74	77	80	45	76	84	68	71	78	66	58	68	90	62	73 *	77	82
SIDC values in the CVB Feed Table 2021																		
77	84	79	80	83	57	81	87	74	84	77	73	62	79	88	69	80	80	-

*: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.10 Feather meal, hydrolyzed

The SIDC evaluation of feather meal, hydrolyzed is based on an initial dataset with 6 observations, in which the average crude protein content was 902 ± 34.3 g/kg DM, with a minimum and maximum value of 860 and 944 g/kg DM, respectively.

Table 3.10.1. Amino acid pattern of all observations for feather meal, hydrolyzed, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	5	5	4	5	3	5	4	5	5	4	4	4	3	4	4	4	3
Average *	6.8	1.1	4.7	8.3	2.5	0.8	5.1	4.5	0.6	7.7	4.8	6.7	5.1	10.3	7.2	9.2	**9.2**	3.0
STDEV	0.17	0.44	0.14	0.25	0.63	0.03	0.21	0.10	0.09	0.45	0.22	0.35	0.38	0.22	0.46	1.15	0.73	0.06
Min	6.6	0.5	4.5	8.0	1.8	0.8	4.8	4.4	0.5	7.0	4.6	6.3	4.7	10.0	6.9	8.1	8.4	2.9
Max	7.1	1.6	4.8	8.5	3.3	0.8	5.4	4.6	0.7	8.2	5.1	7.1	5.5	10.4	7.9	10.5	9.9	3.1
CVB Feed Table 2021																		
Average	6.9	1.0	4.8	8.3	2.5	0.7	4.9	4.7	0.7	7.3	4.7	7.0	5.0	10.9	7.7	9.6	10.7	3.1
STDEV	0.3	0.3	0.2	0.2	0.4	0.1	0.2	0.1	0.1	0.4	0.2	0.3	0.6	0.5	0.4	0.7	0.6	0.1

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.10.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for feather meal, hydrolyzed, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of feather meal, hydrolyzed in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	4	4	4	4	4	3	4	4	4	4	3	3	3	2	3	1	3	3
Average SIDC	67.4	76.2	66.7	78.2	74.2	59.5	63.0	77.8	64.1	70.1	73.5	64.9	41.6	35.2	61.4	62.7	29.4	67.2	69.9
STDEV *	7.46	7.33	9.66	1.15	4.11	15.52	5.29	4.31	5.67	10.89	4.78	8.12	3.01	10.02	0.37	5.37		3.40	4.35
Min	62.1	69.8	60.3	77.4	69.7	39.0	56.9	73.5	60.2	59.7	67.6	56.3	38.4	24.0	61.1	57.7		65.2	65.5
Max	72.6	84.8	80.8	79.9	78.8	76.7	66.5	82.7	72.5	79.7	78.7	72.5	44.3	43.4	61.6	68.4		71.1	74.2
	After conversion to an integral number																		
SIDC	**67**	**76**	**67**	**78**	**74**	**60**	**63**	**78**	**64**	**70**	**74**	**65**	**42**	**35**	**61**	**63**	**65 ****	**67**	**70**
	SIDC values in the CVB Feed Table 2021																		
SIDC	66	80	63	80	76	49	58	81	69	56	78	71	48	64	78	80	87	80	70

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.11 Fishmeal, treated

The SIDC evaluation of fishmeal is based on an initial dataset with 22 observations, in which the average crude protein content was 688 ± 58.7 g/kg DM, with a minimum and maximum value of 601 and 851 g/kg DM, respectively.

Table 3.11.1. Amino acid pattern of all observations for fishmeal, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	21.0	21.0	21.0	22.0	20.0	17.0	22.0	22.0	14.0	21.0	14.0	16.0	14.0	16.0	16.0	15.0	15.0	15.0
Average *	5.9	2.4	4.2	7.1	7.6	2.6	3.9	4.2	**0.9**	4.8	6.0	8.8	0.9	12.7	6.6	4.4	3.8	2.9
STDEV	0.28	0.41	0.19	0.35	0.45	0.53	0.19	0.30	0.12	0.37	0.39	0.77	0.15	1.54	1.92	0.67	0.50	0.41
Min	5.5	1.8	3.8	6.5	6.8	1.7	3.6	3.7	0.8	3.7	4.9	7.3	0.7	10.4	2.9	3.3	3.1	2.1
Max	6.4	3.4	4.5	7.8	8.6	4.2	4.3	4.7	1.2	5.7	6.3	10.0	1.3	15.3	10.2	5.8	4.7	3.7
CVB Feed Table 2021																		
Average	5.9	2.6	4.2	7.3	7.6	2.8	3.9	4.2	1.1	4.9	6.3	9.3	0.9	13.0	6.5	4.4	4.0	3.1
STDEV	0.4	0.5	0.3	0.4	0.5	0.2	0.3	0.2	0.1	0.4	0.3	0.5	0.1	0.7	0.7	0.5	0.3	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.11.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for fishmeal, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of fishmeal in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	20	20	22	22	21	21	18	21	22	13	21	15	16	14	16	15	14	16	17
Average SIDC	85.4	91.5	85.8	86.7	87.8	88.1	87.7	86.3	85.9	85.8	86.2	85.8	80.5	73.1	86.5	86.2	108	84.8	82
STDEV **	7.05	4.28	6.84	6.13	5.55	4.97	6.2	6.61	7.57	2.77	6.14	8.00	9.38	12.23	6.45	11.96	33.44	8.33	8.24
Min	69.5	83	74.3	75	76.3	81	76.3	73.7	73.4	79.9	73.9	70	61.8	48.8	75.3	65.8	49.7	72.8	67.3
Max	99.5	99.3	97.7	96.2	97.1	97.1	96.8	95.6	98.3	90.2	96.4	95.8	95.3	92.9	96.1	107.4	161.8	99.8	95.5
	After conversion to an integral number																		
SIDC	85	92	86	87	88	88	88	86	86	86	86	86	81	73	87	86	85***	85	82
	SIDC values in the CVB Feed Table 2021																		
SIDC	85	92	87	90	90	89	89	87	88	86	89	90	79	74	90	87	98	89	88

*: This evaluation will be used for all four qualities in the CVB Feed Table. **: STDEV > 7% are marked red. ***: SIDC-PRO is the average SIDC of the other 17 AA.

3.12 Grass meal

The SIDC evaluation of grass meal is based on an initial dataset with 2 observations, in which the crude protein content was 228 and 152 g/kg DM for observation 1 and 2, respectively.

Table 3.12.1. Amino acid pattern of the two observations for grass meal in g/16g N. In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation 1 *	3.7	1.7	3.8	6.3	3.9	1.2	3.8	3.6		4.8	**4.6**	11.1	0.9	9.0	4.2	4.5	4.0	2.6
Observation 2 *	4.4	1.7	4.0	6.8	3.9	1.5	4.5	3.6		5.3	5.3	8.2	**2.5**	10.0	4.0	**9.0**	4.0	2.7
CVB Feed Table 2021																		
Average	4.1	1.9	3.8	6.9	3.9	1.5	4.3	4.1	1.4	5.2	6.4	9.1	1.0	10.0	4.6	4.6	4.0	2.7
STDEV	0.5	0.3	0.3	0.5	0.6	0.2	0.6	0.4	0.1	0.6	0.8	1.1	0.2	1.0	0.5	0.6	0.4	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.12.2. Standardized ileal digestibility (SIDC; %) of crude protein and amino acids for two observations of grass meal. The SIDC's of grass meal in the CVB Feed Table 2021 are shown as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation 1	51.7					74.3	78.0		65.1					40.0					
Observation 2		74.8	70.9	71.8	69.4	71.3	49.8	70.0	59.6		74.1			59.3	7.0	21.2		9.7	67.8
	Proposed SIDC for grass meal in future CVB Feed Table																		
SIDC	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	SIDC values in the CVB Feed Table 2021																		
SIDC	48	48	48	48	48	48	63	48	48	48	48	48	48	33	48	48	48	48	48

For grass meal there are 4 protein classes in the CVB Feed Table varying from a class with a CP concentration <140 g/kg to a class with a CP content >200 g/kg. Two (incomplete) observation is insufficient to relate the SIDC evaluation to the crude fiber content. As the two observations have a low and a high CP value it is proposed to average the average SIDC-AA values of the two observations resulting in an average SIDC-AA value of (64.4 + 55.5) / 2 = 60%.

3.13 Groundnut expeller and meal

This SIDC evaluation of groundnut expeller and meal is based on an initial dataset with 20 observations, in which the average crude protein content was 509 ± 31.4 g/kg DM, with a minimum and maximum value of 442 and 560 g/kg DM, respectively.

Table 3.13.1. Amino acid pattern of all observations for groundnut expeller and meal, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	19	19	19	18	18	16	17	18	17	18	15	15	15	15	15	15	15	14
Average *	10.8	2.1	3.1	5.9	3.1	0.9	4.7	2.6	0.8	4.1	**4.2**	11.4	1.3	**17.0**	5.5	4.6	4.3	**2.3**
STDEV	0.8	0.4	0.2	0.3	0.3	0.1	0.3	0.2	0.1	0.3	0.4	0.7	0.2	1.0	0.3	0.7	0.3	0.8
Min	9.7	1.6	2.7	5.3	2.5	0.8	4.1	2.3	0.7	3.6	3.4	10.3	0.9	15.4	5.0	3.5	3.9	1.7
Max	12.4	2.9	3.6	6.6	3.7	1.1	5.2	3.1	1.0	4.8	4.9	12.8	1.6	18.6	6.1	5.5	4.9	3.8
CVB Feed Table 2021																		
Average	10.9	2.3	3.3	6.3	3.3	1.2	4.9	2.6	1.0	4.0	3.9	11.3	1.4	18.5	5.5	4.3	4.7	3.7
STDEV	0.6	0.1	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.1	0.3	0.2	0.7	0.3	0.3	0.2	0.3

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.13.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for groundnut expeller and meal, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of groundnut expeller and meal in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	17	17	17	17	18	17	15	17	18	17	18	14	14	15	15	14	14	15	14
Average SIDC	77.7	96.3	88.5	91.9	92.2	85.7	93	94.1	88.2	87	90.8	90.4	92.6	87.2	93.3	85	91.7	91.3	92.7
STDEV *	6.14	1.75	5.25	3.48	4.45	8.44	4.24	3.28	7.66	5.24	4.82	3.1	5.18	7.86	3.59	7.60	6.22	6.01	2.49
Min	69.6	93.4	80.3	86.7	79.4	66.5	83.4	85.5	71	78.5	79.6	85.8	81.9	72.1	86.7	67.9	83	79.4	88.4
Max	86.9	98.7	96.6	97.9	97.8	94.7	99.2	98.7	97	94.3	97.4	94.4	97.7	97.2	97.2	93.6	104.8	97.6	96.8
	After conversion to an integral number																		
SIDC	78	96	89	92	92	86	93	94	88	87	91	90	93	87	93	85	90**	91	93
	SIDC values in the CVB Feed Table 2021 ***																		
SIDC	85	94	83	88	87	81	85	92	83	86	87	84	87	78	89	76	92	86	91

*: STDEV >7% are marked red. **: SIDC-PRO is the average SIDC of the other 17 AA.
***: These values are identical for the dehulled and dehulled qualities of groundnut expeller and groundnut meal in the current CVB Table.

3.14 Horse beans, colored flowering

This SIDC evaluation of horse beans, colored flowering is based on an initial dataset with 18 observations, in which the average crude protein content was 299 ± 14.0 g/kg DM, with a minimum and maximum value of 271 and 320 g/kg DM, respectively.

Table 3.14.1. Amino acid pattern of all observations for horse beans, colored flowering, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	17	14	17	18	18	15	14	15	5	17	18	18	14	18	17	15	18	14
Average *	8.4	2.6	3.8	7.0	6.0	0.7	4.1	3.4	0.8	4.4	4.0	**10.3**	1.3	16.8	**3.9**	4.5	4.7	**3.0**
STDEV	0.51	0.20	0.33	0.58	0.28	0.09	0.34	0.24	0.06	0.38	0.36	0.75	0.09	2.22	0.20	0.72	0.34	0.55
Min	7.2	2.3	3.4	5.9	5.5	0.5	3.5	2.9	0.7	3.8	3.3	9.0	1.2	12.9	3.6	3.8	4.0	2.1
Max	9.3	3.0	4.4	7.9	6.4	0.9	4.8	3.6	0.9	5.1	4.6	11.2	1.5	19.7	4.2	5.9	5.1	3.6
CVB Feed Table 2021																		
Average	9.1	2.6	4.1	7.3	6.3	0.8	4.1	3.5	0.9	4.5	4.1	10.9	1.3	16.4	4.2	4.3	4.8	3.3
STDEV	0.7	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.5	0.2	0.5	0.1	0.7	0.2	0.3	0.2	0.2

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.14.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for horse beans, colored flowering, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of horse beans, colored flowering in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	11	17	14	17	17	17	13	14	14	4	16	13	13	10	12	13	10	12	6
Average SIDC	77.5	88.5	78.0	78.8	79.9	82.7	69.7	76.6	75.8	56.5	78.0	75.5	82.1	59.0	85.9	72.1	74.7	82.0	76.3
STDEV *	5.83	2.67	5.89	5.15	4.91	3.72	7.27	6.51	6.31	6.35	4.30	5.99	4.02	12.99	2.55	8.37	6.55	3.88	7.22
Min	69.5	84.0	69.0	69.2	71.6	78.0	58.0	67.2	64.0	53.0	71.0	64.1	76.4	48.0	83.0	59.0	65.0	77.0	65.1
Max	87.7	91.9	86.1	89.2	91.0	90.9	81.8	90.8	86.9	66.0	86.8	86.2	90.7	83.1	91.1	88.6	83.9	88.9	86.8
	After conversion to an integral number																		
SIDC	78	89	78	79	80	83	70	77	76	57	78	76	82	59	86	72	76 **	82	76
	SIDC values in the CVB Feed Table 2021																		
SIDC	77	89	80	80	78	82	66	75	77	68	76	75	81	59	83	74	80	79	77

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.15 Horse beans, white flowering

This SIDC evaluation of horse beans, white flowering is based on an initial dataset with 7 observations, in which the average crude protein content was 320 ± 23.8 g/kg DM, with a minimum and maximum value of 270 and 337 g/kg DM, respectively.

Table 3.15.1. Amino acid pattern of all observations for horse beans, white flowering, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	6.0	4.0	6.0	5.0	6.0	6.0	4.0	5.0	2.0	6.0	5.0	5.0	5.0	5.0	6.0	5.0	6.0	3.0
Average *	8.7	2.5	4.0	7.1	**5.9**	0.7	4.1	**3.2**	0.8	4.4	**3.8**	**10.3**	1.2	16.0	4.0	**3.9**	**4.3**	**2.7**
STDEV	1.1	0.2	0.2	0.2	0.3	0.1	0.1	0.1	0.0	0.2	0.1	0.5	0.0	0.6	0.2	0.2	0.5	0.0
Min	7.4	2.3	3.8	6.7	5.5	0.6	4.0	3.1	0.8	4.3	3.7	9.6	1.2	15.2	3.8	3.6	3.6	2.7
Max	9.7	2.6	4.2	7.2	6.4	0.8	4.2	3.3	0.9	4.7	3.9	10.9	1.3	16.9	4.1	4.1	4.9	2.8
CVB Feed Table 2021																		
Average	9.1	2.6	4.1	7.3	6.3	0.8	4.1	3.5	0.9	4.5	4.1	10.9	1.3	16.4	4.2	4.3	4.8	3.3
STDEV	0.7	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.5	0.2	0.5	0.1	0.7	0.2	0.3	0.2	0.2

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.15.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for horse beans, white flowering, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of horse beans, white flowering in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	4	4	4	5	5	4	4	4	3	5	4	4	5	4	4	4	4	2
Average SIDC	82.0	91.1	87.2	85	86.6	87.8	78.5	85.6	81.5	76.8	84.2	81.6	86.3	71.8	88.5	77.5	90.3	85.9	85.7
STDEV *	2.0	1.21	3.16	1.08	3.61	3.28	2.73	1.33	1.76	11.74	3.98	1.38	0.41	7.12	1.16	5.44	13.91	1.49	1.02
Min	80	90	84	83.7	84	84	77	84	80	69	81.6	80	86	64	87	73	82	84.7	85
Max	84.6	92.8	90.6	86.3	92.5	93	82.5	87	83.5	90.3	91.1	82.9	86.9	80.4	89.7	83.9	111.1	88	86.4
	After conversion to an integral number																		
SIDC	82	91	87	85	87	88	79	86	82	77	84	82	86	72	89	78	84**	86	86
	SIDC values in the CVB Feed Table 2021																		
SIDC	86	94	88	86	87	89	86	79	83	76	85	82	87	72	92	84	88	89	78

*: STDEV > 7% are marked red. **: SIDC-PRO is the average SIDC of the other 17 AA.

3.16 Lentils

In the literature 4 observations with lentils were found, 2 with lentils, untreated and 2 with lentils heat treated. As the lentils in the current CVB Feed Table are lentils, untreated the proposal for a new SIDC evaluation of lentils is based on the 2 untreated lentils only.
For these two observations the crude protein content was 274 and 265 g/kg DM for observation 1 and 2, respectively.

Table 3.16.1. Amino acid pattern of the two observations for grass meal in g/16g N. In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation 1	7.3	2.3	3.9	7.0	6.4	0.7	4.7	3.4	0.7	4.4	4.5	10.7	1.1	14.5	3.9	4.4	4.4	3.1
Observation 2	7.2	2.4	4.4	7.1	6.9	0.8	4.9	3.5	0.6	4.9	4.1	10.8	1.1	15.3	4.0	3.6	3.9	2.9
CVB Feed Table 2021																		
Average	8.4	2.7	3.7	6.8	7.6	0.9	4.6	3.3	0.9	4.1	4.7	10.7	0.9	15.3	4.2	4.0	4.3	2.8
STDEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3.16.2. Standardized ileal digestibility (SIDC; %) of crude protein and amino acids for two observations of lentils, untreated. The SIDC's of lentils, untreated in the CVB Feed Table 2021 are shown as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation 1		86.7	86.5	80.9	80.0	80.7	87.6	81.8	80.5	72.9	76.7	78.7	72.6	76.4	77.6	71.6		80.5	75.4
Observation 2	80.3	86.2	79.7	77.8	79.0	80.6	75.6	78.7	79.0	86.4	77.3	77.5	81.3	71.7	82.2	79.2		80.6	80.2
Average	80.3	86.4	83.1	79.4	79.5	80.6	81.6	80.2	79.8	79.6	77.0	78.1	76.9	74.1	79.9	75.4		80.6	77.8
STDEV		0.35	4.81	2.19	0.71	0.07	8.49	2.19	1.06	9.55	0.42	0.85	6.15	3.32	3.25	5.37		0.07	3.39
	Proposed SIDC for lentils in future CVB Feed Table after conversion to an integral number																		
SIDC	80	86	83	79	80	81	82	80	80	80	77	78	77	74	80	75	79*	81	78
	SIDC values in the CVB Feed Table 2021																		
SIDC	77	86	79	77	76	79	71	75	73	68	75	73	79	66	82	75	84	78	77

*: SIDC-PRO is the average SIDC of the other 17 AA.

3.17 Linseed expeller

From the literature initially 13 observations from 3 studies for linseed expeller were collected. In one study 10 batches of linseed expeller were tested. The average SIDC of all AA (except PRO) for these 10 observations is 82.6. For the three remaining observations (from 2 studies) the figure is 71.8%. To prevent that the study with 10 observations would dominate the new SIDC proposal too much it was decided to reduce the number of observations from this study to 3, by taking the average values for the observations 1-3, 4-7 and 8-10. By doing this the number of observations was reduced to 6 in total. The average crude protein content of this dataset was 355 ± 27.5 g/kg DM, with a minimum and maximum value of 319 and 394 g/kg DM, respectively.

Table 3.17.1. Amino acid pattern of all observations for linseed expeller: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference. *

Item	**Amino acid pattern (g/16g N)**																	
	ARG	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
N	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	6	6	6
Average **	8.7	2.5	3.7	6.0	3.8	1.7	4.4	3.4	**1.9**	4.5	4.6	9.0	1.6	17.9	5.6	3.9	4.6	2.2
STDEV	0.70	0.20	0.35	0.58	0.40	0.31	0.45	0.91	1.25	0.33	0.44	0.77	0.18	1.49	0.18	0.14	0.57	0.41
Min	7.9	2.2	3.3	5.3	3.4	1.0	3.6	1.5	1.2	4.2	3.9	8.3	1.2	16.4	5.5	3.7	4.3	1.8
Max	9.5	2.7	4.3	7.1	4.5	1.9	4.8	3.8	4.1	5.0	5.3	10.4	1.7	19.6	6.0	4.1	5.7	2.8
CVB Feed Table 2021																		
Average	8.9	2.2	4.0	5.9	3.7	1.9	4.6	3.6	1.6	4.9	4.5	9.1	1.8	18.8	5.7	3.9	4.5	2.5
STDEV	0.7	0.2	0.3	0.3	0.3	0.1	0.2	0.2	0.1	0.4	0.3	0.7	0.2	1.5	0.3	0.3	0.4	0.4

*: There were no outliers for the AA pattern. **: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.17.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for linseed expeller: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of linseed expeller in the CVB Table 2021 is shown as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	6	6	6	6	6	6	6	6	6	5	6	6	6	6	6	6	3	6	6
Average SIDC	75.0	87.8	75.0	79.4	78.9	71.4	79.3	80.5	72.5	79.3	77.4	74.4	78.1	69.8	82.5	72.3	81.8	77.3	77.4
STDEV *	4.82	5.68	9.29	7.01	8.10	9.00	16.34	9.07	6.09	7.79	7.26	8.94	6.71	12.64	6.72	4.22	15.19	3.93	7.19
Min	69.3	79.1	60.9	69.5	67.0	57.4	50.7	68.0	61.2	70.5	68.3	57.9	66.7	50.3	73.2	67.5	65.2	71.2	65.2
Max	80.5	93.2	82.9	85.4	86.2	79.5	92.4	88.4	78.0	87.9	84.0	81.3	84.1	81.1	88.2	78.8	95.0	80.6	83.5
	After conversion to an integral number																		
SIDC	75	88	75	79	79	71	79	81	73	79	77	74	78	70	83	72	77 **	77	77
	SIDC values in the CVB Feed Table 2021																		
SIDC	75	75	75	75	75	82	85	75	80	85	75	75	75	85	75	75	75	75	75

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

For linseed, full fat there was 1 observation with very low SIDC's. For linseed, full fat that is sufficiently grinded/milled the SIDC's of linseed expeller are proposed.

3.18 Linseed meal, solvent extracted

The SIDC evaluation of linseed meal, solvent extracted is based on an initial dataset with 5 observations, in which the average crude protein content was 362 ± 46.9 g/kg DM, with a minimum and maximum value of 317 and 421 g/kg DM, respectively.

Table 3.18.1. Amino acid pattern of all observations for linseed meal, solvent extracted: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference. *

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	5	5	5	5	5	5	5	4	5	4	4	4	4	4	4	4	4
Average **	8.6	2.0	3.9	5.8	3.5	1.7	4.4	3.4	1.6	**3.9**	4.6	8.6	1.7	18.9	5.6	4.2	4.5	2.1
STDEV	1.15	0.21	0.46	0.46	0.24	0.45	0.29	0.08	0.18	1.37	0.04	0.34	0.43	1.06	0.33	1.28	0.50	0.26
Min	7.6	1.9	3.1	5.3	3.2	0.9	4.0	3.3	1.5	1.6	4.5	8.5	1.1	17.4	5.1	2.8	3.9	1.9
Max	10.3	2.3	4.3	6.2	3.9	2.0	4.8	3.5	1.9	5.0	4.6	9.2	2.0	19.5	5.7	5.3	5.1	2.5
CVB Feed Table 2021																		
Average	8.9	2.2	4.0	5.9	3.7	1.9	4.6	3.6	1.6	4.9	4.5	9.1	1.8	18.8	5.7	3.9	4.5	2.5
STDEV	0.7	0.2	0.3	0.3	0.3	0.1	0.2	0.2	0.1	0.4	0.3	0.7	0.2	1.5	0.3	0.3	0.4	0.4

*: There were no outliers for the AA pattern. **: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.18.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for linseed meal, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of linseed meal in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	5	5	5	5	5	5	5	5	4	5	4	4	4	4	4	4	4	4
Average SIDC	72.3	80.7	73.4	72.9	73.5	65.7	75.0	75.0	66.6	79.9	69.6	67.1	70.4	68.5	78.6	77.0	110.5	74.4	72.6
STDEV **	5.37	7.06	7.17	8.43	6.66	9.22	7.03	4.61	4.68	6.82	5.41	7.80	4.75	10.20	3.95	7.82	10.13	3.29	2.84
Min	68.5	70.8	65.7	64.8	66.7	49.5	64.5	68.5	60.2	70.1	65.2	60.5	64.8	55.2	73.0	65.7	97.8	70.2	70.3
Max	76.1	87.3	82.0	84.6	82.0	72.3	83.4	80.4	72.5	85.9	78.3	78.3	76.4	76.7	81.4	83.8	121.5	78.0	76.5
	After conversion to an integral number																		
SIDC	72	81	73	73	74	66	75	75	67	80	70	67	70	69	79	77	73 ***	74	73
	SIDC values in the CVB Feed Table 2021																		
SIDC	75	75	75	75	75	82	85	75	80	85	75	75	75	85	75	75	75	75	75

*: There were no outliers for the SIDC values. **: STDEV > 7% are marked red. ***: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.19 Lucerne (alfalfa) meal

In this project 3 new observations were found in the literature for lucerne meal, all published after 1996.
In the ILOB-TNO report (1996) quite a large number of data is reported for lucerne/alfalfa: up to 9 observations for the level and digestibility for CP and 5 amino acids, 8 for 1 amino acid, 7 for 2 amino acids and 3 for the remaining 10 amino acids and CP. Unfortunately, we could not trace back the publication(s) that were used in that study.
As the new information is restricted to only 3 observations it was decided to create the following data from the ILOB-TNO data: a) the average values for CP and SIDC's for CP and AA; b) the average - 1*STDEV for CP-level and SIDC's of CP and AA and c) the average + 1*STDEV for CP-level and SIDC's of CP and AA. For the AA pattern we used the published pattern in all cases.
This resulted in a total of 6 observations with an average crude protein content was 183 ± 52 g/kg DM, with a minimum and maximum value of 98 and 253 g/kg DM, respectively.

Table 3.19.1. Amino acid pattern of all observations for lucerne meal, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	6	6	6	6	6	6	6	6	4	6	5	5	6	5	5	5	5	5
Average *	**3.2**	2.2	3.9	**5.6**	4.3	1.4	4.2	4.1	1.4	**4.2**	**4.1**	**9.2**	**1.4**	9.7	4.6	4.8	4.1	2.9
STDEV	0.86	0.55	1.04	0.40	0.23	0.27	1.40	0.33	0.38	0.46	0.32	2.73	0.76	0.99	1.99	1.62	0.54	1.00
Min	1.6	1.5	1.8	5.2	3.8	0.8	3.4	3.6	0.8	4.0	4.0	5.1	0.8	8.2	3.6	3.7	3.7	2.2
Max	4.2	3.2	4.5	6.4	4.5	1.6	6.9	4.4	1.6	5.1	4.7	12.8	2.9	10.4	8.2	7.7	4.8	4.5
CVB Feed Table 2021																		
Average	4.1	2.0	4.0	6.9	4.3	1.5	4.6	4.0	1.4	5.1	5.1	11.1	1.0	9.6	4.7	4.8	4.2	3.1
STDEV	0.3	0.2	0.4	0.4	0.4	0.1	0.4	0.3	0.2	0.4	0.3	0.7	0.1	0.8	0.3	0.6	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.19.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for lucerne meal, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of lucerne meal in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	6	6	6	6	6	6	6	6	4	6	4	4	6	5	5	4	5	5
Average	49.8	76.2	65.3	64.2	69.1	53.8	63.3	71.1	54.4	56.6	67.0	67.1	74.3	34.1	44.2	56.3	62.0	55.1	74.7
STDEV *	13.21	14.19	15.02	13.31	13.48	23.23	17.15	14.53	10.85	7.75	15.70	16.30	12.78	19.06	25.67	21.88	16.53	31.23	15.37
Min	34.4	59.0	49.4	51.8	53.0	24.3	39.0	48.0	41.0	46.9	52.0	53.4	64.2	7.1	13.3	32.1	40.6	12.5	51.7
Max	66.6	99.0	85.2	81.7	90.3	80.8	84.8	88.8	68.1	64.3	89.6	88.6	91.0	61.0	76.7	88.6	80.4	94.9	93.3
	After conversion to an integral number																		
SIDC	50	76	65	64	69	54	63	71	54	57	67	67	74	34	44	56	62 **	55	75
	SIDC values in the CVB Feed Table 2021																		
SIDC	45	73	54	62	62	46	72	65	55	54	58	59	68	9	57	51	73	58	58

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

The SIDC evaluation of CP and AA will be used for all four qualities of lucerne meal that are published in the CVB Feed Table

3.20 Lupins

This SIDC evaluation is based on an initial dataset with 29 observations, in which the average crude protein content was 335.1 ± 95.9 g/kg DM, with a minimum and maximum value of 156 and 476 g/kg DM, respectively.

Table 3.20.1. Amino acid pattern of all observations for lupins, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	25.0	28.0	27.0	28.0	27.0	27.0	26.0	27.0	14.0	28.0	17.0	17.0	22.0	18.0	18.0	17.0	17.0	16.0
Average *	10.1	2.7	4.1	7.1	4.8	0.7	4.1	3.4	0.8	4.0	3.4	**9.2**	1.6	22.3	4.3	**4.7**	4.7	**3.3**
STDEV	1.4	0.3	0.4	0.7	0.3	0.2	0.4	0.2	0.1	0.5	0.3	1.2	0.5	2.5	0.4	1.1	0.4	0.8
Min	7.6	2.2	3.4	4.6	4.3	0.5	3.5	2.9	0.7	3.2	3.0	6.9	0.8	16.3	3.6	3.5	4.1	2.2
Max	12.9	3.5	4.9	8.0	5.8	1.1	4.8	3.9	1.0	4.8	3.9	11.4	2.3	24.8	5.0	6.5	5.6	4.7
CVB Feed Table 2021																		
Average	10.7	2.5	4.1	7.0	4.8	0.7	3.9	3.5	0.8	3.9	3.4	10.1	1.5	20.9	4.1	4.1	4.9	4.0
STDEV	0.7	0.3	0.3	0.3	0.2	0.1	0.2	0.2	0.1	0.3	0.1	0.4	0.2	1.4	0.2	0.2	0.3	0.5

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.20.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for lupins, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of lupin in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	21	20	24	24	24	24	20	24	24	14	24	14	14	21	14	14	13	14	12
Average SIDC	87.6	93.9	87.8	86.1	85.6	86.0	82.3	83.8	82.6	82.4	82.0	82.0	86.9	87.7	89.6	86.6	104.7	86.7	84.9
STDEV **	3.1	1.8	3.8	4.6	4.0	3.5	7.0	5.6	4.4	6.0	4.8	6.1	3.4	7.1	6.0	7.5	21.1	6.3	5.0
Min	80.8	90.0	77.1	75.5	73.7	78.7	71.0	71.4	76.0	74.9	71.3	68.3	80.9	76.8	74.8	72.7	83.9	72.5	76.1
Max	93.9	97.2	94.0	92.0	91.0	92.3	98.2	92.2	91.4	92.9	89.8	90.7	92.7	101.0	96.1	102.6	143.3	97.6	92.3
	After conversion to an integral number																		
SIDC	88	94	88	86	86	86	82	84	83	82	82	82	87	88	90	87	86***	87	88
	SIDC values in the CVB Feed Table 2021																		
SIDC	87	95	89	86	86	88	82	87	86	87	86	81	87	87	92	88	94	89	89

*: The new SIDC evaluation of CP and AA will be used also for both qualities of lupins that are published in the CVB Feed Table.
: STDEV > 7% are marked red. *: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.21 Maize (corn) and maize, heat treated

This SIDC evaluation is based on an initial dataset with 77 observations for maize (not heat treated), in which the average crude protein content was 94.3 ± 11.6 g/kg DM, with a minimum and maximum value of 66 and 129 g/kg DM, respectively.

Table 3.21.1. Amino acid pattern of the dataset of maize, after removal of the outliers: number of observations, average value (g/16g N) and STDEV, minimum and maximum values. The amino acid pattern in the CVB Feed Table 2021 is mentioned as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	75	74	76	77	77	75	73	74	49	77	68	68	63	69	69	55	64	68
Average *	4.6	2.8	3.4	12.2	3.1	2.1	4.8	3.5	0.7	4.7	**7.0**	6.7	2.4	17.7	3.8	8.6	4.5	3.4
STDEV	0.5	0.2	0.3	0.9	0.4	0.2	0.3	0.2	0.1	0.5	0.8	0.5	0.3	1.7	0.4	0.8	0.4	0.4
CVB Feed Table 2021																		
Average	4.7	3.0	3.4	12.1	2.9	2.1	4.8	3.6	0.7	4.8	7.5	6.7	2.2	18.1	3.9	8.9	4.8	3.7
STDEV	0.4	0.2	0.2	0.7	0.3	0.2	0.3	0.2	0.1	0.3	0.4	0.4	0.2	1.0	0.3	0.7	0.2	0.4

*: When there are averages deviating more than 2*STDEV from the average value in the current CVB Feed Table they are marked red.

Table 3.21.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids in maize, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of maize in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	63	76	73	76	77	75	72	74	76	55	76	66	68	65	64	60	55	67	57
Average SIDC	84.3	90.4	85.1	82.7	88.1	75.7	88.3	86.2	78.4	79.4	82.4	84.6	81.3	83.4	86.5	80.9	96.1	84.0	84.2
STDEV	8.0	6.1	4.4	5.4	3.7	8.8	4.1	4.0	7.5	9.0	6.3	4.7	6.0	5.2	4.5	12.8	26.7	6.4	5.0
Min	71.2	76.7	78.7	73.4	80.5	59.6	78.5	76.7	66.4	60.9	69.2	73.4	70.7	72.4	75.0	53.5	47.2	71.3	73.9
Max	101.9	103.9	94.9	95.2	94.7	97.9	96.4	96.1	95.1	101.2	95.6	96.3	94.9	94.3	96.9	111.2	161.1	96.5	96.0
	After conversion to an integral number																		
SIDC	84	90	85	83	88	76	88	86	78	79	82	85	81	83	86	81	84 *	84	84
	SIDC values in the CVB Feed Table 2021																		
SIDC	82	88	86	86	89	75	87	87	79	76	86	87	82	81	89	79	85	88	86

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

The new SIDC evaluation of CP and AA for maize will be used also for maize, heat-treated as only limited information was available on heat treated maize.

3.22 Maize germs and maize germs meal.

This SIDC evaluation maize germs and maize germs meal is based on an initial dataset with 16 observations. The average crude protein content of the 2 observations for maize germs was 167 ± 21.1 g/kg DM, with a minimum and maximum value of 152 and 182 g/kg DM, respectively. The average crude protein content of the 14 observations for maize germs meal was 215 ± 23.8 g/kg DM, with a minimum and maximum value of 184 and 277 g/kg DM, respectively.

Table 3.22.1. Amino acid pattern of all observations for maize germs and maize germs meal, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	16	15	15	16	16	15	16	15	15	16	15	15	14	13	13	15	14	14
Average *	6.3	**3.5**	3.7	**9.0**	**4.6**	1.9	4.9	4.2	0.9	**6.0**	7.2	7.2	2.0	13.9	**5.6**	6.4	4.6	**2.4**
STDEV	0.78	0.33	0.23	0.84	0.55	0.15	0.47	0.29	0.11	0.50	1.04	0.44	0.30	1.07	0.16	1.22	0.37	0.43
Min	4.7	2.9	3.2	7.5	3.8	1.6	4.1	3.6	0.7	5.0	5.3	6.4	1.3	11.5	5.4	4.4	3.9	1.6
Max	7.7	4.0	4.2	10.2	5.6	2.1	5.5	4.6	1.1	6.8	8.6	8.0	2.4	15.2	5.8	8.2	5.2	3.2
CVB Feed Table 2021																		
Average	5.0	2.9	3.5	11.1	3.2	2.1	4.7	3.7	0.7	5.1	7.3	7.0	2.2	17.6	4.2	8.4	4.8	3.6
STDEV	0.9	0.2	0.3	2.0	0.6	0.3	0.6	0.3	0.2	0.4	0.8	0.6	0.2	2.5	0.6	1.2	0.4	0.4

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.22.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for maize germs and maize germs meal, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of maize germs and maize germs meal in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	12	14	14	14	14	14	14	14	14	14	14	13	13	13	13	13	12	13	13
Average SIDC	62.4	85.8	76.1	70.0	77.2	63.4	74.7	75.6	63.5	63.7	72.5	70.4	62.1	68.1	72.0	66.3	94.7	69.5	65.8
STDEV **	5.59	3.76	4.95	6.29	6.05	5.13	3.74	5.23	8.29	11.37	5.83	5.67	6.45	5.67	4.28	9.20	19.26	4.51	7.51
Min	56.0	81.0	65.1	57.0	66.1	58.0	67.7	64.0	51.7	49.4	62.0	61.6	54.9	57.5	66.2	52.4	48.3	64.4	58.8
Max	72.2	93.2	85.8	79.6	86.8	75.9	80.8	82.4	78.1	81.4	79.7	80.4	76.0	77.5	79.6	84.3	117.5	78.7	79.4
	After conversion to an integral number																		
SIDC	62	86	76	70	77	63	75	76	64	64	73	70	62	68	72	66	70***	70	66
	SIDC values in the CVB Feed Table 2021																		
SIDC	65	80	74	71	74	59	79	78	66	62	69	65	65	63	65	65	65	65	79

*: This new SIDC evaluation of CP/AA will be used also for maize germs expellers **: STDEV > 7% are marked red. ***: SIDC of PRO = average SIDC of the remaining 17 AA.

3.23 Maize gluten feed

The SIDC evaluation of maize gluten feed is based on an initial dataset with 11 observations, in which the average crude protein content was 234 ± 23.7 g/kg DM, with a minimum and maximum value of 199 and 277 g/kg DM, respectively.

Table 3.23.1. Amino acid pattern of all observations for maize gluten feed, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	9	10	10	10	10	10	10	9	10	10	10	10	9	9	10	3	9	10
Average *	4.8	2.8	3.1	8.4	3.3	1.6	3.6	3.4	0.6	4.5	6.5	5.7	1.9	**13.9**	4.2	7.8	4.1	2.5
STDEV	0.50	0.21	0.21	1.05	0.58	0.22	0.35	0.18	0.23	0.31	0.74	0.67	0.32	1.01	0.32	0.78	0.17	0.39
Min	4.1	2.6	2.8	6.8	2.4	1.2	3.2	3.1	0.2	4.1	5.1	4.8	1.5	11.7	3.7	7.0	3.9	2.2
Max	5.6	3.2	3.4	10.4	4.4	1.9	4.3	3.7	1.0	4.9	7.5	6.5	2.6	15.0	4.7	8.6	4.4	3.4
CVB Feed Table 2021																		
Average	4.4	3.0	3.1	9.0	3.0	1.7	3.8	3.6	0.6	4.7	6.7	6.1	2.1	15.4	4.5	8.3	4.3	3.0
STDEV	0.4	0.5	0.3	0.4	0.5	0.2	0.3	0.2	0.1	0.4	0.3	0.5	0.1	0.7	0.7	0.5	0.3	0.3

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.23.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for maize gluten feed, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of maize gluten feed in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	10	10	10	10	10	9	10	10	10	9	9	10	10	10	9	10	2	10	9
Average SIDC	69.3	86.3	75.2	76.5	82.9	63.5	83.7	82.6	70.4	67.3	72.8	79.6	69.6	66.6	77.9	65.3	88.0	76.8	82.6
STDEV **	5.48	2.80	5.03	2.49	3.07	3.34	3.71	2.32	2.90	8.76	2.14	3.53	3.06	4.35	1.79	6.29	0.91	2.43	1.93
Min	61.8	82.5	69.6	73.2	78.6	57.7	78.3	79.6	66.7	59.2	69.5	75.0	65.7	60.4	75.8	57.4	87.3	73.9	79.6
Max	77.4	90.6	84.3	80.1	87.8	68.8	89.0	85.9	75.2	87.5	75.7	85.8	74.6	71.6	80.8	76.2	88.6	80.5	85.9
	After conversion to an integral number																		
SIDC	69	86	75	77	83	64	84	83	70	67	73	80	70	67	78	65	88 ***	77	83
	SIDC values in the CVB Feed Table 2021																		
SIDC	70	85	76	80	85	65	81	84	72	66	77	84	72	59	82	62	78	76	84

*: This evaluation will be used for all 3 qualities of maize gluten feed in the CVB Feed Table. **: STDEV > 7% are marked red. ***: SIDC of PRO is the average SIDC of the remaining 17 AA is used.

3.24 Maize gluten meal

The SIDC evaluation of maize gluten meal is based on an initial dataset with 25 observations, in which the average crude protein content was 631 ± 71.9 g/kg DM, with a minimum and maximum value of 498 and 728 g/kg DM, respectively.

Table 3.24.1. Amino acid pattern of all observations for maize gluten meal, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	24	22	23	24	23	22	24	24	23	23	22	22	21	21	22	20	21	21
Average *	2.9	1.9	3.7	15.9	1.6	2.4	5.9	3.2	0.4	4.2	**8.0**	**5.5**	1.9	**19.1**	2.3	8.7	**4.5**	4.5
STDEV	0.38	0.24	0.30	0.98	0.20	0.19	0.38	0.24	0.05	0.31	0.53	0.45	0.14	1.82	0.34	0.46	0.21	0.43
Min	2.5	1.6	3.4	14.7	1.4	2.1	5.5	2.9	0.3	3.7	7.5	5.0	1.7	17.5	1.8	7.9	4.0	4.1
Max	3.7	2.7	4.4	18.3	2.1	2.9	6.7	3.7	0.5	4.9	9.3	6.4	2.3	23.9	3.0	9.8	5.1	5.4
CVB Feed Table 2021																		
Average	3.0	2.1	4.1	16.6	1.7	2.4	6.3	3.4	0.5	4.7	8.9	6.3	1.8	21.6	2.7	9.4	5.3	5.2
STDEV	0.2	0.2	0.2	0.7	0.2	0.2	0.2	0.1	0.1	0.3	0.4	0.2	0.1	1.1	0.2	0.5	0.2	0.4

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.24.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for maize gluten meal, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of maize gluten meal in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	19	23	23	23	23	21	23	23	23	22	23	22	21	21	22	21	21	21	20
Average SIDC	87.9	90.3	89.5	90.7	93.8	84.3	94	92.7	86	73.5	89.5	91.0	87.7	86.5	92.1	76.9	80.2	91.2	93.6
STDEV *	2.47	2.32	3.53	2.52	2.69	2.78	2.89	2.95	2.85	9.11	2.55	2.99	2.26	2.80	2.83	7.23	8.39	1.95	2.55
Min	83.9	86.6	82.8	86.4	89.2	78.7	88.9	88.5	79.6	62.4	84.9	85.4	83.2	81	87.6	65.8	65.7	87.7	89.4
Max	93.6	94.3	94.6	95.3	97.8	89.3	98.7	96.9	92.9	91.8	94.7	95.8	91.7	92	96.5	87.8	97.2	95.2	98.1
	After conversion to an integral number																		
SIDC	88	90	90	91	94	84	94	93	86	74	90	91	88	87	92	77	88 **	91	94
	SIDC values in the CVB Feed Table 2021																		
SIDC	90	93	86	89	91	87	97	91	90	86	88	89	94	88	88	75	89	98	93

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the remaining 17 AA is used.

3.25 Malt culms

In the literature 1 observation was found for malt culms with a crude protein content of 305 g/kg DM.

Table 3.25.1. Amino acid pattern of the single observation for malt culms in g/16g N. In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation	**4.9**	1.8	3.0	5.0	4.6	1.3	2.8	3.3		4.3	4.2	10.6	1.1	**9.6**	3.7	4.4	3.0	1.9
CVB Feed Table 2021																		
Average	4.4	1.7	3.0	5.6	4.2	1.5	3.3	3.2	1.0	4.4	4.7	9.9	1.2	11.3	4.0	5.7	3.3	2.2
STDEV	0.2	0.1	0.2	0.4	0.2	0.2	0.5	0.2	-	0.4	0.3	0.9	0.2	0.8	0.2	1.1	0.3	0.2

*: When the AA level deviates more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.25.2. Standardized ileal digestibility (SIDC; %) of crude protein and amino acids for the single observation of malt culms. The SIDC's of malt culms in the CVB Feed Table 2021 are shown as a reference. In the last line the proposal for the SIDC's in the future CVB Feed Table is given.

SIDC (%) of the single observation available for malt culms																		
CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
30	71	58	63	58	61	73	54	49		59	53	74	30	65	37	66	46	18
Proposal of SIDC values for the future CVB Feed Table																		
66	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**	**66**
SIDC values in the CVB Feed Table 2021																		
77	81	80	79	79	73	79	81	77	74	78	70	73	77	86	75	89	82	80

The new SIDC evaluation is substantial lower than the current valuation in the CVB Feed Table 2021.
Further. it was observed that the SIDC values found in the single observation for malt culms in the CVB database (Brestensky et al. (2013) are also the basis for the SIDC-AA values for pigs included in the French Feed Tables (https://www.feedtables.com/content/barley-rootlets-dried). The values are exactly the same.
However, the ileal digestibility of CP and AA reported by Bretensky et al (2013) is considered too low for a feedstuff like malt culms.
Therefore, it is proposed to use the average of the average SIDC of the observation of Bretensky et al (2013) (53.6%) and the current SIDC evaluation (78.4%) (being (53.6 + 78.4)/2 = 66% for CP and all AA.

3.26 Milk powder, skimmed

The SIDC evaluation of milk powder, skimmed is based on an initial dataset with 5 observations (4 milk powder, skimmed and 1 milk protein concentrate), in which the average crude protein content of the skimmed milk powder was 382 ± 25.8 g/kg DM, with a minimum and maximum value of 356 and 417 g/kg DM, respectively. The protein content of the observation for milk protein concentrate was 732 g/kg DM.

Table 3.26.1. Amino acid pattern of all observations for milk powder, skimmed, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	**Amino acid pattern (g/16g N)**																	
	ARG	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
N	5	5	5	5	5	5	5	5	2	5	5	5	4	5	5	5	5	5
Average *	3.7	3.0	5.1	9.5	8.0	2.5	4.7	4.3	1.5	6.3	3.2	7.6	0.7	21.3	1.9	9.4	5.3	4.7
STDEV	0.36	0.18	0.53	0.99	0.37	0.16	0.47	0.16	0.05	0.49	0.20	0.22	0.04	1.00	0.12	0.56	0.22	0.48
Min	3.4	2.8	4.3	7.8	7.5	2.3	3.9	4.0	1.5	5.5	3.0	7.2	0.7	19.6	1.7	8.4	5.1	4.0
Max	4.3	3.2	5.7	10.2	8.4	2.7	5.0	4.4	1.6	6.8	3.5	7.8	0.8	22.2	2.0	9.8	5.7	5.2
CVB Feed Table 2021																		
Average	3.5	2.8	5.2	9.7	7.8	2.7	4.8	4.4	1.3	6.3	3.3	8.0	0.8	20.8	2.0	9.8	5.6	4.5
STDEV	0.2	0.1	0.3	0.3	0.4	0.2	0.2	0.1	0.1	0.2	0.1	0.3	0.1	0.7	0.1	0.6	0.2	0.6

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.26.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for milk powder, skimmed, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of milk powder, skimmed in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	4	4	4	4	5	4	4	4	2	4	3	4	4	4	4	2	4	4
Average SIDC	92.8	98.2	94.8	89.5	96.2	95.9	96.7	95.2	92.7	94.0	91.1	92.0	92.7	84.8	90.4	105.8	111.9	82.7	93.9
STDEV *	1.49	3.24	4.37	2.34	1.70	0.92	0.60	2.54	0.89	4.24	1.96	3.62	3.70	8.84	2.67	8.63	0.13	3.63	5.60
Min	91.8	94.1	89.1	88.0	94.0	95.0	96.0	92.2	91.4	91.0	89.8	89.0	88.0	73.0	87.5	96.0	111.8	80.0	85.7
Max	93.9	102.0	99.0	93.0	98.0	97.0	97.4	97.6	93.5	97.0	94.0	96.0	97.0	94.4	94.0	117.0	112.0	88.0	98.0
	After conversion to an integral number																		
SIDC	93	98	95	90	96	96	97	95	93	94	91	92	93	85	90	93	93 ***	83	94
	SIDC values in the CVB Feed Table 2021																		
SIDC	91	97	96	89	96	97	97	97	93	91	90	89	93	91	88	95	99	81	97

*: This evaluation will be used also for milk powder, whole. **: STDEV > 7% are marked red. ***: For the SIDC of GLY and PRO the average SIDC of the remaining 16 AA is used.

The SIDC evaluation of milk powder, skimmed will be used also for milk powder, whole.

3.27 Millet and Pearl millet

The SIDC evaluation of millet and pearl millet is based on an initial dataset with 3 observations (1 millet and 2 pearl millet), in which the average crude protein content was 158 ± 29.7 g/kg DM, with a minimum and maximum value of 128 and 187 g/kg DM, respectively.

Table 3.27.1. Amino acid pattern of all observations for millet and pearl millet: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference. *

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	3	3	3	3	3	2	3	3	1	3	2	2	2	2	2	0	2	3
Average	4.3	2.1	4.7	9.7	3.0	2.0	4.2	3.5	0.5	5.1	7.1	7.0	2.0	17.8	2.5		4.1	2.5
STDEV	1.02	0.48	1.33	1.00	0.51	0.24	1.08	0.53	0.00	0.77	0.90	0.62	0.08	1.07	0.03		0.43	1.11
Min	3.3	1.6	3.5	8.8	2.5	1.9	3.2	3.2	0.5	4.7	6.4	6.5	1.9	17.0	2.5		3.8	1.3
Max	5.3	2.5	6.1	10.7	3.5	2.2	5.3	4.2	0.5	6.0	7.7	7.4	2.0	18.5	2.6		4.5	3.5
CVB Feed Table 2021																		
Average	3.7	2.1	3.7	11.5	1.8	2.7	5.3	3.0	1.2	5.0	10.1	6.4	1.8	21.1	2.5	6.6	5.9	3.7
STDEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*: No outliers were identified in this small dataset.

Table 3.27.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for millet and pearl millet, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of millet and pearl millet in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	3	3	3	3	3	3	2	3	3	1	3	2	2	2	2	2	0	2	2
Average SIDC	85.4	88.7	91.1	87.9	91.5	80.3	81.5	89.5	83.9	95.7	87.5	91.0	88.9	87.2	92.2	90.1		91.2	86.1
STDEV *	5.14	5.33	1.85	3.65	0.81	3.45	9.58	3.62	3.50		3.51	0.97	4.61	0.44	0.21	2.83		2.93	1.27
Min	79.6	83.1	89.2	83.9	90.6	76.7	74.7	85.4	80.0		84.6	90.3	85.6	86.9	92.0	88.1		89.1	85.2
Max	89.5	93.7	92.9	91.0	92.0	83.6	88.3	92.1	86.7		91.4	91.7	92.2	87.5	92.3	92.1		93.3	87.0
	After conversion to an integral number																		
SIDC	85	89	91	88	92	80	82	90	84	88 **	88	91	89	87	92	90	88 **	91	86
	SIDC values in the CVB Feed Table 2021																		
SIDC	85	87	90	89	90	85	82	91	85	98	87	90	85	75	93	83	95	90	85

*: When STDEV's are > 7%, they are marked red. **: For the SIDC of TRP and PRO the average SIDC of the other 16 AA is used.

3.28 Oats and oats, peeled

3.28.1 Oats

For oats only one observation was found in the literature. This observation mentioned only ileal digestibility's of CP and 4 amino acids (LYS, MET, THR and CYS). This observation is of no value for an update of the current SIDC evaluation. Therefore, it is proposed to maintain the current evaluation, except for SIDC-PRO for which AA the average SIDC of the remaining AA is used. This implied that the SIDC of PRO decreased from 85% to 81% (see Table 3.28.1).

Table 3.28.1. Oats: Current SIDC evaluation as published in the CVB Feed Table (2021), except for the SIDC of PRO that now has a SIDC value equal to the average SIDC of the 17 other AA.

CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
SIDC (%)																		
76	90	88	82	84	80	84	86	75	77	82	76	76	75	84	77	**81**	80	85

3.28.2 Oats, dehulled / Oats, peeled / Oat groats

The SIDC evaluation of of oat groats is based on an initial dataset with 3 observations, in which the average crude protein content was 143 ± 39.2 g/kg DM, with a minimum and maximum value of 101 and 179 g/kg DM, respectively.

Table 3.28.2. Amino acid pattern of all observations for oat groats: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference. *

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3	2	3	3
Average **	6.8	2.2	3.9	7.5	4.2	1.7	5.1	3.5	**0.8**	5.4	4.9	8.5	3.0	22.1	5.0	5.2	4.9	3.0
STDEV	0.3	0.3	0.0	0.3	0.2	0.2	0.4	0.2	0.1	0.1	0.2	0.8	0.1	1.7	0.2	0.8	0.7	0.8
Min	6.6	1.9	3.9	7.2	3.9	1.5	4.8	3.3	0.8	5.4	4.7	7.7	2.9	20.2	4.8	4.6	4.3	2.3
Max	7.2	2.4	4.0	7.7	4.4	1.8	5.5	3.7	0.9	5.5	5.2	9.4	3.1	23.0	5.1	5.8	5.6	3.9
CVB Feed Table 2021																		
Average	6.5	2.2	3.7	7.3	4.1	1.7	4.8	3.5	1.2	5.2	4.8	8.2	3.0	19.2	4.9	5.3	4.8	3.3
STDEV	0.5	0.2	0.2	0.3	0.3	0.1	0.4	0.2	0.1	0.3	0.3	0.5	0.3	1.5	0.4	0.5	0.3	0.3

*: No outliers removed.

**: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.28.3. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for oats groats, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of oat groats in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3	2	3	3
Average SIDC	88.4	93.5	91.9	89.5	89.8	91.5	90.7	91.8	87.1	85.1	89.3	87.1	87.1	80.8	93.4	85.0	98.2	87.1	83.6
STDEV *	5.3	3.2	3.7	2.6	3.0	8.9	1.6	2.9	5.7	4.6	4.1	5.5	3.3	4.8	1.8	3.0	29.8	2.8	11.8
Min	84.6	90.1	88.1	86.5	87.2	84.5	89.7	88.4	81.3	81.9	84.7	81.1	85.1	77.4	91.3	81.7	77.1	84.5	70.7
Max	92.1	96.3	95.5	91.2	93.2	101.5	92.5	93.5	92.6	88.3	92.6	92.0	90.9	84.2	94.9	87.4	119.3	90.1	94.0
	After conversion to an integral number																		
SIDC	88	93	92	89	90	92	91	92	87	85	89	87	87	81	93	85	89 **	87	84
	SIDC values in the CVB Feed Table 2021																		
SIDC	81	96	94	88	90	86	90	92	81	83	88	82	82	81	90	83	91	86	91

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.29 Palm kernel expeller and meal

The SIDC evaluation of palm kernel expeller and meal is based on an initial dataset with 9 observations (5 observations for palm kernel expeller and 4 for palm kernel meal), in which the average crude protein content was 168 ± 13.1 g/kg DM, with a minimum and maximum value of 155 and 187 g/kg DM, respectively.

Table 3.29.1. Amino acid pattern of all observations for palm kernel expeller and meal, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	9	9	9	9	9	9	8	9	8	9	9	9	9	9	9	9	8	7
Average *	10.2	1.6	3.4	5.9	2.6	**1.5**	3.7	2.9	0.7	4.9	3.9	**7.5**	1.2	17.2	4.2	**2.7**	3.9	2.2
STDEV	1.36	0.29	0.37	0.61	0.39	0.28	0.27	0.46	0.19	0.72	0.41	1.01	0.24	1.86	0.46	0.28	0.61	0.24
Min	7.8	1.2	3.0	5.0	1.9	1.0	3.3	2.4	0.4	4.1	3.4	6.2	0.7	14.9	3.4	2.3	3.2	1.8
Max	12.3	2.0	4.1	6.9	3.1	1.8	4.1	3.5	1.0	6.1	4.5	9.2	1.6	19.8	4.9	3.1	4.9	2.5
CVB Feed Table 2021																		
Average	12.0	1.7	3.3	6.3	3.0	1.9	4.1	3.1	0.8	4.8	4.0	8.3	1.5	17.9	4.6	3.4	4.2	2.6
STDEV	1.1	0.1	0.1	0.2	0.4	0.1	0.2	0.1	0.1	0.2	0.1	0.3	0.2	0.7	0.2	0.3	0.2	0.2

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.29.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for palm kernel expeller and meal, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of palm kernel expeller and meal in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	6	8	8	8	8	8	8	8	8	5	8	8	8	8	8	8	8	8	7
Average	68.8	83.8	72.6	72.9	75.3	59.7	77.1	77.7	67.5	76.5	73.8	68.2	61.5	60.8	73.2	56.0	5.1	73.2	70.4
STDEV **	12.32	7.18	10.97	10.52	7.33	16.24	7.61	6.79	10.61	17.02	8.89	9.36	15.56	15.89	10.42	23.70	164.89	10.09	13.69
Min	52.8	69.1	56.4	57.6	61.4	39.1	67.4	64.4	48.9	54.9	57.9	52.7	43.2	39.7	55.1	17.6	-265.0	54.6	53.6
Max	85.0	92.5	85.4	85.2	84.3	78.8	87.0	86.0	78.2	90.0	82.8	81.8	78.4	77.5	84.3	83.8	137.0	82.7	83.7
	After conversion to an integral number																		
SIDC	69	84	73	73	75	60	77	78	68	77	74	68	62	61	73	56	71 ***	73	70
	SIDC values in the CVB Feed Table 2021																		
SIDC	65	65	65	65	65	65	73	65	70	58	65	65	65	66	65	65	64	65	65

*: This evaluation is used for 2 qualities palm kernel expeller, the 2 qualities palm kernel meal and palm kernels as published in the CVB Table 2021 **: STDEV > 7% are marked red.
***: SIDC of PRO = the average SIDC of the other 17 AA.

3.30 Peas

This SIDC evaluation is based on a dataset with 59 observations, in which the average crude protein content was 248.7 ± 22.5 g/kg DM, with a minimum and maximum value of 199 and 310 g/kg DM, respectively.

Table 3.30.1. Amino acid pattern of the dataset of peas, after removal of the outliers: number of observations, average value (g/16g N) and STDEV, minimum and maximum values. The amino acid pattern in the CVB Feed Table 2021 is mentioned as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	56	52	62	66	63	63	64	63	42	61	55	55	62	56	55	34	54	55
Average *	8.5	2.4	4.1	7.0	7.3	1.0	4.6	3.7	0.9	4.6	4.2	11.3	1.4	17.0	4.2	4.3	4.5	**2.8**
STDEV	1.0	0.2	0.3	0.4	0.5	0.1	0.3	0.3	0.1	0.3	0.3	0.7	0.1	1.3	0.3	0.6	0.5	0.5
CVB Feed Table 2021																		
Average	8.8	2.5	4.1	7.1	7.1	1.0	4.7	3.7	0.9	4.6	4.4	11.7	1.5	16.7	4.4	4.0	4.7	3.3
STDEV	0.7	0.1	0.2	0.2	0.3	0.1	0.2	0.2	0.1	0.3	0.2	0.5	0.1	0.7	0.2	0.3	0.2	0.2

*: When there are averages deviating more than 2*STDEV from the average value in the current CVB Feed Table they are marked red and bold.

Table 3.30.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids in peas, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of peas in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	53	59	56	59	59	58	56	59	57	39	57	53	55	53	53	53	32	54	49
Average SIDC	80.0	90.3	82.6	79.8	80.5	84.6	76.6	80.3	76.5	70.5	77.5	76.1	82.4	69.5	85.1	77.3	88.5	79.5	80.0
STDEV *	3.8	2.6	4.1	4.3	4.3	3.4	5.9	4.4	4.6	5.9	4.2	4.9	3.1	6.0	3.6	7.0	21.7	5.1	5.2
Min	70.5	83.4	74.9	69.8	68.8	75.0	59.7	70.8	65.6	59.3	66.5	64.2	72.6	56.5	77.3	55.7	49.3	60.1	67.3
Max	87.0	95.4	94.3	87.7	88.0	91.1	88.6	89.2	84.0	85.1	85.0	85.9	89.3	84.8	92.7	89.8	121.1	93.1	92.9
	After conversion to an integral number																		
SIDC	80	90	83	80	81	85	77	80	87	71	78	76	82	70	85	77	79 **	80	80
	SIDC values in the CVB Feed Table 2021																		
SIDC	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79	79

*: STDEV > 7% are marked red. **: SIDC of PRO = the average SIDC of the other 17 AA.

3.31 Potato protein

This SIDC evaluation of potato protein is based on an initial dataset with 5 observations, in which the average crude protein content was 791 ± 98.3 g/kg DM, with a minimum and maximum value of 643 and 866 g/kg DM, respectively.

Table 3.31.1. Amino acid pattern of all observations for potato protein, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	5	4	5	5	4	5	5	3	4	3	3	3	3	3	3	3	0
Average *	5.5	2.5	5.6	11.7	**8.7**	2.2	**7.1**	**6.5**	1.4	6.7	**5.4**	13.3	1.5	11.5	**5.4**	5.4	5.5	
STDEV	0.37	0.27	0.52	1.41	0.91	0.11	0.73	0.65	0.07	0.08	0.67	1.43	0.16	1.15	0.45	0.56	0.18	
Min	5.2	2.2	4.9	10.0	7.7	2.2	6.3	5.7	1.4	6.6	5.0	12.5	1.4	10.8	5.0	5.0	5.3	
Max	6.1	2.8	6.0	13.1	9.8	2.4	8.0	7.1	1.5	6.8	6.2	15.0	1.7	12.8	5.9	6.1	5.6	
CVB Feed Table 2021																		
Average	5.2	2.2	5.6	10.2	7.8	2.3	6.4	5.7	1.4	6.6	4.9	12.7	1.5	10.9	4.9	4.9	5.3	5.6
STDEV	0.1	0.1	0.2	0.3	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.4	0.2	0.4	0.2	0.3	0.2	0.3

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.31.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for potato protein, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of potato protein in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	4	4	4	4	4	4	4	4	3	4	3	3	3	3	3	3	3	1
Average SIDC	89.6	93.3	91	90.5	92	90.9	92.8	88.3	88.8	83.1	90.7	88.6	86.9	70.2	87.7	89.5	103.2	87.7	95.8
STDEV **	5.63	3.01	4.93	4.75	4.30	4.60	3.37	7.96	5.86	10.07	3.90	5.57	5.90	9.49	4.51	8.35	26.40	3.51	
Min	83	90	85	85	87	86	89	80	82	75	86	84	81	62	83	82	87	84	
Max	95.4	97	96	94.5	96.3	96.8	96	95.3	94.7	94.4	94.5	94.8	92.8	80.6	92	98.5	133.7	91	
	After conversion to an integral number																		
SIDC	90	93	91	91	92	91	93	88	89	83	91	89	87	70	88	90	88 ***	88	88 ***
	SIDC values in the CVB Feed Table 2021																		
SIDC	90	93	87	89	91	89	91	90	86	80	88	87	83	76	88	82	95	87	91

*: The evaluation is used for both qualities of potato protein published in the CVB Feed Table. **: STDEV > 7% are marked red. ***: SIDC PRO and TYR = average SIDC of the remaining 16 AA.

3.32 Rapeseed, full fat

The SIDC evaluation of rapeseed, full fat is based on an initial dataset with 2 observations, in which the average crude protein content was 235 g/kg DM, with a minimum and maximum value of 207 and 263 g/kg DM, respectively.

Table 3.32.1. Amino acid pattern of all observations for rapeseed, full fat: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2
Average *	5.7	2.7	3.9	**6.4**	5.6	2.0	4.1	4.2	1.3	5.1	4.2	7.0	2.4	17.3	**4.2**	5.5	**3.8**	2.7
STDEV	5.6	2.6	3.9	6.3	5.5	1.9	3.7	3.7	1.3	4.9	4.0	6.3	2.4	15.5	3.9	5.5	3.1	2.6
Min	5.8	2.8	3.9	6.5	5.7	2.2	4.4	4.7	1.3	5.3	4.4	7.7	2.4	19.1	4.6	5.5	4.4	2.9
Max	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2
CVB Feed Table 2021																		
Average	6.1	2.8	3.9	7.0	5.5	2.0	4.1	4.4	1.3	5.1	4.5	7.5	2.5	16.9	5.2	6.0	4.4	3.1
STDEV	0.3	0.2	0.1	0.2	0.3	0.1	0.2	0.2	0.1	0.2	0.2	0.4	0.2	0.9	0.2	0.4	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.32.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for rapeseed, full fat: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of rapeseed, full fat in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Average SIDC	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2
Min	65.4	78.4	70.7	67.1	68.0	63.3	72.3	70.5	61.5	83.5	66.7	69.8	73.4	69.2	78.9	78.6	137.1	65.5	60.9
Max	62.8	75.3	67.9	66.6	67.4	58.8	70.2	68.9	59.2		65.4	68.1	68.4	67.7	78.8	78.6		64.8	59.9
	After conversion to an integral number																		
SIDC	65	78	71	67	68	63	72	71	62	69 *	67	70	73	69	79	79	69 *	66	61
	SIDC values in the CVB Feed Table 2021																		
SIDC	72	84	80	74	76	73	81	77	70	71	71	75	71	70	84	73	79	76	75

*: For the SIDC of PRO and TRP the average SIDC of the other 16 AA is used.

The SIDC values of CP and AA for rapeseed, full fat, are lower than those for rapeseed expeller and rape seed meal. Possibly this is due to improper milling of the small seed.

3.33 Rapeseed / Canola seed expeller, warm and cold pressed

This SIDC evaluation of rapeseed expeller, warm and cold pressed is based on an initial dataset with 29 observations, in which the average crude protein content was 361 ± 43.4 g/kg DM, with a minimum and maximum value of 269 and 447 g/kg DM, respectively. When analyzing the dataset, no significant differences were found between rapeseed expeller, warm (18 observations) and rapeseed expeller, cold pressed (11 observations). So, the combined dataset was used in the further processing. Further it was decided to remove one observation with an extremely high Crude Fat content of 339 g/kg DM.

Table 3.33.1. Amino acid pattern of all observations for rapeseed expeller, warm and cold pressed, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	27	26	26	26	26	23	25	26	19	26	20	21	20	19	21	20	21	19
Average *	5.8	2.6	3.9	6.8	5.6	1.9	3.8	4.1	1.2	4.9	4.3	7.0	2.2	15.9	4.9	5.7	4.0	2.8
STDEV	0.31	0.13	0.23	0.27	0.31	0.12	0.23	0.21	0.10	0.29	0.19	0.40	0.22	0.94	0.24	0.32	0.57	0.29
Min	5.2	2.4	3.3	6.3	5.0	1.6	3.4	3.7	1.0	4.3	3.8	6.4	1.8	13.9	4.4	5.1	3.1	2.3
Max	6.3	2.8	4.2	7.3	6.1	2.1	4.2	4.5	1.4	5.5	4.7	7.8	2.6	17.3	5.4	6.4	5.1	3.3
CVB Feed Table 2021																		
Average	6.1	2.8	3.9	7.0	5.5	2.0	4.1	4.4	1.3	5.1	4.5	7.5	2.5	16.9	5.2	6.0	4.4	3.1
STDEV	0.3	0.2	0.1	0.2	0.3	0.1	0.2	0.2	0.1	0.2	0.2	0.4	0.2	0.9	0.2	0.4	0.2	0.3

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Further it was observed that there are significant correlations between SIDC of CP and AA and crude protein. In the Table 3.33.2 a correlation matrix is presented, showing the number of observations, correlation coefficients and the significance of the correlation.

Table 3.33.2. Correlation matrix for rapeseed expeller, warm and cold pressed showing the correlation of the standardized ileal digestible CP and Amino Acid contents (g/kg DM) to crude protein (g/kg DM): number of observations, correlation coefficient (r) and significance (p).

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	25	28	28	28	28	28	24	28	28	21	28	22	22	22	22	22	12	22	21
Corr. Coeff. (r)	0.628	0.522	-0.105	0.601	0.567	0.034	0.478	0.571	0.347	0.058	0.577	0.388	0.471	0.446	0.515	0.311	0.300	0.574	0.449
Significance (p)	0.001	0.004	0.595	0.001	0.002	0.862	0.018	0.002	0.071	0.802	0.001	0.074	0.027	0.037	0.014	0.159	0.344	0.005	0.041

Based on the results in Table 3.3.2 prediction equations were developed by performing regression analysis with the model: SID level of CP or AA = a*Crude Protein + c (results not shown). In Table 3.33.3 the SIDC's of CP and AA are calculated using these prediction equations for rapeseed expeller using the crude protein content and the amino acid pattern as published in the CVB Feed Table (2021). Also, the current SIDC evaluation is mentioned as a reference.

Table 3.33.3. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for rapeseed expeller, warm and cold pressed, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. These SIDC's were calculated with the regression equations. The SIDC's of rapeseed, warm and cold pressed in the CVB Feed Table 2021 are mentioned as a reference.

SIDC values (in %-units)																		
CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
75.7	87.4	84.6	75.6	78.4	77.5	86.3	78.3	74.8	82.2	75.5	78.3	75.6	74.2	84.7	77.4	79.0	74.3	78.4
After conversion to an integral number																		
76	87	85	76	78	78	86	78	75	82	76	78	76	74	85	77	79	74	78
SIDC values in the CVB Feed Table 2021																		
72	84	80	75	77	74	81	77	71	71	72	76	71	70	84	74	80	76	75

*: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.34 Rapeseed / canola meal, solvent extracted

This SIDC evaluation of rapeseed meal, solvent extracted is based on an initial dataset with 142 observations, with an average crude protein content of 412 ± 35.3 g/kg DM, with a minimum and maximum value of 193 and 513 g/kg DM, respectively.
In 66 samples studied the total glucosinolate level was analyzed, in 76 samples not.

Table 3.34.1. Amino acid pattern of all observations for rapeseed meal, solvent extracted, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	136	128	135	133	134	123	137	133	107	134	123	128	121	128	128	119	126	105
Average *	5.8	2.7	3.8	6.9	5.4	1.9	3.8	4.2	1.2	4.9	4.4	7.1	2.2	16.6	4.9	6.0	4.0	2.6
STDEV	0.5	0.2	0.3	0.4	0.4	0.2	0.4	0.3	0.1	0.4	0.3	0.6	0.3	1.5	0.4	0.6	0.5	0.3
Min	4.8	2.2	3.0	5.9	4.4	1.3	2.9	3.3	0.8	4.0	3.5	6.1	1.2	13.6	3.6	4.2	3.0	1.9
Max	6.8	3.5	4.5	7.7	6.3	2.4	4.7	5.0	1.5	5.8	5.2	8.6	2.9	20.2	6.8	7.7	5.2	3.3
CVB Feed Table 2021																		
Average	6.1	2.8	3.9	7.0	5.5	2.0	4.1	4.4	1.3	5.1	4.5	7.5	2.5	16.9	5.2	6.0	4.4	3.1
STDEV	0.3	0.2	0.1	0.2	0.3	0.1	0.2	0.2	0.1	0.2	0.2	0.4	0.2	0.9	0.2	0.4	0.2	0.3

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Table 3.34.2. New values for SIDC (%) of crude protein and amino acids for rapeseed meal, solvent extracted, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of rapeseed meal, solvent extracted in the CVB Feed Table 2021 is mentioned as a reference. The SIDC PRO is calculated as the average SIDC of the other 16 AA.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	120	127	126	125	127	128	121	126	128	98	127	121	120	121	120	121	91	116	120
Average SIDC	73.8	86.0	81.9	77.1	79.6	74.2	84.6	79.1	72.9	79.0	74.6	77.8	73.6	73.6	84.0	77.1	86.9	75.9	73.8
STDEV	5.7	3.7	5.7	4.9	4.4	7.5	3.3	4.5	6.3	8.4	5.2	5.3	6.3	7.0	3.6	7.7	14.4	5.5	5.7
Min	60.0	76.0	67.3	66.0	69.0	55.0	76.6	68.4	59.0	63.0	60.6	65.7	59.0	59.0	75.0	58.1	54.5	62.0	60.0
Max	84.3	94.0	94.0	87.0	89.5	88.9	91.6	89.6	87.6	93.6	86.1	89.4	88.8	87.5	92.1	93.6	115.0	88.8	84.3
	After conversion to an integral number																		
SIDC	74	86	82	77	80	74	85	79	73	79	75	78	74	74	84	77	87	76	74
	SIDC values in the CVB Feed Table 2021																		
SIDC	77	79	79	78	79	75	81	82	74	76	78	70	78	82	91	79	97	84	76

Further it was observed that there are significant correlations between SIDC of CP and AA and some other nutrients. In the Table 3.34.3. a correlation matrix is presented, showing the number of observations, correlation coefficients and the significance of the correlation of the SIDC's to crude protein, glucosinolate content, crude fiber, NDF and ADF. This Table clearly demonstrates that there is a very significant correlation between almost all SIDCs and NDF. The correlation to other cell wall parameters (crude fiber and ADF) is much less.

Table 3.34.3. Correlation matrix for rapeseed meal, solvent extracted showing the correlation of the standardized ileal digestible CP and Amino Acid contents (g/kg DM) to crude protein (g/kg DM), glucosinolate content (µmol/g DM), crude fiber (g/kg DM), NDF (g.kg DM) and ADF (g/kg DM): number of observations, correlation coefficient (r) and significance (p). *

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Crude protein																			
Number	129	141	141	140	140	142	133	140	141	105	140	131	130	133	131	131	100	130	114
Corr.coeff. (r)	0.298	0.056	0.083	0.102	0.066	0.146	-0.016	-0.004	0.140	0.436	0.149	0.039	0.038	0.007	0.140	0.047	-0.023	0.123	-0.029
Significance (p)	0.001	0.509	0.326	0.230	0.438	0.084	0.858	0.967	0.097	<.0001	0.080	0.657	0.671	0.940	0.111	0.596	0.820	0.162	0.757
Glucosinolates																			
Number	55	56	56	56	56	56	56	56	56	46	56	48	48	56	48	48	44	48	35
Corr.coeff. (r)	-0.010	-0.225	0.083	-0.306	-0.258	-0.211	-0.150	-0.269	-0.257	-0.117	-0.294	-0.088	-0.082	0.034	-0.031	0.014	0.160	-0.017	-0.101
Significance (p)	0.941	0.095	0.543	0.022	0.055	0.118	0.271	0.045	0.056	0.438	0.028	0.552	0.579	0.802	0.836	0.923	0.301	0.911	0.564
Crude Fiber																			
Number	33	36	36	36	36	37	35	36	37	24	36	35	35	35	35	35	35	35	34
Corr.coeff. (r)	-0.317	0.364	-0.745	0.310	0.231	0.330	0.328	0.405	0.040	-0.263	0.345	0.274	0.158	-0.398	0.415	0.008	0.179	0.036	-0.186
Significance (p)	0.072	0.029	<.0001	0.065	0.176	0.046	0.054	0.014	0.815	0.214	0.039	0.112	0.366	0.018	0.013	0.962	0.305	0.836	0.292
NDF																			
Number	88	97	97	96	96	97	91	96	96	82	96	89	88	91	89	89	77	88	73
Corr.coeff. (r)	-0.767	-0.539	-0.385	-0.432	-0.461	-0.704	-0.537	-0.557	-0.465	-0.582	-0.473	-0.577	-0.459	-0.644	-0.519	-0.441	-0.480	-0.419	-0.045
Significance (p)	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.704
ADF																			
Number	71	80	80	79	79	80	74	79	79	66	79	72	71	74	72	72	60	71	56
Corr.coeff. (r)	-0.708	-0.437	-0.266	-0.373	-0.375	-0.611	-0.603	-0.544	-0.375	-0.686	-0.405	-0.403	-0.312	-0.605	-0.344	-0.261	-0.280	-0.230	0.005
Significance (p)	<.0001	<.0001	0.017	0.001	0.001	<.0001	<.0001	<.0001	0.001	<.0001	0.000	0.000	0.008	<.0001	0.003	0.027	0.030	0.054	0.971

*: For this correlation matrix all observations (so including outliers with respect to the AA patten) were used.

Looking to the variation in the NDF content extremely high levels were found. As crude protein and NDF are the predominant nutrients in rapeseed meal, one would expect that an increase in the NDF content would result in a decrease of the crude protein content. This, however, appeared not to be the case (Figure 1). Further, it was observed that the mass balance (= Ash + crude protein + crude fat + NDF + starch + sugars + RNSP) exceeds 1000 g/kg DM at higher NDF contents. As not in all samples all nutrients were analyzed, the following figures were added in case of missing values (= the average value of the samples where the nutrient of concern was analyzed): Ash: 81.2 g/kg DM; crude fat: 38.3 g/kg DM; Starch: 9.1 g/kg DM; Sugars: 27.1 g/kg DM. Finally, in this calculation the RNSP[2] figure was used as mentioned in the CVB Feed Table for rapeseed meal, CP<370 g/kg (= 110 g/kg). Figure 2 shows that for about 50% of the samples the mass balance exceeds 1000 g/kg DM. Based on this evidence it is concluded that the NDF level is an artefact. Depending on the processing conditions less or more (denatured) crude protein will be attached to the fiber fraction, resulting in a lower digestibility. Although being an artefact, NDF appeared to be a good predictor of the SIDC of CP and AA in rapeseed / canola meal. As can be seen, in approximately 70% of the samples NDF is analyzed. So, there is a robust dataset to execute regression analysis. For this analysis the following model was used: (Standardized ileal digestible level of CP or AA; %) = a*NDF + c (results not shown).

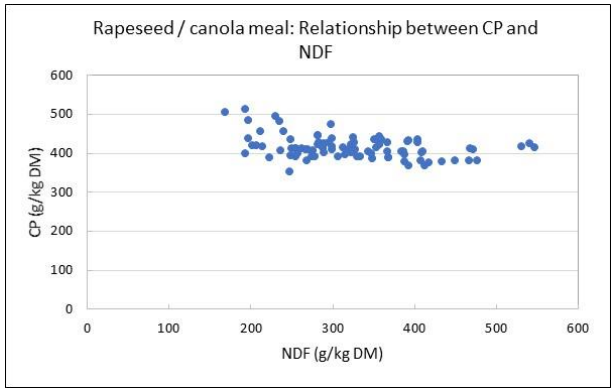


Figure 1 (left).
Relationship between crude protein and NDF in rapeseed / canola meal.

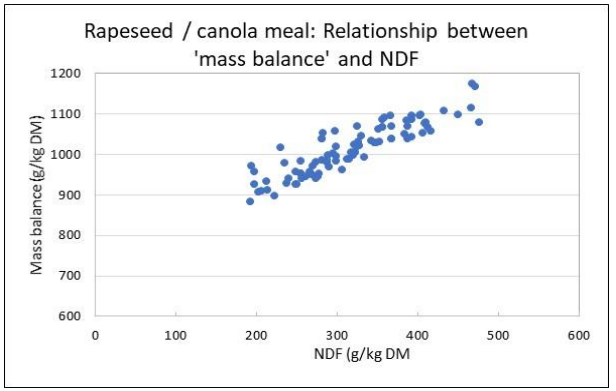


Figure 2 (right).
Relationship between the mass balance and the NDF content in rapeseed / canola meal.

In Table 3.34.5 the SIDC's of CP and AA are calculated using the prediction equations for rapeseed meal, solvent extracted as published in the CVB Feed Table (2021). Also, the current SIDC evaluation is mentioned as a reference.

It has been decided to present two evaluations for the SIDC of rapeseed meal:

1. An evaluation based on the average STDEV's are removing outliers for the amino acid pattern and, subsequently, outliers for the SIDC's of the individual amino acids (Table 3.34.4).

[2] RNSP = Remainder NSP fraction, after subtracting NDF from NSP (RNSP = NSP – NDF)

Table 3.34.4. SIDC coefficients to be used for rapeseed / canola meal if no NDF content is known.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Average SIDC	73.8	86.0	81.9	77.1	79.6	74.2	84.6	79.1	72.9	79.0	74.6	77.8	73.6	73.6	84.0	77.1	77.7**	75.9	73.8
	After conversion to an integral number																		
SIDC	74	86	82	77	80	74	85	79	73	79	75	78	74	74	84	77	78**	76	74
	SIDC values in the CVB Feed Table 2021																		
SIDC	77	79	79	78	79	75	81	82	74	76	78	70	78	82	91	79	97	84	76

*: The proposed SIDC values (except for PRO) are based on the data in Table 3.34.2. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

2. SIDC's calculated with the regression equations developed with the model SIDC-AA = a*NDF + c when the NDF content is identical to the content on the product sheet of rape seed meal in the CVB Feed Table 2021 (Table 3.34.5).

Table 3.34.5. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for rapeseed meal, solvent extracted, calculated with the regression equations developed with the model SIDC = a*NDF + c (see Table 3.34.4). *

SIDC values (in %-units)																		
CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Rapeseed <370 g CP/kg																		
74.0	86.0	81.7	77.6	79.8	75.2	85.0	79.8	73.2	79.5	75.1	78.4	73.8	73.3	84.3	77.8	87.2	76.1	80.2
74	86	82	78	80	75	85	80	73	79	75	78	74	73	84	78	78**	76	80
Rapeseed >370 g CP/kg																		
76.1	86.9	82.9	78.5	80.9	78.1	85.8	80.7	75.0	81.7	76.5	80.0	75.5	75.3	85.3	80.3	90.5	77.9	80.3
76	87	83	79	81	78	86	81	75	82	77	80	76	75	85	80	79**	78	80
SIDC values (in %-units) in current CVB Feed Table (2021)																		
77	79	79	78	79	75	81	82	74	76	78	70	78	82	91	79	97	84	76

*: SIDC values were calculated with the NDF content as published on the product sheet in the CVB Feed Table 2021, after recalculation to the content in DM.

**: For the SIDC of PRO the average SIDC of the other (by regression) calculated 17 AA is used.

3.35 Rice, with hulls and dehulled

Eight observations with rice, dehulled were collected from the literature: five observations with rice, broken, one with rice, polished, one with brown rice and 1 with brewer's rice. No observations were found for rice with hulls. The average crude protein content of the 8 observations with rice, dehulled was 88 ± 9.6 g/kg DM, with a minimum and maximum value of 74 and 104 g/kg DM, respectively.

Table 3.35.1. Amino acid pattern of all observations of rice, dehulled, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	8	7	8	8	8	7	8	8	4	8	7	7	6	7	7	5	7	6
Average *	8.6	2.4	4.2	7.7	3.8	2.4	4.8	3.9	1.1	5.8	5.3	9.6	1.8	16.6	4.4	5.1	4.6	3.1
STDEV	2.19	0.22	0.44	0.72	0.37	0.24	0.62	1.03	0.32	0.87	0.50	1.95	0.53	1.74	0.59	0.53	0.61	1.17
Min	6.0	2.1	3.7	6.5	3.3	2.0	3.8	2.9	0.8	4.4	4.5	7.6	0.9	14.2	3.6	4.6	3.8	1.7
Max	12.5	2.7	5.1	8.7	4.4	2.8	5.9	5.8	1.4	7.0	5.8	12.8	2.5	19.8	5.4	5.9	5.3	4.6
CVB Feed Table 2021																		
Average	7.8	2.7	3.7	7.3	4.2	2.1	4.7	3.7	1.1	5.5	5.9	9.0	2.2	14.6	5.1	4.5	4.7	3.4
STDEV	0.6	0.3	0.3	0.5	0.6	0.3	0.4	0.3	0.2	0.4	0.4	0.5	0.2	1.7	0.5	0.3	0.4	0.5

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.35.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids of rice, dehulled, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of rice, dehulled in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	7	7	7	7	7	7	6	7	7	4	7	6	6	5	5	6	4	6	3
Average SIDC	92.8	95.3	93.4	92.5	93.3	92	93.7	93.2	91.4	92	91.8	92.2	93.3	94.2	94.5	97	131.4	94.4	86.8
STDEV *	3.42	2.95	1.81	2.38	1.97	3.08	1.37	1.56	3.39	3.77	5.27	2.46	1.79	1.45	1.39	4.02	35.4	2.2	5.12
Min	88.1	90.9	91.4	88.7	89.3	87	92.1	90.5	85.7	86.6	80.6	89.2	91.1	92.9	93.0	92.6	112	90.6	82
Max	97.3	98.9	96.6	95.5	95	94.7	95.2	95.3	95.2	94.7	95.1	94.9	95	96.5	96.0	103.9	184.4	96.5	92.2
	After conversion to an integral number																		
SIDC	93	95	93	93	93	92	94	93	91	92	92	92	93	94	95	97	93 **	94	87
	SIDC values in the CVB Feed Table 2021																		
SIDC	95	96	95	96	96	94	95	92	93	93	95	95	93	90	96	95	93	96	97

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

This SIDC evaluation of CP and AA will be used for rice, dehulled, polished as published in the CVB Feed Table.

As there are no new observations for rice with hulls (Paddy rice) it is decided to maintain the current values of the CVB Feed Table, as shown below.

SIDC values (in %-units) for rice with hulls																	
CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
76	90	88	82	84	80	84	85	74	74	81	76	75	74	83	77	85 -> 81*	79	84

*: As the average SIDC of all AA (except PRO) is 80.6; it is proposed to adjust the current value of 85 to 81%.

3.36 Rice bran

The SIDC evaluation of rice bran is based on an initial dataset with 6 observations, in which the average crude protein content was 162 ± 10.7 g/kg DM, with a minimum and maximum value of 150 and 181 g/kg DM, respectively.

Table 3.36.1. Amino acid pattern of all observations for rice bran, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	5	5	5	4	4	5	5	5	4	4	4	4	5	5	2	5	5
Average *	8.1	2.8	3.3	6.8	4.5	1.9	4.3	3.7	1.1	5.0	5.8	8.1	1.8	12.9	5.3	3.9	4.4	**2.1**
STDEV	0.25	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.5	0.2	0.2	0.4	0.6
Min	7.8	2.7	3.3	6.6	4.2	1.7	4.0	3.4	0.8	4.9	5.7	8.0	1.7	12.3	5.1	3.7	3.7	1.6
Max	8.5	3.0	3.5	7.2	4.7	2.1	4.5	3.9	1.3	5.1	6.1	8.4	2.0	13.6	5.6	4.1	4.7	3.0
CVB Feed Table 2021																		
Average	7.8	2.7	3.7	7.3	4.2	2.1	4.7	3.7	1.1	5.5	5.9	9.0	2.2	14.6	5.1	4.5	4.7	3.4
STDEV	0.6	0.3	0.3	0.5	0.6	0.3	0.4	0.3	0.2	0.4	0.4	0.5	0.2	1.7	0.5	0.3	0.4	0.5

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.36.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for rice bran, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of rice bran in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0
Average	80.9	91.5	86.9	85.8	86.8	85.6	86.7	84.4	81.9	81.5	83.8	84.6	82.9	81.3	89.7	84.1	124.6	85.4	
STDEV **	3.02	1.16	0.98	0.85	0.95	1.64	1.23	0.92	1.33	2.09	0.9	1.32	1.17	1.58	1.2	2.23	3.26	1.27	
Min	77.9	90.5	85.8	85.2	86.3	83.9	85	83.4	81.1	79.6	82.7	83.2	81.9	79.3	88.6	82.1	122.2	84.5	
Max	85.1	93.1	87.8	87.1	88.2	87.8	87.8	85.2	83.9	83.9	84.7	86.1	84.6	82.6	90.8	87.2	129.3	87.3	
	After conversion to an integral number ****																		
SIDC	81	92	87	86	87	86	87	84	82	82	84	85	83	81	90	84	85 ***	85	85 ***
	SIDC values in the CVB Feed Table 2021 ****																		
SIDC	66	77	66	68	66	62	71	62	61	75	66	66	63	52	71	58	65	68	69

*: This evaluation is used for both qualities in the CVB Table. **: STDEV > 7% are marked red. ***: For the SIDC of PRO and TYR the average SIDC of the other 16 AA is used.
****: the new evaluation is much more in line with SIDC evaluation in the INRA tables than the old one.

3.37 Rice bran meal, solvent extracted.

The SIDC evaluation of rice bran meal, solvent extracted is based on an initial dataset with 11 observations, in which the average crude protein content was 179 ± 15.7 g/kg DM, with a minimum and maximum value of 155 and 210 g/kg DM, respectively.

Table 3.37.1. Amino acid pattern of all observations for rice bran meal, solvent extracted, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	9	9	9	9	8	8	9	9	9	9	9	8	8	9	9	8	9	8
Average *	6.8	2.4	3.1	**6.2**	4.3	1.8	**3.4**	3.5	1.1	4.9	5.5	8.4	1.9	12.2	4.8	4.2	4.0	2.5
STDEV	1.03	0.33	0.27	0.53	0.3	0.35	0.72	0.22	0.13	0.34	0.35	0.36	0.42	1.11	0.44	0.33	0.37	0.23
Min	5.0	2.0	2.6	5.6	3.8	1.3	2.6	3.0	0.9	4.3	5.1	7.8	1.3	10.5	3.9	3.6	3.4	2.1
Max	8.3	2.9	3.5	6.9	4.6	2.3	4.3	3.7	1.3	5.3	6.0	8.7	2.6	13.6	5.4	4.6	4.5	2.8
CVB Feed Table 2021																		
Average	7.8	2.7	3.7	7.3	4.2	2.1	4.7	3.7	1.1	5.5	5.9	9.0	2.2	14.6	5.1	4.5	4.7	3.4
STDEV	0.6	0.3	0.3	0.5	0.6	0.3	0.4	0.3	0.2	0.4	0.4	0.5	0.2	1.7	0.5	0.3	0.4	0.5

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.37.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for rice bran meal, solvent extracted after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of rice bran meal, solvent extracted in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	8	9	9	9	9	9	9	9	8	9	9	9	9	9	9	9	3	8	6
Average SIDC	75.4	85.1	74.4	74.5	75.6	73.8	83.6	78.2	76.4	71.4	76.3	76.2	75.9	73.1	80	64	127.6	79.6	78.1
STDEV *	4.76	5.43	5.81	6.81	6.41	6.58	9.29	9.53	3.47	9.47	5.43	5.6	6.78	9.83	5.52	15.48	14.82	3.96	7.35
Min	67.6	75	64.4	65.5	66	61.9	68.9	63.5	69.4	56.2	66.5	66.1	63.7	54	69.7	37	113.2	71.6	63.6
Max	81.5	90.7	83.7	81.6	82.5	81.8	95.8	93	79.7	81.1	82.4	82	82.6	85.8	87	80	142.8	83.8	83.1
	After conversion to an integral number																		
SIDC	75	85	74	75	76	74	84	78	76	71	76	76	76	73	80	64	76**	80	78
	SIDC values in the CVB Feed Table 2021																		
SIDC	63	77	66	68	66	62	63	71	61	75	67	66	63	53	71	58	66	68	70

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.38 Rye

The SIDC evaluation of rye is based on an initial dataset with 14 observations, in which the average crude protein content was 126 ± 14.8 g/kg DM, with a minimum and maximum value of 108 and 153 g/kg DM, respectively.

Table 3.38.1. Amino acid pattern of all observations for rye, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	13	13	12	13	12	13	13	13	8	12	13	13	13	13	13	12	13	5
Average *	5.6	2.4	**2.9**	6.4	3.6	**1.4**	4.7	3.3	1.0	4.2	3.9	6.8	**1.9**	24.0	4.3	**11.6**	4.4	2.5
STDEV	0.76	0.14	0.11	0.27	0.08	0.19	0.10	0.11	0.02	0.12	0.25	0.28	0.35	0.64	0.10	0.38	0.42	0.31
Min	5.0	2.2	2.8	6.1	3.5	1.1	4.5	3.2	1.0	4.1	3.5	6.3	1.4	23.0	4.1	11.1	3.7	2.3
Max	7.0	2.6	3.1	7.0	3.7	1.7	4.8	3.6	1.0	4.5	4.3	7.1	2.2	25.4	4.4	12.2	4.8	3.1
CVB Feed Table 2021																		
Average	5.1	2.4	3.4	6.2	3.8	1.7	4.6	3.3	1.0	4.7	4.3	7.2	2.4	22.7	4.4	9.4	4.3	2.6
STDEV	0.3	0.2	0.2	0.2	0.2	0.1	0.3	0.1	0.1	0.3	0.2	0.5	0.2	1.5	0.2	0.8	0.2	0.2

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.38.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for rye, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of rye in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	10	12	12	12	12	13	13	12	13	8	12	12	12	13	12	11	10	12	4
Average SIDC	71.9	78.6	75.1	71.5	76.0	66.2	77.1	78.7	66.6	64.9	72.7	64.3	70.6	76.5	86.8	62.0	98.3	74.5	68.5
STDEV	1.82	3.26	1.61	3.20	3.77	5.87	2.59	1.70	4.59	1.36	2.10	2.84	3.28	2.52	1.37	4.36	5.46	2.59	1.79
Min	68.0	75.0	73.0	65.0	73.0	60.0	74.0	76.0	62.0	63.0	70.7	61.0	66.0	72.0	85.0	57.0	89.7	72.0	65.9
Max	74.0	84.7	77.7	76.9	83.3	78.2	81.5	81.1	75.4	67.0	77.1	71.1	77.9	80.3	89.0	69.8	104.0	79.5	70.0
	After conversion to an integral number																		
SIDC	72	79	75	72	76	66	77	79	67	65	73	64	71	77	87	62	73 **	75	69
	SIDC values in the CVB Feed Table 2021																		
SIDC	77	79	79	78	79	75	81	82	74	76	78	70	78	82	91	79	97	84	76

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.39 Sesame expeller and meal

The SIDC evaluation of sesame meal and expeller is based on an initial dataset with 3 observations (2 observations for meal, solvent extracted and 1 expeller), in which the average crude protein content was 532 ± 14.6 g/kg DM, with a minimum and maximum value of 516 and 544 g/kg DM, respectively.

Table 3.39.1. Amino acid pattern of all observations for sesame meal and expeller, after removal of outliers for the AA pattern *: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	2	2	2	2	1	2	2	1	2	2	2	1	2	2	2	2	1
Average **	10.6	2.1	3.2	5.9	2.2	3.0	3.9	3.2	1.5	4.0	4.1	7.2	2.0	16.2	4.5	3.1	3.9	3.0
STDEV	9.3	1.9	2.8	5.4	1.9		3.6	3.0		3.6	3.7	6.9		14.6	4.1	3.0	3.6	
Min	11.9	2.4	3.5	6.3	2.5		4.2	3.4		4.4	4.4	7.5		17.7	4.8	3.2	4.2	
Max	2	2	2	2	2	1	2	2	1	2	2	2	1	2	2	2	2	1
CVB Feed Table 2021																		
Average	11.6	2.4	3.6	6.5	2.5	2.7	4.4	3.4	1.3	4.6	4.7	8.1	1.9	17.9	4.8	3.5	4.5	3.5
STDEV	0.8	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.3	0.3	0.6	0.2	1.2	0.3	0.2	0.3	0.3

*: One observation (for meal) was completely removed. **: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.39.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for sesame meal and expeller, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of sesame meal and expeller in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	2	2	2	2	2	1	2	2	1	2	2	2	1	2	2	2	2	1
Observation low	84.2	83.9	80.1	75.0	76.0	67.7	84.6	78.4	78.5	79.9	75.1	83.4	81.7	77.8	76.4	82.8	84.4	78.9	75.7
Observation	88.5	96.9	92.6	90.6	91.4	84.5	94.7	91.8	87.8	90.0	90.4	88.1	87.0	87.9	90.1	88.4	84.6	90.9	85.8
Average	86.4	90.4	86.4	82.8	83.7	76.1	89.7	85.1	83.2	85.0	82.8	85.8	84.4	82.9	83.3	85.6	84.5	84.9	80.8
	After conversion to an integral number																		
SIDC	86	90	86	83	84	80 **	90	85	83	85	83	86	84	83	83	86	84 ***	85	81
	SIDC values in the CVB Feed Table 2021																		
SIDC	84	84	84	87	87	82	84	90	79	84	88	84	84	84	84	84	84	84	84

*: STDEV > 7% are marked red. **: The SIDC for LYS pragmatically has been set at 80%. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.40 Sorghum

For sorghum an initial dataset was obtained with 31 observations. In 25 observations condensed tannins were analysed. After surveying the effect of tannins in the SIDC values of sorghum it was decided to prepare a proposal for the SIDC evaluation of sorghum on a subset of 10 observations with a tannin content < 5 g/kg DM in which the AIDC values were also converted in SIDC values using an experiment specific BEL pattern. The average crude protein content of this subset was 110 ± 20.8 g/kg DM, with a minimum and maximum value of 91 and 156 g/kg DM, respectively.

Table 3.40.1. Amino acid pattern of all observations for sorghum, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	10	9	10	10	10	6	10	9	9	10	9	9	6	9	9	6	8	9
Average *	3.8	2.3	4.1	13.5	2.2	1.7	5.3	3.2	0.9	6.3	8.8	6.6	2.0	21.0	3.0	**6.6**	4.2	3.4
STDEV	0.37	0.10	0.27	0.98	0.24	0.22	0.35	0.18	0.12	1.41	0.64	0.24	0.38	0.86	0.28	1.45	0.07	1.01
Min	3.1	2.1	3.7	12.6	1.9	1.4	4.7	3.0	0.7	4.7	8.1	6.3	1.7	20.1	2.7	5.3	4.0	2.1
Max	4.3	2.4	4.5	15.5	2.6	2.0	5.8	3.5	1.1	8.1	9.9	6.9	2.8	22.7	3.4	8.5	4.3	4.6
CVB Feed Table 2021																		
Average	4.0	2.4	4.0	13.0	2.4	1.8	5.3	3.3	1.1	5.0	8.9	7.1	1.9	20.0	3.4	8.1	4.6	3.9
STDEV	0.3	0.2	0.2	0.6	0.3	0.1	0.3	0.1	0.1	0.3	0.4	0.3	0.1	1.1	0.3	0.5	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.40.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for sorghum, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of sorghum in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	6	10	10	10	10	10	6	10	10	9	10	7	8	5	8	8	5	8	7
Average SIDC	77.7	87.5	81.6	80.5	81.9	84.2	81.4	83.0	81.5	82.2	80.9	82.6	82.8	75.9	83.0	91.1	139.0	86.4	82
STDEV *	7.72	5.84	7.11	5.98	3.52	17.76	1.56	6.45	8.36	7.36	4.83	1.86	4.98	4.45	5.17	14.18	12.03	5.31	5.77
Min	65.4	79.0	73.1	71.4	75.6	66.4	79.2	72.7	74.4	70.5	75.6	80.2	79.0	71.3	75.9	74.1	124.5	81.4	74.5
Max	84.5	98.4	91.2	91.0	87.6	109.1	83.3	92.7	95.9	93.9	88.8	85.4	92.6	82.1	90.9	111.6	152.9	96.8	90.1
	After conversion to an integral number																		
SIDC	78	88	82	81	82	84	81	83	82	82	81	83	83	76	83	91	83 **	86	82
	SIDC values in the CVB Feed Table 2021																		
SIDC	84	86	83	88	89	80	89	89	86	86	87	85	84	86	93	82	93	91	90

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.41 Soybeans, heat treated

The SIDC evaluation of soybeans, heat treated is based on an initial dataset with 30 observations, in which the average crude protein content was 400 ± 32.5 g/kg DM, with a minimum and maximum value of 319 and 502 g/kg DM, respectively. There are two observations in the dataset for soybeans full fat high protein with CP contents of 502 and 463 g/kg DM. The SIDC's of these two observations were within the range of the total dataset.

Table 3.41.1. Amino acid pattern of all observations for soybeans, heat treated, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	28	27	29	28	29	22	28	28	22	29	25	25	20	25	25	24	26	23
Average *	7.5	2.7	4.7	7.9	6.4	1.4	5.1	4.0	1.4	4.9	4.5	11.7	1.6	18.1	4.3	4.8	4.9	3.7
STDEV	0.44	0.14	0.30	0.42	0.33	0.13	0.24	0.28	0.19	0.31	0.31	0.55	0.11	0.98	0.24	0.72	0.56	0.22
Min	6.8	2.2	4.1	7.2	5.8	1.2	4.5	3.5	0.9	4.4	3.9	10.8	1.4	15.9	3.9	3.1	4.1	3.3
Max	8.5	2.9	5.3	8.7	7.2	1.6	5.5	4.5	1.8	5.5	5.1	12.9	1.8	19.9	4.7	5.9	6.0	4.3
CVB Feed Table 2021																		
Average	7.4	2.7	4.6	7.7	6.2	1.4	5.1	3.9	1.3	4.8	4.4	11.6	1.5	18.1	4.3	5.1	5.2	3.7
STDEV	0.3	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.4	0.1	0.8	0.2	0.3	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.41.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for soybeans, heat treated, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of soybeans, heat treated in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	20	27	27	27	27	27	20	27	27	15	26	24	24	14	23	24	16	24	21
Average SIDC	83.2	89.3	85.4	82.4	81.9	84.2	86.2	83.1	79.2	85.5	80.5	81.9	82.4	78.9	86.4	84.7	119.3	82.1	84.3
STDEV **	7.11	6.19	6.33	7.06	7.46	6.46	6.92	7.81	8.39	8.24	7.58	8.59	6.98	10.23	5.80	9.66	35.27	8.27	6.25
Min	72.0	76.2	74.0	69.3	68.7	73.2	72.0	67.0	63.0	67.0	68.3	63.4	69.4	58.0	72.8	67.0	74.0	66.5	70.4
Max	94.1	99.1	95.2	93.1	93.0	94.2	95.6	94.1	95.3	94.7	92.4	94.7	94.1	92.9	95.2	100.7	171.8	96.0	93.6

*: In one publication with several observations the levels of TRP and CYS were analyzed, but no SIDC's were presented for these AA.

**: STDEV > 7% are marked red.

Further it was observed that there are significant correlations between the SIDC of CP and many AA and NDF. In the Table 3.41.3 a correlation matrix is presented, showing the number of observations, correlation coefficients and the significance of the correlation of the SIDC's to NDF.

Table 3.41.3. Correlation matrix for showing the correlation of the standardized ileal digestible CP and Amino Acid contents (g/kg DM) to NDF: number of observations, correlation coefficient (r) and significance (p). *

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
NDF																			
Number	8	11	11	11	11	11	10	11	11	10	10	9	9	9	9	9	7	9	8
Corr.coeff. (r)	-0.614	-0.704	-0.794	-0.695	-0.770	-0.480	-0.742	-0.753	-0.717	-0.476	-0.706	-0.769	-0.631	-0.681	-0.854	-0.739	-0.346	-0.744	-0.724
Significance (p)	0.106	**0.016**	**0.004**	**0.018**	**0.006**	0.135	**0.014**	**0.008**	**0.013**	0.165	**0.023**	**0.016**	0.069	**0.043**	**0.003**	**0.023**	0.447	**0.022**	**0.042**

*: For this correlation matrix all observations (so including outliers with respect to the AA patten) were used.

It was decided to develop regression equations for the prediction of the STDEV's of CP and AA, based on the NDF content. It further was decided not to publish these equations, first because the number of observations on which the regression formulas are based is rather limited, and secondly because in the CVB database the number of observations on NDF is limited. Based on calculations with these internal formulas the SIDC evaluation for soybeans full fat, heat treated shown in Table 3.41.4 will be used for the chemical composition of soybeans heat treated as published in the CVB Feed Table 2021.

Table 3.41.4. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for soybeans, heat treated after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. SIDC-values were calculated using the NDF content on the product sheet in the CVB Feed Table 2021. The SIDC's of soybeans, heat treated in the CVB Feed Table 2021 is mentioned as a reference.

Item	**SIDC (%)**																		
	CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
	Calculated with internal regression equations																		
SIDC	84	90	86	83	82	85	87	83	80	86	81	82	83	80	87	85	84*	83	85
	SIDC values in the CVB Feed Table 2021																		
SIDC	82	87	83	79	78	83	82	81	78	82	78	77	82	75	84	74	87	77	80

*: SIDC is based on the average SIDC of the 17 other AA.

3.42 Soybean hulls

As no observations for soybean hulls are mentioned in the ILOB-TNO report (1966), the current evaluation of soybean hulls is based on an expert judgement. In the literature two observations were found in one study, one with soybean hulls, untreated and one with soybean hulls, extruded. For the new evaluation only the observation with untreated soybean hulls was used. This observation has a CP content of 105 g/kg DM.

Table 3.42.1. Amino acid pattern of all observations for soybean hulls, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

	Amino acid pattern (g/16g N)																	
	ARG	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Observation	4.8	2.7	4.3	**7.1**	7.2	1.1	4.2	4.0	1.0	4.9	4.4	10.1	**2.1**	11.5	8.9	**5.9**	6.0	4.0
CVB Feed Table 2021																		
Average	5.3	2.7	3.8	6.3	6.6	1.2	4.2	3.6	1.1	4.6	4.2	9.6	1.7	12.1	7.5	4.9	5.6	4.3
STDEV	0.6	0.2	0.4	0.3	0.3	0.2	0.4	0.2	0.1	0.1	0.1	0.6	0.1	1.6	1.1	0.2	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

In Table 3.42.2 the SIDC values of the new observation, the current values in the CVB Feed Table, the INRA Tables (only as a reference) and the new SIDC values (average of new observation and current CVB Table values) are shown.

Table 3.42.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for the soybean hull observation. The SIDC's of soybean hulls in the CVB Feed Table 2021 is mentioned as a reference. *

Item	**SIDC (%)**																	
	CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Observation	61.8	77.0	69.6	72.5	73.4	68.5	79.0	74.8	70.6	89.5	68.5	58.5	70.6	63.1	78.3	27.4	111.1	68.1	
	SIDC values in the CVB Feed Table 2021																		
SIDC	54	80	53	65	66	56	68	69	62	60	60	54	54	62	53	54	53	54	62
	SIDC values in the INRA Tables																		
SIDC		*84*	*58*	*68*	*70*	*60*	*71*	*72*	*61*	*63*	*61*	*56*	*69*	*63*	*74*	*38*	*59*	*38*	*64*
New SIDC values for future CVB Feed Table																			
Average new	**58**	**79**	**61**	**69**	**70**	**62**	**74**	**72**	**66**	**75**	**64**	**56**	**62**	**63**	**66**	**41**	**65 ****	**61**	**66*******

*: The new SIDC evaluation of CP and AA will be used for all 3 classes of soybean hulls that are published in the CVB Feed Table.

** The average SIDC-PRO value is calculated by taking the average of the SIDC-CP and SIDC-AA values (excluding the SIDC-PRO) for both the observation (=68.9%) and the CVB Feed Table values (=60.3) and to average these two averages ((68.9 + 60.3) / 2 = 65%).

*** The average SIDC-TYR value is calculated by first ‘predicting’ the SIDC-TYR value of the observation by adding the average absolute difference in SIDC values (SIDC-PRO values excluded) of 8.6% in SIDC between the observation and the CVB Feed Table value to the CVB Feed Table value of 62% (=70.6%). Then this value was combined with the CVB Feed Table value of 62% and averaged ((62 + 70.6) / 2 = 66%).

3.43 Soybean expeller

For soybean expeller the same evaluation is applied as for soybean meal, solvent extracted for feed evaluation systems. Also, for the ileal digestibility of CP and AA of soybean expeller in pigs identical values were used as for soybean meal. The reason for this is the lack of studies with soybean expeller. In this project we collected 5 observations where the ileal digestibility of soybean expeller was studied. The average crude protein content was 507 ± 53.0 g/kg DM, with a minimum and maximum value of 465 and 592 g/kg DM, respectively. For the observations with the highest CP content, it is explicitly mentioned that it was an expeller from a high protein source. For all observations crude fat was analyzed; the values ranged from 44 to 95 g/kg DM. In all samples TIA was analyzed, the highest value (for the expeller from the high protein source) was 6.3 TIU/g. It should be mentioned that for 4 out of the 5 observations it is explicitly mentioned that the expellers were (also) extruded.

Table 3.43.1. Amino acid pattern of all observations for soybean expeller, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	4	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	4
Average *	7.4	2.6	4.5	7.6	6.2	1.4	5.0	3.8	1.4	4.9	4.2	11.3	1.5	17.8	4.2	4.9	**4.6**	3.6
STDEV	0.15	0.04	0.17	0.18	0.14	0.03	0.13	0.20	0.06	0.21	0.15	0.22	0.07	0.28	0.12	0.11	0.30	0.22
Min	7.2	2.6	4.3	7.3	5.9	1.3	4.8	3.5	1.3	4.6	3.9	10.9	1.4	17.5	4.1	4.8	4.4	3.4
Max	7.6	2.7	4.7	7.8	6.3	1.4	5.2	4.0	1.4	5.1	4.3	11.5	1.6	18.1	4.4	5.1	5.1	3.9
CVB Feed Table 2021																		
Average	7.5	2.7	4.6	7.7	6.2	1.4	5.2	3.9	1.3	4.8	4.4	11.6	1.5	17.8	4.3	5.1	5.1	3.7
STDEV	0.3	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.4	0.1	0.8	0.2	0.3	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

A comparison between the updated SIDC-CP and SIDC-AA values of soybean expeller with the current CVB Feed Table shows that the new values are on average an absolute 2.2% higher.

A comparison between the new SIDC evaluation of soybean expeller with the new SIDC evaluation of soybean meal, solvent extracted shows the average SIDC of all AA (except PRO) of soybean expeller, shown in Table 3.43.2, is 1.6 %-units lower than new SIDC evaluation for soybean meal (see 3.44.2), ranging from 0.0 for TYR to -7.5% for GLY.

Table 3.43.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for soybean expeller: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of soybean expeller the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	4
Average SIDC	89.5	96.3	91.7	91.2	91.3	91.4	91.7	91.4	87.0	91.1	89.4	88.4	88.7	83.3	89.5	87.8	113.6	90.5	91.5
STDEV **	2.70	1.92	2.51	2.57	2.53	2.22	1.79	3.19	3.91	3.67	2.89	3.72	2.61	4.10	3.07	4.82	16.51	3.39	1.21
Min	85.0	93.0	88.0	87.0	87.0	88.0	89.0	86.0	81.0	85.0	85.0	82.0	86.0	79.0	87.0	80.0	89.0	85.0	90.2
Max	91.5	97.6	94.4	93.4	93.4	93.3	93.8	94.1	91.4	94.9	92.6	90.9	92.3	88.9	94.6	91.6	124.0	94.0	93.1
	After conversion to an integral number																		
SIDC	90	96	92	91	91	91	92	91	87	91	89	88	89	83	90	88	90 ***	91	92
	SIDC values in the CVB Feed Table 2021																		
SIDC	87	93	90	88	87	89	90	89	85	88	87	86	87	83	90	86	92	89	88

*: There were no outliers for the SIDC values.
**: STDEV > 7% are marked red.
***: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.44 Soybean meal, solvent extracted

In total 208 observations for soybean meal, solvent extracted were collected from the scientific literature. From this dataset all experimental treatments (e.g., extra toasting, expanding etc.) or fermentation or enzyme treatment were already excluded. Also, observations with >50 g crude fat/kg DM were removed because it is impossible to discriminate whether these are insufficient extracted meals or expellers.
From these 208 observations the following observations were removed:

a. Observations where TIA level was not analyzed. This step resulted in the removal of 92 observations (remaining dataset 116 observations).
b. TIA is expressed in the publications in three different ways: in mg/g CP (18 observations), in mg/g DM (32 observations) and in TIU/g DM (66 observations. The relationship between the average SIDC of all AA (except PRO) and TIA level for each of these subsets is shown in Figure 44.1. Removal of observations with TIA > 8 mg/g DM resulted in the removal of 4 observations (remaining dataset 112 observations)

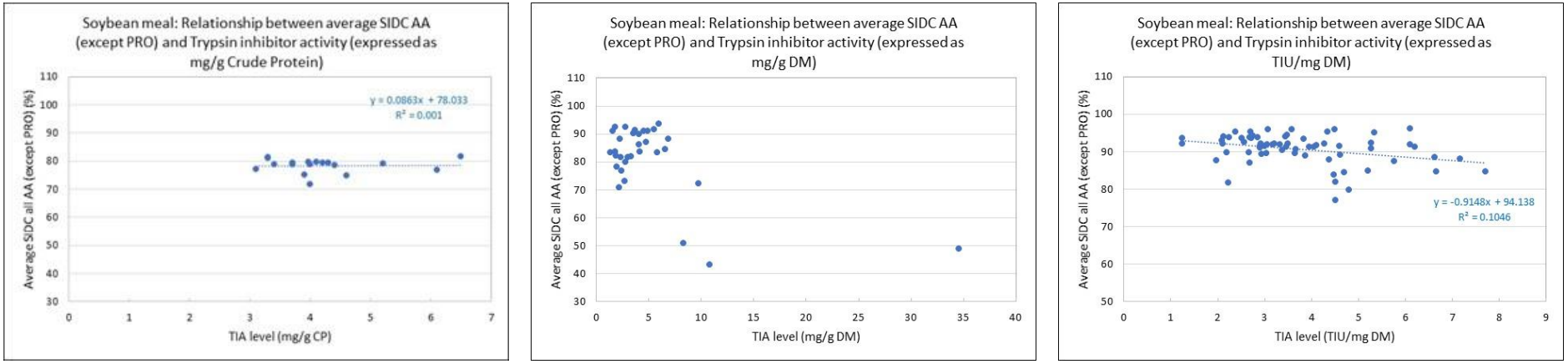


Figure 3.44.1. Soybean meal, solvent extracted: Relationship between average SIDC of all AA (except PRO) and TIA, expressed as mg/g crude protein (left graph), mg/g DM (middle graph) and TIU/g DM (right graph).

c. The third step was an inventory on the potential effect of the moment of studying the ileal digestibility. As a measure for this the year of publication was used. The underlying argumentation for this was that improvement of technology over time might have resulted in an increased ileal digestibility. Figure 44.2 shows that there was no relationship between the average SIDC of all AA (except PRO) and year of publication. So, in this step no observations were removed.
d. The next step was to investigate whether there was an effect of body weight on the average SIDC of all AA (except PRO). The results are shown in Figure 44.3. There was 1 study with piglets (body weight at the start of the experiment 5.6 kg) with 19 observations (6 from Argentina, 6 from Brazil, 7 from USA) where the digestibility's were much lower than the other observations in the dataset (see Figure 44.2). It was decided to remove all observations where the initial body weight <10 kg. Next to the 19 observations of the study mentioned, 10 other observations from different studies were removed (resulting in a remaining dataset with 83 observations). For the observations with an initial body weight >10 kg, there is no relationship between the average SIDC of all AA, except PRO and body weight.

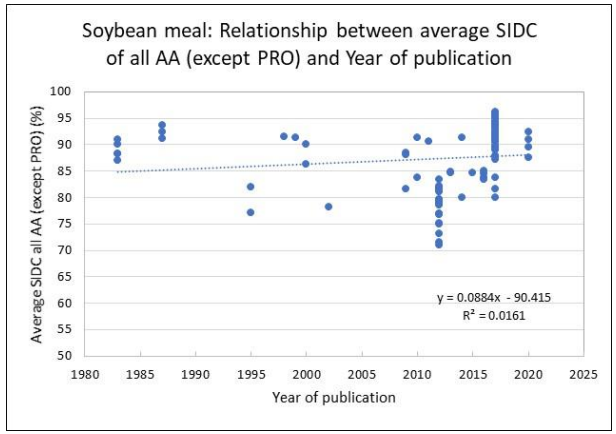
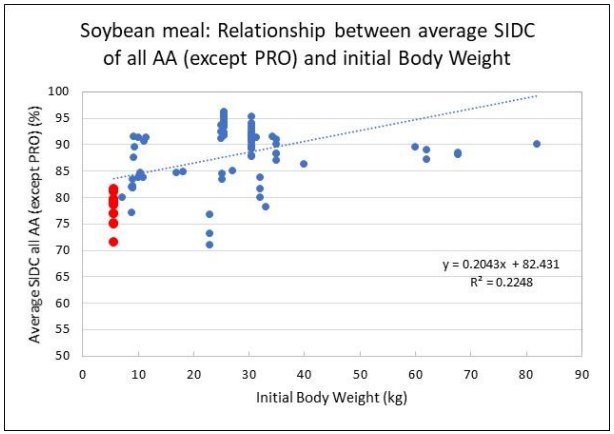


Figure 3.44.2. Soybean meal, solvent extracted: Relationship between the average SIDC of all AA (except PRO) and the year of publication.



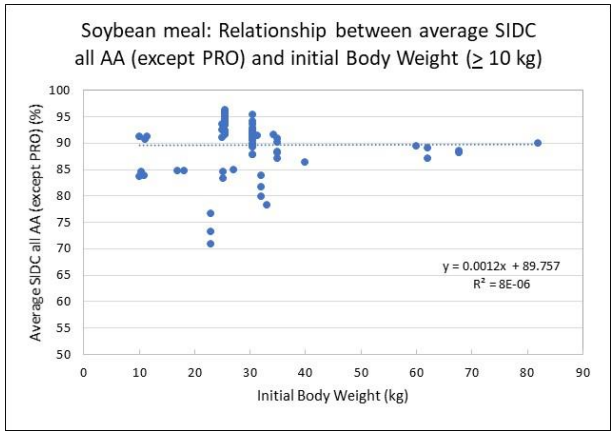
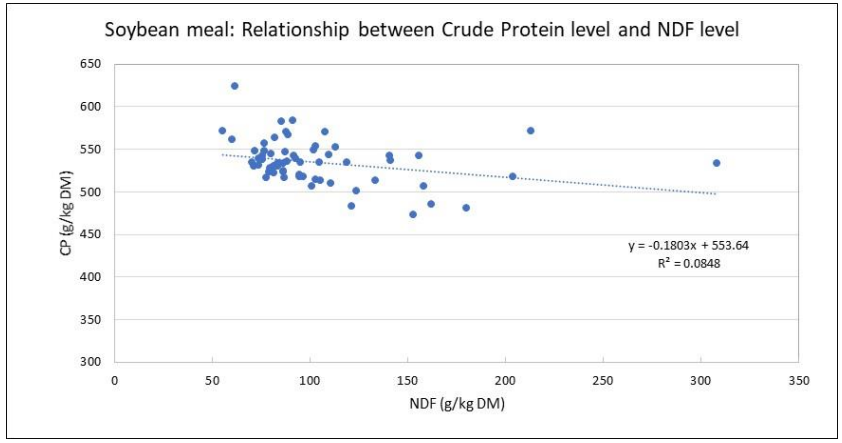


Figure 3.44.3. Relationship between the average SIDC of AA and the initial body weight of the animals at the moment they were placed in the experiment. In the left graph the results for all observations are shown, with in red the results of the study with piglets of 5.6 kg at the start of the experiment. In the right graph the results for observations with an initial body weight ≥ 10 kg.

e. The last step was the investigation of the relation between crude protein and NDF. In the processing of rapeseed meal, it was clearly observed that – most likely due to overheating – the NDF content increases without an accompanying decrease in crude protein level. In Figure 44.4 the relationship between crude protein and NDF for the dataset is shown. It can be seen that at NDF levels higher than approx. 150 g NDF/kg the crude protein content remains rather constant.



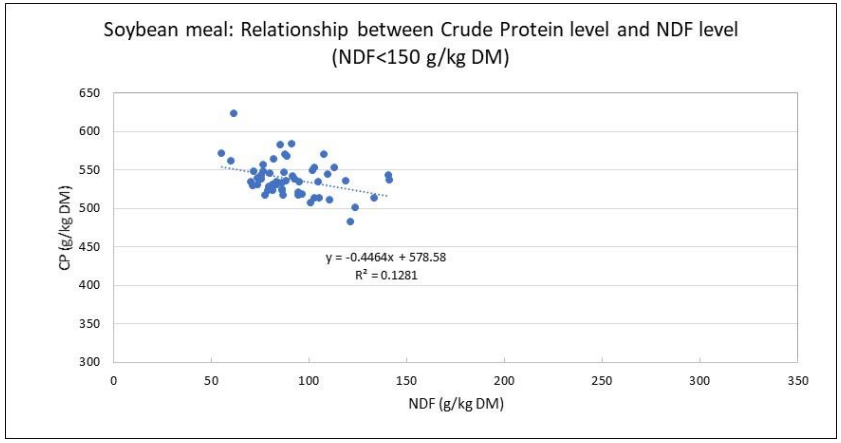


Figure 3.44.4. Soybean meal, solvent extracted: Relationship between CP and NDF. In the left graph all observations with an analyzed NDF are shown; in the right graph observations with NDF >150 g/kg DM are removed.

In Figure 44.5 the relationship between the average SIDC of all AA (except PRO) and NDF is shown. Therefore, it was decided to remove from the dataset 8 observations with a NDF content >150 g/kg DM, resulting in a final dataset with 83 – 8 = 75 observations for further processing.

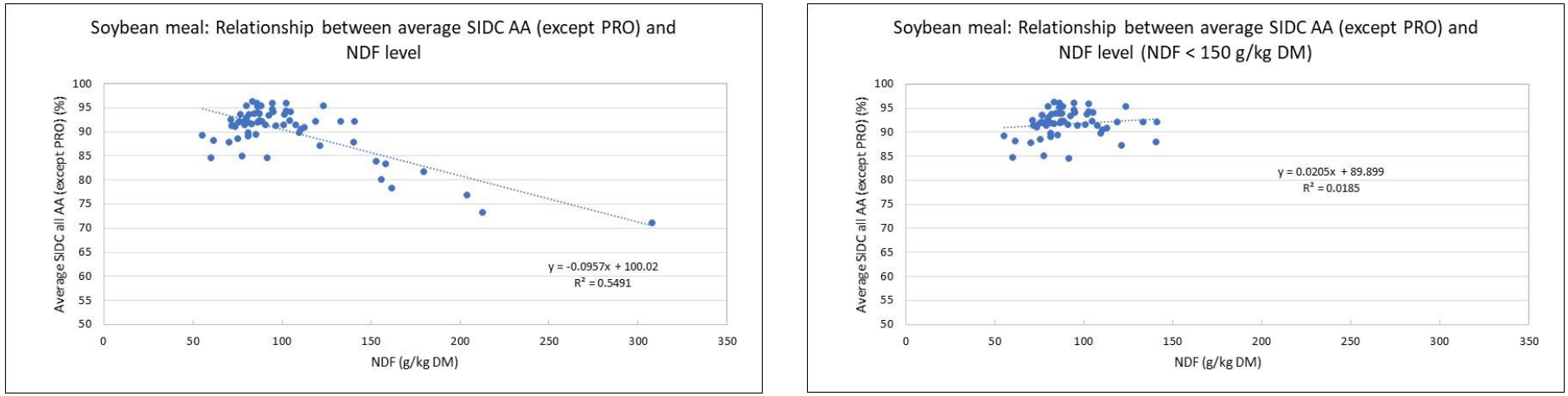


Figure 3.44.5. Soybean meal, solvent extracted: Relationship between average SIDC of all AA (except PRO) and NDF. In the left graph all observations with an analyzed NDF are shown; in the right graph observations with NDF >150 g/kg DM are removed.

The dataset of 75 observations had an average crude protein content of 538 ± 22.8 g/kg DM, with a minimum and maximum value of 483 and 624 g/kg DM, respectively. Most observations were performed with soybean meals with high crude protein content. For the quality in the CVB Feed Table with the highest crude fiber and the lowest crude protein content (crude fiber > 70 g/kg) there were only 3 observations that fell in the range of the CP content ± 2*STDEV of this quality.
It was examined if there were significant correlations between the SIDC's of CP and the individual AA om the one hand and crude protein, NDF and ADF on the one hand. This appeared not to be the case. Therefore, there was no scientific base to relate the SIDC's of CP and AA to CP or a fiber component (crude fiber, NDF or ADF). It implies that the same SIDC's must be proposed for all 5 qualities of soybean meal, solvent extracted in the CVB Feed Table.

Table 3.44.1. Amino acid pattern of the dataset with 75 observations for soybean meal, solvent extracted, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	68	68	65	67	69	69	67	68	63	64	65	68	69	68	68	68	67	67
Average *	7.2	2.7	4.6	7.6	6.3	1.4	5.0	3.7	1.4	4.8	4.2	11.0	1.3	17.2	4.1	4.8	**4.5**	3.6
STDEV	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.3	0.2	0.5	0.1	0.8	0.2	0.2	0.2	0.1
Min	6.8	2.4	4.1	7.1	5.8	1.3	4.6	3.4	1.1	4.0	3.7	10.2	1.2	15.3	3.4	4.5	4.1	3.4
Max	7.6	2.9	5.1	8.1	6.7	1.5	5.3	4.2	1.5	5.2	4.6	12.4	1.6	19.1	4.4	5.3	5.0	3.8
CVB Feed Table 2021																		
Average	7.5	2.7	4.6	7.7	6.2	1.4	5.2	3.9	1.3	4.8	4.4	11.6	1.5	17.8	4.3	5.1	5.1	3.7
STDEV	0.3	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.4	0.1	0.8	0.2	0.3	0.2	0.3

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.44.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for soybean meal, solvent extracted, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of soybean meal, solvent extracted, CF 45-70 g/kg (CP < or > 450 g/kg) in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	61	65	65	63	64	65	64	65	65	60	64	65	65	58	64	65	36	64	63
Average SIDC	92.4	96.5	92.9	91.8	91.4	91.5	93.2	92.0	89.3	93.4	90.4	90.8	89.9	86.5	91.3	95.3	126.9	93.2	91.5
STDEV*	2.78	1.70	2.04	2.42	2.38	2.05	2.43	2.06	2.93	2.50	3.01	2.81	2.26	3.84	2.21	5.02	11.40	2.56	2.26
Min	86.9	92.6	88.1	84.3	83.7	86.7	86.5	85.4	82.7	86.6	82.8	84.1	84.4	78.7	85.7	84.5	93.8	86.7	85.1
Max	97.4	99.6	96.2	95.6	95.2	95.4	96.6	95.4	95.2	97.1	95.3	95.4	94.5	94.0	95.4	104.4	142.1	97.8	95.2
	After conversion to an integral number																		
SIDC	92	97	93	92	91	92	93	92	89	93	90	91	90	87	91	95	92**	93	92
	Soybean meal, solvent extracted crude fiber < 45 g/kg, Crude Protein > 485 g/kg																		
SIDC	88	94	91	89	88	90	91	90	86	89	88	87	88	84	91	87	93	90	89

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.45 Sugar beet pulp, dried

The SIDC evaluation of sugar beet pulp, dried is based on an initial dataset with 2 observations, in which the crude protein content was 94 and 113 g/kg DM for observation 1 and 2, respectively. As can be seen below, for the second observation both the AA composition and the SIDC's of the AA is rather incomplete.

Table 3.45.1. Amino acid pattern of the two observations for sugar beet pulp, dried in g/16g N. In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation 1	3.6	2.6	3.4	6.4	5.3	0.8	4.2	4.0	0.9	5.6	6.0	7.4	0.8	11.1	4.0	5.4	4.4	4.2
Observation 2	3.2	2.4	3.6	5.3	6.3	1.2	2.8	3.8		4.8			1.0					
CVB Feed Table 2021																		
Average	4.0	2.8	3.4	5.5	4.9	1.4	3.4	4.4	0.9	5.3	4.6	10.1	1.2	9.8	3.9	4.0	4.5	4.5
STDEV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3.45.2. Standardized ileal digestibility (SIDC; %) of crude protein and amino acids for two observations of sugar beet pulp, dried. The SIDC's of sugar beet pulp, dried in the CVB Feed Table 2021 are shown as a reference. In the last line the proposal for the future SIDC values for sugar beet pulp, dried are presented. *

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation 1	50.0	69.3	57.3	50.2	52.5	37.0	51.6	60.0	40.7	46.2	48.9	43.3	53.9	53.8	60.6	46.5	54.1	47.7	64.0
Observation 2		54.0	52.0	53.0	51.0	56.0	61.0	46.0	30.0		43.0			-21.0					
	SIDC values in the CVB Feed Table 2021																		
SIDC	46	53	52	51	52	55	59	46	28	50	42	47	25	46	58	45	45	34	52
	Proposed SIDC values for sugar beet pulp, dried in future CVB Feed Table																		
SIDC **	**48**	**59**	**54**	**51**	**52**	**49**	**57**	**51**	**33**	**48**	**45**	**45**	**39**	**50*****	**59**	**46**	**50**	**41**	**58**

*: When the proposed SIDC differs ≥3 %-units from the current value, the value is printed in green (if higher) or in red (if lower).

**: The proposed SIDC's are the average values of the observations 1 and 2 and the current SIDC evaluation in the CVB Table.

***: Because of the negative SIDC-CYS value for observation 2 the average SIDC value for CYS was calculated with on observation 1 and the CVB Table value.

This SIDC evaluation will be used for the four classes of sugar beet pulp, dried as well as for sugar beet pulp, pressed, ensiled.

3.46 Sunflower seed meal, solvent extracted, sunflower seed expeller and (full fat) sunflower seed

The SIDC evaluation of sunflower seed meal, sunflower seed expeller and sunflower seed, full fat is based on an initial dataset with:

- 29 observations for sunflower seed meal, in which the average crude protein content was 366 ± 43.4 g/kg DM, with a minimum and maximum value of 293 and 460 g/kg DM, respectively.
- 3 observations for sunflower seed expeller, in which the average crude protein content was 331 ± 42.0 g/kg DM, with a minimum and maximum value of 305 and 380 g/kg DM, respectively
- 1 observation for sunflower seed, full fat with a crude protein content was 231 g/kg DM.

Table 3.46.1. Amino acid pattern of all observations for sunflower meal, sunflower expeller and sunflower seed, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	**Amino acid pattern (g/16g N)**																	
	ARG	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
N	32	32	33	32	32	28	32	32	24	31	31	29	28	30	29	31	31	26
Average *	7.7	2.5	4.1	6.2	3.9	2.2	4.4	3.6	1.1	5.1	4.4	8.8	1.7	19.1	5.7	3.9	3.9	2.3
STDEV	0.40	0.21	0.19	0.20	0.46	0.11	0.24	0.17	0.03	0.20	0.34	0.29	0.10	1.22	0.26	0.31	0.47	0.21
Min	7.1	2.2	3.8	5.9	3.1	2.0	3.8	3.2	1.0	4.6	4.0	8.2	1.5	16.3	5.1	3.4	3.0	1.9
Max	8.7	3.0	4.5	6.6	4.7	2.5	4.8	3.8	1.2	5.4	5.1	9.2	1.8	21.3	6.1	4.5	4.6	2.8
CVB Feed Table 2021																		
Average	8.1	2.5	4.1	6.3	3.5	2.2	4.6	3.7	1.2	4.9	4.3	9.2	1.7	19.3	5.7	4.3	4.3	2.5
STDEV	0.5	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.4	0.1	0.9	0.3	0.3	0.2	0.2

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.46.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for sunflower meal, sunflower expeller and sunflower seed, full fat, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of sunflower meal, sunflower expeller and sunflower seed in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	31	29	31	31	31	31	28	31	31	27	30	27	29	28	29	28	17	29	25
Average SIDC	77.9	90.7	81.6	80.4	80.1	78.0	88.0	82.9	77.1	82.5	79.2	77.0	78.0	73.5	86.2	67.0	85.0	75.9	82.9
STDEV*	5.17	2.36	3.59	4.55	4.82	4.71	2.68	4.56	4.35	6.03	4.77	4.36	4.46	6.24	3.10	7.97	20.52	5.26	6.48
Min	67.3	86.5	74.3	71.6	70.8	66.7	83.0	72.9	67.9	71.0	70.0	69.8	70.4	63.4	81.3	51.9	46.0	65.1	72.8
Max	86.7	94.6	87.5	87.6	88.2	84.2	92.8	89.9	84.6	91.1	87.2	85.1	85.4	84.8	91.6	77.7	127.5	83.3	93.9
	After conversion to an integral number																		
SIDC	78	91	82	80	80	78	88	83	77	83	79	77	78	74	86	67	80**	76	83
	SIDC values in the CVB Feed Table 2021																		
SIDC	80	92	82	83	81	79	88	82	80	83	81	78	81	77	88	73	86	82	83

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

For the SIDC of PRO the average SIDC of the other 17 AA is used.
This new evaluation will be used for:

- Sunflower seed meal, solvent extracted, dehulled and partly dehulled
- Sunflower seed expeller, dehulled and partly dehulled
- Sunflower seed, dehulled and partly dehulled.

3.47 Tapioca, dried

The current SIDC evaluation in the CVB Feed Table (2021) is based on an expert judgement, because in the ILOB-0TNO report (1996), on which the current table on the ileal digestibility of CP and AA is based, no observations are mentioned for tapioca. This is logic, as the feedstuff is of marginal importance as protein source in rations for pigs. In this project one observation was collected from the scientific literature.

Table 3.47.1. Amino acid pattern of tapioca (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Content *	**9.2**	1.9	3.1	4.6	3.8	1.1	2.7	3.4	1.5	3.8	4.6	7.3	1.5	17.2	3.4	3.4	3.4	
CVB Feed Table 2021																		
Average	4.9	2.4	3.1	5.4	3.7	1.3	3.4	3.3	1.1	4.1	5.2	7.6	1.2	13.9	3.7	3.9	3.6	2.1
STDEV	0.9	0.7	0.3	0.6	0.4	0.2	0.7	0.3	0.2	0.3	0.7	0.7	0.3	1.9	0.6	0.7	0.4	0.4

*: When the AA content of the single observation deviates more than 2*STDEV from the CVB average the value is depicted in red and bold.

The current SIDC evaluation in the CVB Feed Table is based on the ILOB-TNO report (1966). In this report 3 observations are mentioned. In this project we could not trace back these observations. In Table 3.47.2 it is shown that the new evaluation in the average of the new observation and the current evaluation in the CVB Feed Table.

Table 3.47.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for wheat gluten meal. The table shows the SIDC's of the new observation, the SIDC's in the CVB Feed Table 2021, and the average of these two (which will be the new evaluation in the future CVB Feed Table).

SIDC (%)																		
CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
New observation																		
30	72	29	41	44	44	53	17	46	41	42	45	40	27	57	25	41	36	41
Evaluation in current CVB Feed Table (2021)																		
54	54	53	54	54	54	55	53	53	55	54	54	53	55	52	53	51	52	53
Average of new observation and current evaluation in CVB Feed Table (2021)																		
42	63	41	48	49	49	54	35	50	48	48	50	47	41	54	44	46	44	46

Because of the very low protein content of tapioca, it is very difficult to reliable estimate SIDC values, and this may explain the wide variation in observed SIDC-AA values ranging from 72% for ARG to 17% for CYS. The average SIDC-CP and SIDC-AA for the observation in the present dataset is 40.5% whereas the average SIDC-CP and SIDC-AA value in the CVB Feed Table 2021 is 53.6%.
It is proposed to take the average SIDC of CP and all AA of these two averages, which is 47% and to use this value for CP and all amino acids for all starch qualities of tapioca. Furthermore, it is proposed to also use the value of 47% for sweet potatoes in the CVB Feed Table.

3.48 Triticale

The SIDC evaluation of triticale is based on an initial dataset with 26 observations, in which the average crude protein content was 132 ± 19.0 g/kg DM, with a minimum and maximum value of 102 and 183 g/kg DM, respectively.

Table 3.48.1. Amino acid pattern of all observations for triticale, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	24	24	24	22	24	24	23	23	19	23	14	16	15	16	16	14	16	8
Average *	5.0	2.3	3.2	**6.2**	3.1	1.6	4.3	3.0	1.1	4.2	3.7	5.9	2.2	26.2	4.1	10.0	4.5	2.9
STDEV	0.3	0.2	0.2	0.2	0.2	0.1	0.5	0.2	0.1	0.3	0.3	0.4	0.4	2.7	0.4	1.5	0.3	0.4
Min	4.2	2.0	2.7	5.5	2.8	1.3	2.7	2.7	0.9	3.7	3.3	5.0	0.9	22.9	3.3	6.8	3.8	2.5
Max	6.0	2.7	3.5	6.6	3.8	1.7	4.9	3.3	1.1	4.9	4.2	6.5	3.1	34.4	5.0	11.4	4.8	3.8
CVB Feed Table 2021																		
Average	5.0	2.3	3.4	6.5	3.3	1.7	4.5	3.1	1.1	4.6	4	6.1	2.3	25.3	4.2	9.4	4.5	2.8
STDEV	0.3	0.1	0.1	0.1	0.3	0.1	0.3	0.2	0.1	0.3	0.2	0.4	0.1	1.8	0.2	0.7	0.2	0.2

*: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.48.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for triticale, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of triticale in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	20	21	20	21	21	21	21	20	21	18	21	13	13	12	12	13	11	13	4
Average SIDC	83.5	85.4	84.4	83.4	84.2	75.5	84.2	83.3	76.7	79.0	82.2	79.2	79.8	86.5	93.3	82.4	109.9	85.7	83.2
STDEV *	1.8	2.5	2.3	2.7	2.6	5.4	2.8	3.9	3.6	2.9	2.9	4.3	2.6	1.2	0.9	8.0	9.6	2.8	3.8
Min	80.4	82.2	81.6	79.0	79.9	68.7	80.2	77.3	72.4	75.2	78.7	74.0	78.0	85.0	92.0	71.0	103.0	82.0	78.2
Max	87.9	91.7	90.7	91.0	91.1	89.9	89.7	91.8	86.4	83.0	90.7	88.7	86.5	88.1	95.1	99.4	128.3	90.7	86.4
	After conversion to an integral number																		
SIDC	84	85	84	83	84	76	84	83	77	79	82	79	80	87	93	82	83 **	86	83
	SIDC values in the CVB Feed Table 2021																		
SIDC	85	87	86	88	87	83	89	87	78	80	88	83	83	90	93	81	93	88	86

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.49 Wheat

The SIDC evaluation of wheat is based on a dataset with 61 observations, in which the average crude protein content was 147.7 ± 43.1 g/kg DM, with a minimum and maximum value of 118 and 208 g/kg DM, respectively.

Table 3.49.1. Amino acid pattern of the dataset of wheat, after removal of the outliers: number of observations, average value (g/16g N) and STDEV, minimum and maximum values. The amino acid pattern in the CVB Feed Table 2021 is mentioned as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	60.0	57.0	61.0	60.0	59.0	54.0	59.0	61.0	39.0	60.0	55.0	55.0	42.0	55.0	55.0	51.0	54.0	45.0
Average *	4.6	2.4	3.4	6.7	2.9	1.5	4.6	2.8	1.1	4.3	3.7	5.0	2.3	28.8	4.1	10.7	4.4	2.2
STDEV	0.4	0.4	0.3	0.4	0.3	0.1	0.5	0.2	0.1	0.4	0.4	0.3	0.4	3.1	0.3	1.7	0.5	0.8
CVB Feed Table 2021																		
Average	4.7	2.3	3.4	6.6	2.8	1.6	4.5	2.9	1.2	4.3	3.7	5.3	2.2	28.3	4.0	9.7	4.6	2.8
STDEV	0.3	0.2	0.2	0.2	0.2	0.1	0.3	0.2	0.1	0.3	0.3	0.4	0.2	2.5	0.2	0.8	0.2	0.3

*: When there are averages deviating more than 2*STDEV from the average value in the current CVB Feed Table they are marked red.

Table 3.49.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids in wheat, after removal of the outliers: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of wheat in the CVB Feed Table 2021 is mentioned as a reference.

Item	SIDC (%)																	
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	50	56	52	56	57	57	51	53	57	34	57	53	54	37	50	53	47	51	40
Average SIDC	90.1	91.1	90.1	89.6	89.9	82.2	89.4	91.0	85.0	86.7	87.7	84.0	83.8	89.6	95.7	90.0	103.3	91.1	91.7
STDEV *	4.4	4.4	3.9	4.2	3.8	7.8	3.5	4.1	5.7	5.3	4.3	6.3	5.8	2.8	1.7	7.8	10.4	3.3	5.4
Min	83.0	83.0	83.5	79.4	79.6	69.0	84.0	82.3	70.2	74.0	78.1	71.3	73.4	84.7	91.7	75.1	71.7	82.9	79.6
Max	98.6	99.9	98.3	96.7	97.0	95.7	97.8	97.9	98.2	94.6	96.8	93.9	93.2	95.1	98.4	106.3	129.7	98.0	100.1
	After conversion to an integral number																		
SIDC	90	91	90	90	90	82	89	91	85	87	88	84	84	90	96	90	89 **	91	92
	SIDC values in the CVB Feed Table 2021																		
SIDC	89	90	90	90	90	84	90	90	86	88	88	83	83	90	96	87	96	92	91

*: STDEV > 7% are marked red. **: For the SIDC of PRO the average SIDC of the other 17 AA is used.

The new SIDC evaluation of CP and AA for wheat will be used also for wheat, heat-treated.

3.50 Wheat germs

The SIDC evaluation of wheat germs is based on only two observations with a crude protein content of 366 and 266 g/kg DM.

Table 3.50.1. Amino acid pattern of the single new observation for wheat germs. In the last line the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Observation 1 *	9.1	2.3	3.3	5.9	6.2	1.7	3.5	3.9		4.8	5.4	8.4	1.4	11.4	5.5	3.9	3.7	2.5
Observation 2 *	7.0	1.8	2.9	5.4	5.0	0.5	3.2	3.3	1.0	4.4			1.6					2.6
CVB Feed Table 2021	7.3	2.3	3.3	6.0	6.0	1.7	3.4	3.5	1.1	4.9	5.6	7.8	1.4	14.2	5.4	4.4	3.9	2.7

*: Observation 1 had a crude protein content of 366 g/kg DM; observation 2 266 g/kg DM.

It is proposed to base then new SIDC values in the CVB Feed Table on the average of Observation 1, Observation 2 and the values in the current CVB Feed Table. This is further elaborated in Table 3.50.2.

Table 3.50.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for wheat germs.

Item	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
	SIDC (%-units)																		
Observation 1	85.0	98.0	95.0	95.0	94.0	95.0	96.0	94.0	91.0		94.0	94.0	94.0	88.0	95.0	92.0		91.0	87.0
Observation 2	80.5	91.1	85.4	83.0	84.1	86.3	87.7	84.8	76.5	80.4	81.3			76.3					86.3
CVB Feed Table 2021	85	87	87	87	86	80	86	87	83	84	85	80	80	86	93	84	93	89	88
Average Observation 1, Observation 2 and current CVB Feed Table	83.5	92.0	89.1	88.3	88.0	87.1	89.9	88.6	83.5	82.2	86.8	87.0	87.0	83.4	94.0	88.0	87.8	90.0	87.1
After conversion to an integer																			
New values CVB Feed Table	84	91	89	88	88	85	89	88	83	82	86	87	87	84	94	88	88*	90	87

*: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.51 Wheat gluten meal

Four observations for wheat gluten were collected from the literature, 2 with non-hydrolyzed gluten meal and 2 with hydrolyzed gluten meal. As the hydrolyzed meals were considered as different products, they were removed from the dataset. Of the two remaining observations 1 was tested in young piglets, showing much lower SIDC's than the third observation studied in pigs between 22-60 kg. The difference in the average SIDC of all AA (except PRO) between these two observations was 8 %-units. It was decided to base the new SIDC evaluation of wheat gluten meal on the single observation op pigs in the weight range 22-60 kg.

Table 3.51.1. Amino acid pattern of wheat gluten meal (g/16g N) of the single observation. In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Content *	3.4	**1.8**	3.2	**6.4**	2.1	**1.9**	5.2	2.3		4.3	2.4	3.0	**1.5**	37.7	3.2		4.7	3.8
CVB Feed Table 2021																		
Average	3.6	2.1	3.7	7.0	1.7	1.6	5.3	2.5	0.9	4.0	2.7	3.4	2.2	34.3	3.4	12.6	4.8	3.4
STDEV	0.2	0.1	0.3	0.2	0.2	0.1	0.3	0.1	-	0.2	0.2	0.2	0.1	4.0	0.1	0.7	0.2	0.2

*: When the AA content of the single observation deviates more than 2*STDEV from the CVB average the value is are depicted in red and bold.

The current SIDC evaluation in the CVB Feed Table is based on the ILOB-TNO report (1966). In this report 3 observations are mentioned. In this project we could not trace back these observations. In Table 3.51.2 the SIDC-CP and SIDC-AA values of the new observations and the current CVB Feed Table values are shown. Also, the new SIDC values to be published in the future CVB Feed Table are shown.

Table 3.51.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for wheat gluten meal. The table shows the SIDC's of the new observation, the SIDC's in the CVB Feed Table 2021, and the average of these two (which will be the new evaluation in the future CVB Feed Table).

SIDC (%)																		
CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
New observation																		
96	95	96	93	96	91	96	96	91	94	90	92	99	93	98	94	*94**	96	93
Current evaluation in CVB Feed Table (2021)																		
100	100	100	100	99	99	99	98	99	99	100	99	99	99	100	100	100	100	99
SIDC values in future CVB Feed Table																		
98	98	98	96	98	95	98	97	95	96	95	96	99	96	99	97	97*	98	96

*: For the SIDC of PRO the average SIDC of the other 17 AA is used.

3.52 Wheat milling by-products

This SIDC evaluation for wheat by-products from the dry milling is based on a dataset with 34 observations, in which the average crude protein content was 178.6 ± 22.9 g/kg DM, with a minimum and maximum value of 88 and 210 g/kg DM, respectively.

Table 3.52.1. Amino acid pattern of all observations for wheat by-products from the dry milling, after removal of outliers for the AA pattern: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference.

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	31	31	31	31	31	28	32	32	27	31	20	21	26	21	21	17	21	31
Average *	6.4	2.5	3.1	6.0	3.9	1.5	3.9	3.1	**1.0**	4.4	4.4	6.6	**1.7**	18.8	4.9	5.8	3.8	6.4
STDEV	0.62	0.21	0.13	0.25	0.34	0.26	0.26	0.18	0.19	0.23	0.30	0.50	0.19	2.64	0.38	0.67	0.48	0.62
Min	4.9	2.1	2.9	5.5	3.1	0.7	3.2	2.6	0.8	3.7	3.7	5.2	1.6	16.2	4.0	5.0	3.2	4.9
Max	7.9	3.0	3.4	6.6	4.4	2.2	4.5	3.5	1.4	4.9	4.9	7.8	2.3	27.0	5.5	7.2	4.5	7.9
CVB Feed Table 2021																		
Average	6.7	2.7	3.2	6.2	4.0	1.6	4.0	3.3	1.4	4.7	4.7	7.1	2.1	19.4	5.1	6.5	4.4	2.9
STDEV	0.5	0.2	0.2	0.3	0.3	0.1	0.3	0.2	0.1	0.3	0.4	0.5	0.1	2.2	0.4	0.8	0.3	0.3

*: Averages deviating more than 2*STDEV from the CVB average are depicted in red and bold.

Based on samples in the CVB Database in which both crude Fiber and NDF was analyzed a good relationship between these two parameters could be developed, enabling the calculation of crude fiber for observations where only NDF was analyzed and vice versa.
Further it was observed that there are significant correlations between SIDC of CP and AA and NDF as well as crude fiber. In the Table 3.52.2 a correlation matrix is presented, showing the number of observations, correlation coefficients and the significance of the correlation.
Also, the number of observations and the significance of the correlation is shown.

Table 3.52.2. Correlation matrix for wheat by-products from the dry milling showing the correlation of the standardized ileal digestible CP and Amino Acid contents (%) to NDF and crude fiber (g/kg DM): number of observations, correlation coefficient (r) and significance (p).

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
NDF																			
Number	32	31	31	31	31	32	32	31	32	30	31	21	21	29	21	10	4	21	31
Corr. Coeff. (r)	-0.754	-0.585	-0.684	-0.778	-0.874	-0.584	-0.790	-0.764	-0.783	-0.694	-0.692	-0.601	-0.756	-0.611	-0.701	-0.839	0.340	-0.657	-0.785
Significance (p)	<.0001	0.001	<.0001	<.0001	<.0001	0.001	<.0001	<.0001	<.0001	<.0001	<.0001	0.004	<.0001	0.000	0.000	0.002	0.660	0.001	<.0001
RC																			
Number	32	31	31	31	31	32	32	31	32	30	31	21	21	29	21	10	4	21	31
Corr. Coeff. (r)	-0.811	-0.663	-0.745	-0.835	-0.911	-0.647	-0.840	-0.822	-0.829	-0.719	-0.750	-0.697	-0.823	-0.622	-0.787	-0.892	0.273	-0.730	-0.827
Significance (p)	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.000	<.0001	0.000	<.0001	0.001	0.727	0.000	<.0001

Based on the results in Table 3.52.2 prediction equations it was decided to develop prediction equations by performing regression analysis with the model: (Standardized ileal digestible level of CP or AA; %) = a*crude fiber + c (results not shown).

These regression equations were used to calculate the SIDC values of amino acids of wheat milling by-products in the CVB Feed Table 2021. These regression formulas are valid in the crude fiber range 15 – 113 g/kg DM. For observations with higher crude fiber levels the regression formula should be used with a maximum crude fiber value of 113. In Table 3.52.4 the calculated SIDC's are presented including the present SIDC values. For PRO it is proposed to calculate this value as the average of the other 17 SIDC-AA values. In the CVB Feed Table the following wheat milling by-products are defined:

- Wheat flour: crude fiber 13 g/kg DM,
- Wheat feed flour: crude fiber 51 g/kg DM
- Wheat feed meal: crude fiber 83 g/kg DM
- Wheat middling's: crude fiber 101 g/kg DM
- Wheat bran CF < 125 g/kg: crude fiber 125 g/kg DM
- Wheat bran CF > 125 g/kg: crude fiber 144 g/kg DM

CF (g/kg DM)	Future SIDC values (in %-units)																		
	CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
13 *	91.9	95.2	94.7	93.1	93.6	91.7	95.1	95.2	88.8	91.9	91.4	88.6	89.1	91.0	97.8	93.5	92.9	95.4	93.6
51	79.6	89.7	87.3	82.8	84.4	77.3	85.8	85.9	76.6	82.7	80.8	74.5	79.8	82.3	90.9	84.3	83.3	85.9	84.3
83	68.7	84.9	80.8	73.7	76.3	64.4	77.6	77.5	65.7	74.5	71.4	62.1	71.5	74.6	84.7	76.2	74.7	77.5	75.9
101	62.6	82.2	77.1	68.6	71.7	57.2	72.9	72.9	59.6	69.9	66.1	55.0	66.9	70.3	81.3	71.6	69.8	72.8	71.3
125–144**	58.5	80.4	74.7	65.2	68.7	52.3	69.8	69.7	55.5	66.9	62.5	50.4	63.8	67.4	79.0	68.6	66.6	69.7	68.1
	After conversion to an integral number																		
13*	92	95	95	93	94	92	95	95	89	92	91	89	89	91	98	93	93	95	94
51	80	90	87	83	84	77	86	86	77	83	81	75	80	82	91	84	83	86	84
83	69	85	81	74	76	64	78	78	66	75	71	62	72	75	85	76	75	78	76
101	63	82	77	69	72	57	73	73	60	70	66	55	67	70	81	72	70	73	71
125–144**	59	80	75	65	69	52	70	70	56	67	63	50	64	67	79	69	70	70	68
	SIDC values in the CVB Feed Table 2021																		
13	91	93	92	93	92	89	92	91	89	90	91	89	89	89	96	90	94	94	94
51	85	91	89	87	87	84	87	85	82	86	86	82	84	84	93	84	92	89	88
83	78	89	84	79	80	77	82	77	73	81	78	74	77	78	89	77	89	82	81
101	77	91	84	79	80	78	82	84	73	81	81	77	79	76	90	75	89	83	83
125	68	87	79	67	70	68	73	60	60	75	65	58	66	72	83	67	86	72	68
144	68	87	79	67	70	68	73	60	60	75	65	58	66	72	83	67	86	72	68

*: Calculated with a CF level of 15 g/kg DM

**: Calculated with a CF level of 113 g/kg DM.

3.53 Whey powder and whey powder, low lactose

The SIDC evaluation of whey powder and whey powder, low lactose could not be based on observations for these products, because no observations were found in the literature. The evaluation is based on an initial dataset with 4 observations for whey protein concentrate (average crude protein content was 714 ± 210.8 g/kg DM, with a minimum and maximum value of 385 and 847 g/kg DM, respectively) and 1 observation for whey protein isolate (CP = 914 g/kg DM). The underlying assumption for this decision is that processing of products generally decrease the protein digestibility rather than increasing it.

Table 3.53.1. Amino acid pattern of all observations for whey protein concentrate and isolate: number of observations, average content and STDEV, lowest and highest value reported (g/16g N). In the last two lines the pattern from the CVB Feed Table 2021 is given as a reference. *

Item	Amino acid pattern (g/16g N)																	
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3
Average **	2.7	2.0	**6.4**	**11.2**	**9.7**	**2.2**	3.6	**7.1**	2.0	**6.1**	**5.2**	**11.1**	**2.4**	**17.8**	2.0	6.1	4.9	**3.1**
STDEV	0.44	0.13	0.43	0.50	0.43	0.13	0.27	0.54	0.14	0.12	0.27	0.65	0.12	0.61	0.15	0.19	0.78	0.16
Min	2.3	1.8	5.8	10.7	9.2	2.0	3.3	6.2	1.8	6.0	4.8	10.2	2.3	17.2	1.8	5.8	3.7	3.0
Max	3.3	2.2	7.0	11.9	10.1	2.3	3.9	7.7	2.1	6.2	5.4	12.0	2.5	18.7	2.2	6.3	5.8	3.3
CVB Feed Table 2021																		
Average	2.4	1.8	5.1	8.9	7.5	1.5	3.3	5.4	1.4	4.9	4.3	9.1	1.9	15.5	2.0	5.5	4.4	2.4
STDEV	0.3	0.2	0.4	0.4	0.5	0.2	0.4	0.8	0.4	0.3	0.2	0.5	0.2	0.6	0.2	0.5	0.3	0.3

*: In this small dataset no values were identified as outlier (values deviating more than 2*STDEV from the average value).

**: When averages deviate more than 2*STDEV from the CVB average they are depicted in red and bold.

Table 3.51.1 shows that for quite many amino acids the average AA content per 100 g protein (which is identical to 9/16gN) deviates more than 2*STDEV from the pattern in the CVB Feed Table. There are two aspects which may be the reason for this. First, in small datasets the standard deviation often is relatively large, having as a result that individual values less frequent are identified as an outlier. Secondly, it may be that the protein composition – and therefore the amino acids composition of whey protein concentrate and isolates is not identical to that of whey (powder).

Table 3.53.2. New values for the standardized ileal digestibility (SIDC; %) of crude protein and amino acids for whey protein concentrate and isolate: number of observations, average SIDC and STDEV, minimum and maximum values. The SIDC's of whey protein concentrate and isolate in the CVB Feed Table 2021 is mentioned as a reference. *

Item	SIDC (%)																		
	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	5	3
Average SIDC	90.5	98.1	94.6	96.3	97.0	95.7	96.6	91.6	89.3	97.2	94.3	94.1	95.4	91.8	94.6	97.4	88.0	91.2	93.7
STDEV **	4.95	4.53	4.53	1.97	1.82	2.28	1.71	5.55	3.67	5.02	2.49	3.31	2.86	5.33	2.94	17.1	4.34	2.97	6.81
Min	87.0	93.0	89.0	94.0	95.0	92.0	93.9	84.0	84.0	89.0	91.0	90.0	92.0	84.8	91.0	76.0	83.0	87.0	86.0
Max	94.0	104.0	100.0	98.0	99.0	98.0	98.0	98.0	94.0	102.2	97.0	98.0	99.0	98.0	98.0	117.0	91.0	95.0	99.0
	After conversion to an integral number																		
SIDC	91	98	95	96	97	96	97	92	89	97	94	94	95	92	95	97	95***	91	94
	SIDC values in the CVB Feed Table 2021																		
	Whey powder, low lactose, ASH<210 g/kg																		
SIDC	92	92	92	92	92	94	94	92	93	92	92	92	92	94	92	92	92	92	92
	Whey powder, low lactose, ASH>210 g/kg																		
SIDC	92	92	92	92	92	93	93	92	93	91	92	92	92	94	92	92	92	92	92
	Whey powder																		
SIDC	90	90	90	90	90	92	92	90	90	88	90	90	90	92	90	89	90	90	90

*: In this small dataset no values were identified as outlier (values deviating more than 2*STDEV from the average value).
**: STDEV > 7% are marked red.
*: For the SIDC of PRO the average SIDC of the other 17 AA is used.

In the current CVB Feed Table (2021) the SIDC evaluation of whey powder is on average 2%-units lower than that of whey powder, low lactose. As per product for most AA identical SIDC's are used, it is evident that the current evaluation is based on an 'educated guess'. Why it was decided to use different SIDC values for whey powder and whey powder, low lactose is not clear. Therefore, it is decided to use the new values – based on observations for whey protein concentrate and isolate – for both whey powder and whey powder, low lactose.

4. References

Below all publications are mentioned from which one or more (sometimes >20) observations have been included in one of the five initial databases. When performing the outlier procedure sometimes a complete observation was removed from the dataset of an individual feedstuff. If from a publication only one or very few observations were inserted in one of the databases, it cannot be excluded that in the final datasets no observation of one of the references cited is included.

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ANNEX I: Basal endogenous losses of crude protein and amino acids at the terminal ileum of pigs

In this Annex the data for the Basal Endogenous Losses (BEL) obtained with N-free diets, casein diets and the regression method are evaluated in the paragraphs 1 – 3. In paragraph 4 the mean BEL patterns obtained with the different methods are compared to each other. In paragraph 5 the relations between amino acids in the separate datasets are evaluated. In paragraph 6 the overall average values for BEL are calculated in various ways, and in paragraph 7 the final BEL amino acid pattern is calculated that was used in this study.

1. BEL pattern determined with N-free diets

1.1 Complete dataset

Table 1. Characteristics of the complete N-free dataset.

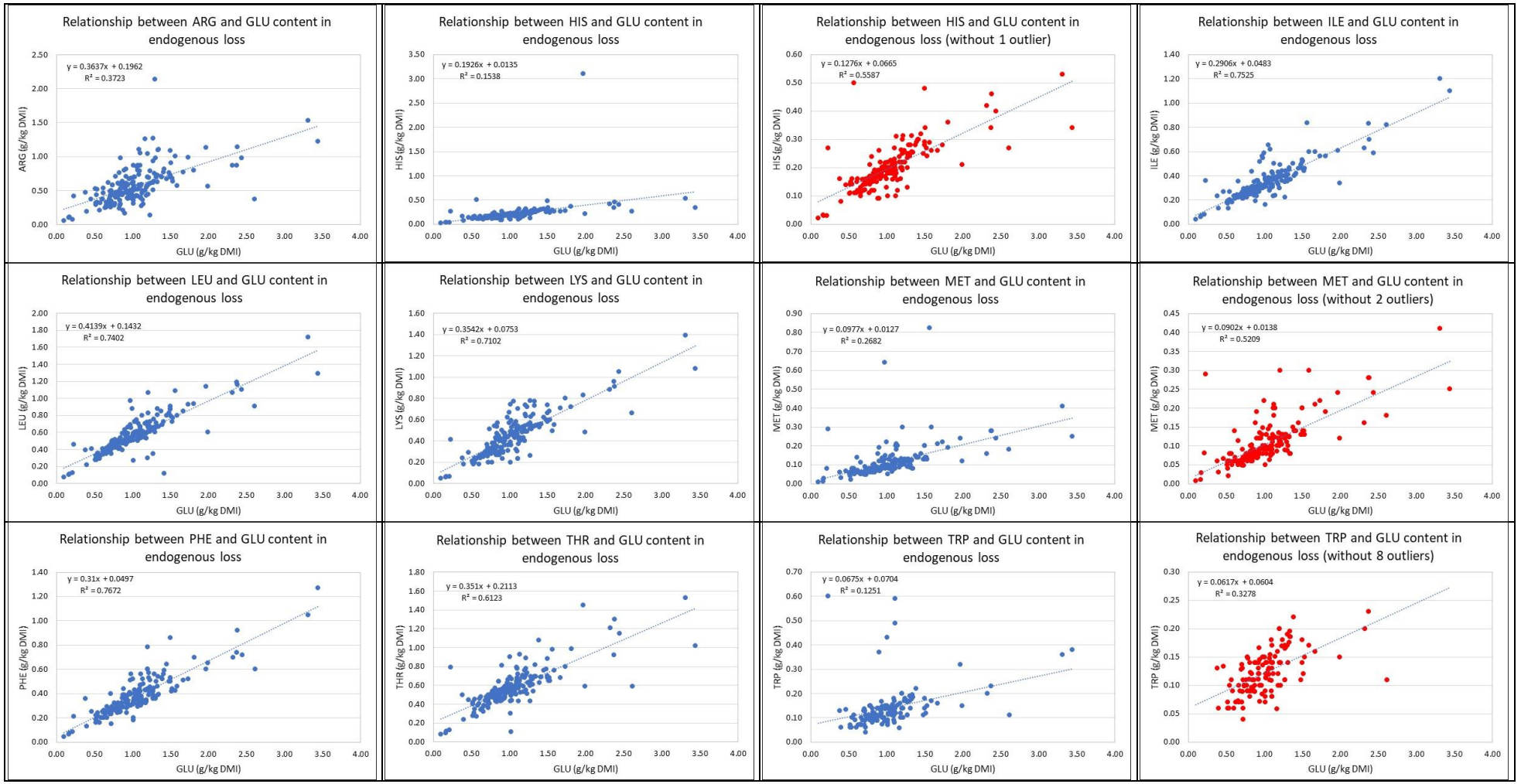
	BW* (kg)	FL in times MEm**	Basal endogenous loss g/kg DMI)																	
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	186	187	172	187	187	187	187	187	183	187	187	145	187	186	183	164	182	181	155	183	151
Average	44.4	2.8	17.3	0.58	0.22	0.35	0.57	0.45	0.11	0.37	0.58	0.14	0.51	0.64	0.84	0.21	1.05	1.50	4.27	0.58	0.28
STDEV.	23.2	0.5	6.3	0.28	0.23	0.16	0.22	0.19	0.09	0.16	0.21	0.09	0.19	0.26	0.33	0.10	0.47	0.70	3.17	0.27	0.12
Min.	8.0	0.8	6.8	0.06	0.02	0.04	0.07	0.05	0.01	0.05	0.08	0.04	0.09	0.06	0.09	0.03	0.10	0.21	0.02	0.07	0.05
Max.	109.8	3.6	48.6	2.14	3.10	1.20	1.72	1.39	0.83	1.27	1.53	0.60	1.48	2.05	2.57	0.68	3.44	4.30	20.10	2.05	0.92
STDEV/Average			0.36	0.48	1.05	0.46	0.39	0.42	0.82	0.43	0.36	0.64	0.37	0.41	0.39	0.48	0.45	0.47	0.74	0.47	0.43

*: BW = Initial body weight in kg

**: FL = Feeding Level in (estimated) times Metabolisable Energy for maintenance (MEm). In many observations FL is reported in times MEm. In other cases, FL is given as g/kg $BW^{0.75}$, % of kg BW or in kg diet per day. In these cases, FL was estimated using the initial BW and assuming a ME-content of the diet of 13.7 ME/kg.

Table 1 shows that for several amino acids BEL values are reported for all observations (187). For TRP the number of observations is lowest, which can be explained by the fact that in a couple of studies no separate analytical run was performed to determine this amino acid. Next to TRP, TYR is the amino acid with the lowest number of observations. This most likely is because in these studies the amino acid derivatives are measured at a wavelength at which MET can be detected but where TYR is not detected. This assumption is supported by the fact that the number of observations for MET is remarkably higher than that for CYS. Subsequently, the number of observations is lowest for PRO. In the publications where PRO values are missing no explanation if given for not reporting a value for PRO. May be that these values were that strange that they were judged as artificial. Table 1 further shows that the average BEL value for PRO is by far the highest of all amino acids, followed by GLY, GLU and ASP, respectively. Table 1 also shows that the average BEL values for the amino acids HIS, MET, TRP, CYS and TYR are low compared to the values for other amino acids. It is plausible to assume that for these amino acids, because of their low levels in the ileal chyme, the accuracy of these average values will be

less than for amino acids that are present in larger amounts. That this is indeed the case can be seen from the STDEV/Average values, which are very high for HIS, MET and TRP. Also, for PRO the accuracy of the average value is low.
As the variation in the BEL values of individual amino acids is very large, it was considered useful to explore possible relationships between the BEL values of amino acids. In Figure 1 the relationship of the BEL values of all amino acids to those of GLU is presented. It was decided to compare the BEL losses to that of GLU because GLU is the third amino acid after PRO and GLY with the highest average BEL value.



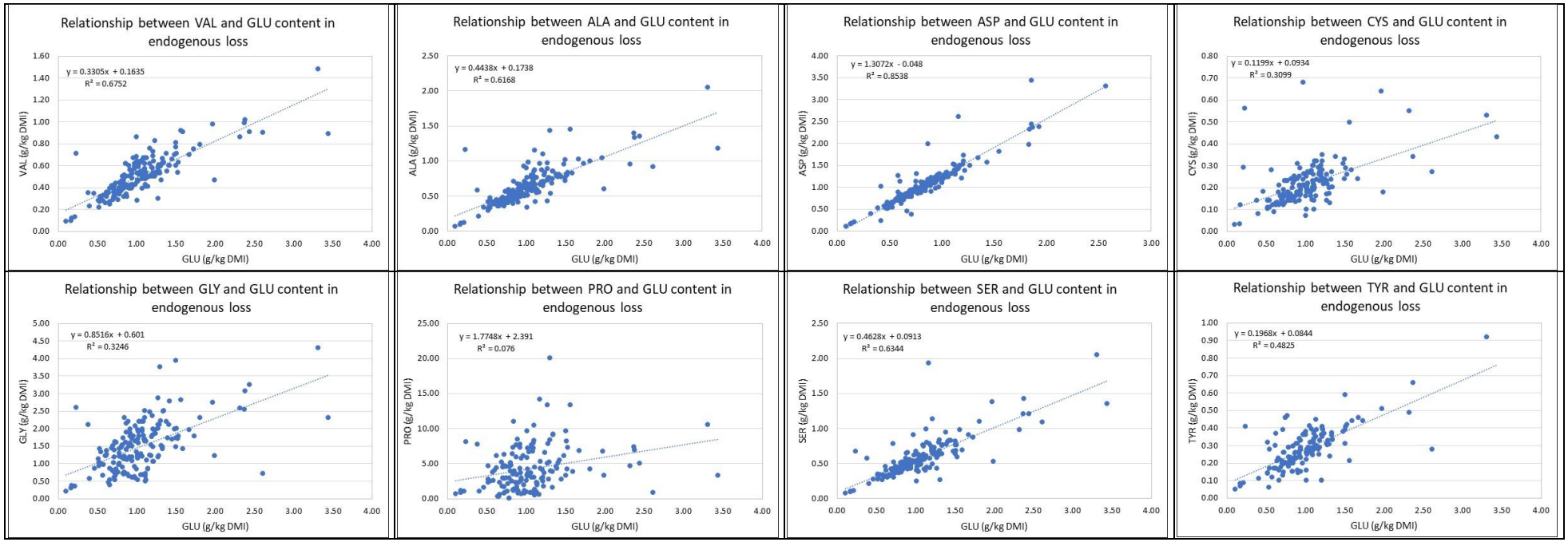


Figure 1. Relationship between BEL values of amino acids and the BEL values for GLU in the complete dataset of N-free diets. For the amino acids HIS, MET and TRP the relationship is also presented after deleting one or more outliers (see graphs with red symbols).

In Table 2 statistical data of the relationships between BEL for all amino acids to resp. GLU, THR and PRO is presented. R^2 values are given in blue when the value was >0.30. As can be seen the relationships between BEL AA_X and BEL for GLU and THR (for HIS, MET and TRP after elimination of 1 or more observations) all have R^2 values >0.30, except in the case of PRO. The relationships between PRO and GLU and between PRO and THR, is poor with very low R^2 values.
The relationships between BEL-AA_X and BEL for GLU and THR, respectively, have higher R^2 values than the relationships between BEL-AA_X and BEL-PRO, except for ARG and GLY.
These results support the assumption that feeding N-free diets to pigs may disturb the metabolism of PRO. Further, they indicate that the metabolism of ARG and GLY may be disturbed in a similar way, but – because there is still a relationship between BEL-ARG and BEL-GLY to BEL-GLU and BEL-THR – possibly to a lesser extent than for PRO.
After observing that for the amino acids GLU and THR there is a (rather) good relationship to all other amino acids, except PRO, it was decided to further explore the relationships between the amino acids. This was done by making correlation matrices for the total dataset of N-free diets (Table 3), and also for this dataset after deleting the observations with Feeding Level <2.5*MEm (Table 5) and for this dataset after deleting both the observations with Feeding Level <2.5*MEm and the values of amino acids that deviated more than 2*STDEV from the average value of that amino acid (Table 7).

Table 2. Relationship for the data in the complete dataset of N-free diets between BEL-AA_X and BEL of GLU, THR and PRO. *

	Relationship Y = aX + c					
	X = GLU		X = THR		X = PRO	
Y	Formula	R^2	Formula	R^2	Formula	R^2
ARG	Y = 0.364*GLU + 0.196	**0.372**	Y = 0.844*THR + 0.091	**0.404**	Y = 0.0753*PRO + 0.254	**0.683**
HIS	Y = 0.192*GLU + 0.014	0.154	Y = 0.590*THR – 0.125	0.295	Y = 0.014*PRO + 0.161	0.030
ILE	Y = 0.291*GLU + 0.048	**0.753**	Y = 0.592*THR + 0.010	**0.608**	Y = 0.011*PRO + 0.310	0.043
LEU	Y = 0.414*GLU + 0.143	**0.740**	Y = 0.906*THR + 0.049	**0.704**	Y = 0.016*PRO + 0.511	0.046
LYS	Y = 0,354*GLU + 0.075	**0.710**	Y = 0.704*THR + 0.042	**0.565**	Y = 0.017*PRO + 0.375	0.070
MET	Y = 0.098*GLU + 0.013	0.268	Y = 0.237*THR – 0.023	**0.320**	Y = 0.006*PRO + 0.095	0.035
PHE	Y = 0.310*GLU + 0.050	**0.767**	Y = 0.622*THR + 0.015	**0.619**	Y = 0.008*PRO + 0.340	0.024
THR	Y = 0.351*GLU + 0.211	**0.612**			Y = 0.023*PRO + 0.484	0.109
TRP	Y = 0.068*GLU + 0.070	0.125	Y = 0.260*THR – 0.010	**0.341**	Y = 0.002*PRO + 0.138	0.003
VAL	Y = 0.331*GLU + 0.164	**0.675**	Y = 0.774*THR + 0.061	**0.742**	Y = 0.021*PRO + 0.422	0.111
ALA	Y = 0.444*GLU + 0.174	**0.617**	Y = 1.016*THR + 0.052	**0.656**	Y = 0.049*PRO + 0.425	0.324
ASP	Y = 1.307*GLU + 0.048	**0.854**	Y = 1.397*THR + 0.030	**0.786**	Y = 0.040*PRO + 0.678	0.133
CYS	Y = 0.120*GLU + 0.093	**0.311**	Y = 0.339*THR + 0.023	**0.489**	Y = 0.006*PRO + 0.189	0.042
GLU			Y = 1.745*THR + 0.039	**0.611**	Y = 0.043*PRO + 0.878	0.076
GLY	Y = 0.852*GLU + 0.601	**0.325**	Y = 2.280*THR + 0.179	**0.461**	Y = 0.193*PRO + 0.647	**0.685**
PRO	Y = 1.775*GLU + 2.391	0.076	Y = 4.772*THR + 1.500	0.109		
SER	Y = 0.463*GLU + 0.091	**0.634**	Y = 1.090*THR + 0.055	**0.707**	Y = 0.029*PRO + 0.460	0.102
TYR	Y = 0.197*GLU + 0.084	**0.483**	Y = 0.402*THR + 0.056	**0.478**	Y = 0.008*PRO + 0.249	0.045

*: When two formulas are given for an amino acid, the second formula represents the relationship after deleting one of more outliers (see Figure 1)
R^2 values>0.30 are printed in green; If there is a good relation between AAy and PRO the cell with R^2 is marked grey; when R^2 for the relation of AAy to GLU and TYR is higher than to PRO the

Table 3 shows that for HIS and TRP the correlation to most other amino acids is poor (R below 0.50). As can be concluded from Table 7, showing much better correlations, this is caused by one or more outliers. The correlations between THR and all other amino acids (except TRP and PRO) is (rather) good (R>0.50). For GLU the correlations to other amino acids also are (rather) good (R>0.50), except for HIS, TRP and PRO. In line with the results presented in Table 2, for PRO the correlation coefficients to most other amino acids are poor; exceptions are CP, ARG, GLY and ALA.

Table 3. Correlation matrix showing the correlation coefficients between CP and amino acids for the complete dataset of N-free diets.

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
CP	1																		
ARG	0.796	1																	
HIS	0.347	0.346	1																
ILE	0.599	0.532	0.362	1															
LEU	0.602	0.533	0.425	0.861	1														
LYS	0.634	0.602	0.388	0.802	0.835	1													
MET	0.344	0.291	0.259	0.619	0.677	0.501	1												
PHE	0.589	0.517	0.353	0.795	0.816	0.755	0.527	1											
THR	0.660	0.636	0.543	0.780	0.839	0.752	0.566	0.787	1										
TRP	0.320	0.247	0.275	0.413	0.462	0.330	0.609	0.510	0.584	1									
VAL	0.678	0.621	0.428	0.879	0.890	0.843	0.624	0.756	0.861	0.467	1								
ALA	0.790	0.755	0.361	0.778	0.825	0.761	0.652	0.734	0.810	0.612	0.852	1							
ASP	0.729	0.677	0.482	0.871	0.906	0.876	0.573	0.857	0.886	0.431	0.890	0.855	1						
CYS	0.481	0.351	0.498	0.599	0.698	0.558	0.716	0.587	0.700	0.418	0.656	0.613	0.662	1					
GLU	0.662	0.610	0.392	0.867	0.860	0.843	0.518	0.876	0.782	0.354	0.822	0.785	0.924	0.557	1				
GLY	0.859	0.867	0.338	0.493	0.532	0.565	0.331	0.518	0.679	0.278	0.619	0.773	0.687	0.438	0.570	1			
PRO	0.717	0.827	0.173	0.206	0.215	0.265	0.186	0.156	0.329	0.059	0.333	0.569	0.365	0.206	0.276	0.828	1		
SER	0.639	0.601	0.453	0.755	0.813	0.734	0.579	0.788	0.841	0.425	0.807	0.783	0.845	0.667	0.796	0.625	0.320	1	
TYR	0.449	0.449	0.333	0.713	0.784	0.700	0.457	0.732	0.690	0.426	0.706	0.673	0.746	0.520	0.695	0.424	0.211	0.660	1

In this table the colors used have the following meaning:

XXX	R <0.25
XXX	0.25 ≤ R < 0.50
XXX	0.50 ≤ R < 0.70
XXX	0.7- ≤ R < 0.80
XXX	R >0.80

*1.2 Dataset with N-free diets from which observations with (estimated) Feeding Levels <2.5*MEm have been deleted.*

In Table 4 some characteristics are given for the dataset of N-free diets after removing observations with an (estimated) Feeding Level (FL) below 2.5*MEm, whereas in Table 5 the correlation matrix showing the correlations between CP and amino acids is presented.
Comparison of Table 4 with Table 1 shows that the average values for CP and Amino acids are very similar. The number of observations in Table 4 is 20-25 lower than in Table 1.

Table 4. Characteristics of the dataset after elimination of observations with a Feeding Level (FL) below 2.5*MEm.

	BW (kg)	FL in times MEm	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	162	163	152	163	163	163	163	163	162	163	163	131	163	162	159	148	158	157	133	159	133
Average	42.9	2.9	17.1	0.58	0.21	0.33	0.55	0.43	0.11	0.36	0.56	0.14	0.49	0.62	0.81	0.21	1.01	1.50	4.39	0.56	0.28
STDEV.	22.6	0.2	5.6	0.27	0.24	0.14	0.20	0.17	0.09	0.15	0.19	0.08	0.16	0.23	0.27	0.10	0.39	0.64	3.17	0.23	0.10
Min.	8.0	2.5	8.1	0.06	0.02	0.04	0.07	0.05	0.01	0.05	0.08	0.04	0.09	0.06	0.09	0.03	0.10	0.21	0.02	0.07	0.05
Max.	109.8	3.6	36.3	2.14	3.10	1.10	1.29	1.08	0.83	1.27	1.45	0.60	0.98	1.45	1.86	0.68	3.44	3.95	20.10	1.93	0.59

Table 5. Correlation matrix showing the correlations between amino acids for the dataset of N-free diets from which observations with FL <2.5*MEm have been deleted. *

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER
CP	1																	
ARG	0.763	1																
HIS	0.319	0.316	1															
ILE	0.527	0.530	0.358	1														
LEU	0.478	0.476	0.413	0.819	1													
LYS	0.508	0.550	0.368	0.761	0.775	1												
MET	0.207	0.204	0.222	0.547	0.611	0.389	1											
PHE	0.467	0.444	0.318	0.760	0.755	0.678	0.428	1										
THR	0.538	0.580	0.551	0.772	0.795	0.670	0.482	0.720	1									
TRP	0.203	0.188	0.275	0.377	0.404	0.230	0.600	0.469	0.530	1								
VAL	0.583	0.590	0.425	0.847	0.848	0.800	0.546	0.674	0.835	0.405	1							
ALA	0.704	0.732	0.334	0.736	0.759	0.662	0.589	0.640	0.744	0.606	0.798	1						
ASP	0.621	0.643	0.493	0.874	0.876	0.830	0.482	0.809	0.856	0.376	0.864	0.785	1					
CYS	0.411	0.299	0.490	0.599	0.700	0.526	0.712	0.555	0.700	0.442	0.656	0.591	0.642	1				
GLU	0.557	0.588	0.380	0.851	0.820	0.796	0.420	0.853	0.741	0.322	0.762	0.697	0.910	0.518	1			
GLY	0.819	0.845	0.309	0.478	0.445	0.467	0.232	0.414	0.606	0.208	0.575	0.731	0.614	0.391	0.492	1		
PRO	0.733	0.827	0.150	0.209	0.176	0.217	0.148	0.089	0.292	0.021	0.330	0.595	0.338	0.149	0.240	0.844	1	
SER	0.491	0.538	0.449	0.677	0.735	0.623	0.493	0.707	0.793	0.379	0.726	0.677	0.766	0.648	0.694	0.535	0.270	1
TYR	0.253	0.359	0.330	0.640	0.721	0.606	0.357	0.646	0.622	0.353	0.618	0.561	0.653	0.471	0.632	0.308	0.138	0.550

*: For an explanation of the colors see Table 3.

From Table 5 it can be concluded that the correlations between CP and Amino acids are very similar to those in Table 3, with the exception for MET. For this AA the correlations to several other amino acids are lower in Table 5.

*1.3 Dataset with N-free diets from which first observations with an (estimated) FL <2.5*MEm have been deleted and subsequently outliers (observations deviating more than 2*STDEV from the average value) were removed.*

In Table 6 some characteristics of the dataset are given for the N-free diets after deleting observations with a FL <2.5*MEm and removing values of amino acids that deviate >2*STDEV from the average value of that amino acid.
It must be recognized that the assumption that values deviating more than 2*STDEV from the average value are considered as outliers implicitly means that we consider the dataset as a random data population, and that the variation is not related to any (experimental) factor.

Table 6. Characteristics of the dataset after elimination of observations with a Feeding Level (FL) <2.5*MEm and elimination of outliers (values deviating more than 2.0 times STDEV from the average value) *

	BW (kg)	FL in times MEm	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	151	152	136	149	152	149	149	151	147	150	150	121	150	147	151	138	149	145	121	149	124
Average	43.4	2.9	16.3	0.56	0.20	0.33	0.55	0.43	0.10	0.36	0.56	0.12	0.49	0.61	0.81	0.20	1.00	1.45	4.08	0.54	0.28
STDEV.	23.0	0.3	4.6	0.21	0.07	0.09	0.15	0.15	0.04	0.11	0.13	0.04	0.13	0.17	0.21	0.06	0.28	0.51	2.44	0.16	0.09
Min.	8.0	2.5	8.1	0.14	0.08	0.13	0.22	0.18	0.02	0.13	0.24	0.04	0.22	0.21	0.32	0.08	0.23	0.50	0.02	0.21	0.10
Max.	109.8	3.6	27.9	1.11	0.50	0.60	0.93	0.78	0.22	0.65	0.93	0.22	0.81	1.03	1.35	0.35	1.73	2.61	10.45	0.99	0.47

*: If more than 5 AA or CP were identified as outliers the complete observations was deleted. This was the case for 11 observations.

Comparing Table 6 with Table 4 leads to the following conclusions:

- The number of observations in Table 6 is 8 – 16 less than in Table 4.
- The mean BW of the animals is slightly higher in Table 6 (+0.5 kg), whereas the average Feeding Level is the same (2.9*MEm).
- For most amino acids the differences in the average values between Table 4 and 6 are small (≤0.02 g/kg DMI). For CP, GLY and PRO the differences are higher (1.2, 0.05 and 0.31 g/kg DMI, respectively). For some amino acids the STDEV in Table 6 is only slightly lower than in Table 4, but for CP and several other amino acids STDEV decreased more, due to the removal of outliers with high numerical values.

For the dataset with N-free diets without FL <2.5*MEm and without outliers the correlation coefficients between CP and amino acids are presented in Table 7. Table 8 shows for how many amino acids the correlation coefficient is below 0.25, between 0.25 – 050; between 0.50 – 0.70; between 0.70 – 0.80 and >0.80 for the correlations based on the dataset with N-free diets.
From Table 7 and 8 the following can be concluded:

- For PRO and GLY the correlation to other Amino acids is <0.50 for 14 and 12 Amino acids, respectively. For TYR the correlation is <0.50 for 10 Amino acids. For CP and all other amino acids, the correlation coefficients to the majority of the other amino acids is >0.50 (see Table 8)
- For all amino acids, except for ARG and GLY and for CP, the correlation coefficients to PRO are the lowest (Table 7).

- For HIS and MET the correlations in Table 7 to many other amino acids are higher than in Table 3 and 5, due to the deleting of outliers (Table 7). For TRP this is less clear, but for this amino acid the accuracy in the analysis of the low levels may play a disturbing role.

Table 7. Correlation matrix showing the correlation coefficients between CP and amino acids for the dataset of N-free diets from which observations with FL <2.5*MEm and outliers have been deleted. *

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
CP	1																		
ARG	0.848	1																	
HIS	0.595	0.503	1																
ILE	0.588	0.509	0.676	1															
LEU	0.481	0.431	0.601	0.920	1														
LYS	0.486	0.458	0.564	0.796	0.741	1													
MET	0.150	0.135	0.433	0.644	0.712	0.496	1												
PHE	0.448	0.404	0.561	0.691	0.729	0.586	0.667	1											
THR	0.642	0.549	0.614	0.806	0.756	0.628	0.537	0.718	1										
TRP	0.490	0.459	0.491	0.557	0.552	0.493	0.551	0.658	0.624	1									
VAL	0.609	0.555	0.607	0.871	0.819	0.788	0.569	0.630	0.808	0.523	1								
ALA	0.802	0.689	0.595	0.779	0.768	0.674	0.536	0.680	0.721	0.591	0.785	1							
ASP	0.684	0.588	0.650	0.883	0.891	0.770	0.622	0.779	0.785	0.657	0.808	0.829	1						
CYS	0.398	0.245	0.522	0.588	0.654	0.472	0.618	0.612	0.647	0.439	0.611	0.512	0.657	1					
GLU	0.600	0.562	0.607	0.835	0.855	0.731	0.703	0.777	0.690	0.618	0.730	0.794	0.911	0.595	1				
GLY	0.904	0.791	0.419	0.414	0.345	0.293	0.045	0.288	0.500	0.437	0.458	0.664	0.465	0.277	0.360	1			
PRO	0.771	0.762	0.260	0.181	0.110	0.121	-0.098	0.081	0.227	0.298	0.248	0.503	0.266	0.047	0.212	0.857	1		
SER	0.651	0.552	0.598	0.684	0.722	0.544	0.622	0.736	0.842	0.731	0.701	0.727	0.769	0.605	0.697	0.535	0.336	1	
TYR	0.239	0.244	0.339	0.596	0.663	0.471	0.556	0.484	0.540	0.414	0.516	0.475	0.551	0.402	0.507	0.176	0.105	0.557	1

*: For an explanation of the colors see Table 3.

In Table 9 the significances of the correlations between CP and amino acids are presented. As can be seen, most of the correlation coefficients are significant, even when the R-value of the correlation was below 0.50. For example, the correlation between ILE and PRO has a R-value of 0.181, but still is significant (p-value 0.049). That the correlations are significant even when the R-value is (relatively) low can be ascribed to the large number of observations. The lowest number of observations was 93 (for the correlation between TRP and PRO). In all other cases there were more than 100 observations. From Table 9 it is also evident that the correlation coefficients of PRO to 5 Amino acids (LEU, LYS, MET, PHE and CYS) is not significant. Further the correlation coefficient between ARG and MET and that between GLY and MET was not significant, whereas that between CP and MET there was a trend.

Table 8. Distribution of the correlation coefficients of CP and amino acids to each other for the N-free dataset.

CP or AA	Number of correlations coefficients to other amino acids with an R-value:				
	R>0.80	0.70 ≤ R < 0.80	0.50 ≤ R < 0.70	0.25 ≤ R < 0.50	R < 0.25
CP	**3**	**1**	**7**	**5**	**2**
ARG	**1**	**2**	**8**	**4**	**3**
HIS	**0**	**0**	**13**	**5**	**0**
ILE	**5**	**2**	**9**	**1**	**1**
LEU	**5**	**2**	**7**	**3**	**1**
LYS	**0**	**5**	**5**	**7**	**1**
MET	**0**	**2**	**10**	**2**	**4**
PHE	**0**	**5**	**8**	**4**	**1**
THR	**3**	**4**	**10**	**0**	**1**
TRP	**0**	**1**	**9**	**8**	**0**
VAL	**4**	**4**	**8**	**1**	**1**
ALA	**2**	**6**	**8**	**1**	**1**
ASP	**5**	**4**	**7**	**2**	**0**
CYS	**0**	**0**	**11**	**5**	**1**
GLU	**3**	**5**	**8**	**1**	**1**
GLY	**2**	**1**	**3**	**10**	**2**
PRO	**1**	**2**	**1**	**4**	**10**
SER	**1**	**6**	**10**	**1**	**0**
TYR	**0**	**0**	**8**	**6**	**4**

In this table the colors used have the following meaning:

	<5 observations		5 - 9 observations		10 – 12 observations		13 – 15 observations		>15 observations

From this inventory it is evident that in the ileal chyme of animals fed a N-free diet PRO has a low correlation to most other amino acids, which in 5 cases also were not significant. This supports the assumption that the metabolism of PRO is disturbed in these diets. PRO has the highest correlation to GLY, followed by that to CP and ARG, respectively. GLY has the highest correlation coefficient to CP, followed by that to PRO and ARG, respectively. ARG has the highest correlation to CP, followed by that to GLY and PRO, respectively. This shows that also the metabolism of GLY and ARG is disturbed as a result of feeding N-free diets, but to a lesser extent than PRO.

Table 9. Significances of the correlations between CP and amino acids for the dataset with N-free diets from which observations with FL <2.5*MEm as well as outliers were deleted.

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER
CP																		
ARG	<.0001																	
HIS	<.0001	<.0001																
ILE	<.0001	<.0001	<.0001															
LEU	<.0001	<.0001	<.0001	<.0001														
LYS	<.0001	<.0001	<.0001	<.0001	<.0001													
MET	0.086	0.107	<.0001	<.0001	<.0001	<.0001												
PHE	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001											
THR	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001										
TRP	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001									
VAL	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001								
ALA	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001							
ASP	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001						
CYS	<.0001	0.004	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001					
GLU	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001				
GLY	<.0001	<.0001	<.0001	<.0001	<.0001	0.000	0.599	0.001	<.0001	<.0001	<.0001	<.0001	<.0001	0.001	<.0001			
PRO	<.0001	<.0001	0.004	0.049	0.237	0.187	0.293	0.380	0.013	0.004	0.007	<.0001	0.003	0.627	0.020	<.0001		
SER	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.000	

2. BEL patterns determined with (low) casein diets

In Table 10 some characteristics are presented for the complete dataset of observations where BEL was determined with animals fed (low) casein diets. As can be seen the number of observations for TRP is lowest. Further, the number of observations for non-essential amino acids is much lower than for essential amino acids, because in several (older) publications only results for essential amino acids were published. Of these, the publication of Van Kempen et al. (2002) reports 5 patterns for BEL, determined at different locations. Further, for the two patterns in the publication of Hook et al. (2010) also only data for the essential amino acids is presented.

In the next tables the characteristics for the database with (low) casein diets are presented after deleting observations with (estimated) FL <2.5*MEm (Table 11) and the dataset remaining when subsequently also the outliers were removed (Table 12). Both Tables show that the number of observations for the non-essential amino acids is 5 – 8 less than for the essential amino acids (except for TRP).

Table 10. Characteristics of BEL determined in animals fed (low) casein diets. Complete dataset.

	BW (kg)	FL in times MEm	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	25	26	21	24	26	26	26	26	24	26	26	12	26	19	19	21	19	18	19	19	17
Average	41.8	2.7	14.0	0.54	0.42	0.50	0.65	0.47	0.14	0.35	0.70	0.15	0.60	0.62	0.94	0.25	1.62	1.12	2.82	0.82	0.38
STDEV.	26.1	0.6	5.0	0.27	0.49	0.19	0.18	0.16	0.04	0.13	0.25	0.09	0.20	0.23	0.35	0.15	0.55	0.70	2.36	0.27	0.39
Min.	6.2	1.2	5.3	0.15	0.10	0.17	0.25	0.20	0.07	0.15	0.25	0.06	0.24	0.12	0.41	0.03	0.95	0.13	0.54	0.33	0.01
Max.	100.0	3.9	22.8	1.21	2.39	0.87	1.10	0.86	0.24	0.63	1.22	0.40	1.14	0.98	1.70	0.76	2.80	2.54	9.12	1.35	1.84

Table 11. Characteristics of BEL pattern determined with (low) casein diets; dataset after deleting of observations with a FL <2.5*MEm.

	BW (kg)	FL in times MEm	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	22	23	19	21	23	23	23	23	21	23	23	10	23	16	16	18	16	15	16	16	15
Average	40.2	2.9	13.7	0.53	0.45	0.46	0.64	0.48	0.14	0.35	0.69	0.16	0.57	0.62	0.93	0.23	1.51	1.20	3.11	0.82	0.40
STDEV.	23.5	0.4	5.0	0.23	0.52	0.16	0.18	0.17	0.04	0.12	0.24	0.09	0.18	0.18	0.32	0.11	0.49	0.74	2.47	0.25	0.41
Min.	6.2	2.5	5.3	0.15	0.10	0.17	0.25	0.20	0.07	0.15	0.25	0.09	0.24	0.20	0.43	0.03	0.95	0.13	0.57	0.37	0.14
Max.	93.2	3.9	22.8	1.08	2.39	0.87	1.10	0.86	0.21	0.63	1.22	0.40	1.14	0.90	1.70	0.43	2.80	2.54	9.12	1.35	1.84

Table 12. Characteristics of BEL pattern determined with (low) casein diets; dataset after deleting of observations with a FL <2.5*MEm and removal of outliers (values deviating more than 2*STDEV from the average value) *

	BW (kg)	FL in times MEm	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	21	22	19	19	19	22	21	22	20	21	22	8	22	14	15	17	15	14	14	14	14
Average	39.4	2.9	13.7	0.48	0.26	0.44	0.64	0.46	0.13	0.33	0.67	0.13	0.55	0.63	0.88	0.22	1.42	1.12	2.49	0.80	0.30
STDEV.	23.7	0.4	5.0	0.18	0.10	0.13	0.13	0.15	0.04	0.10	0.22	0.04	0.13	0.14	0.26	0.10	0.36	0.71	1.81	0.21	0.09
Min.	6.2	2.5	5.3	0.15	0.10	0.17	0.41	0.20	0.07	0.15	0.25	0.09	0.24	0.36	0.43	0.03	0.95	0.13	0.57	0.37	0.14
Max.	93.2	3.9	22.8	0.70	0.47	0.65	0.85	0.72	0.21	0.52	1.00	0.19	0.73	0.88	1.29	0.42	2.11	2.54	5.38	1.19	0.46

*: If more than 5 AA or CP were identified as outliers the complete observations was deleted. This was the case for 1 observation.

In Table 13 the correlations between CP and amino acids are presented for the dataset with low casein diets without FL <2.5*MEm and without outliers. In Table 14 it is shown for how many amino acids the correlation coefficient is below 0.00; between 0.00 – 0.25, between 0.25 – 050; between 0.50 – 0.70; between 0.70 – 0.80 and >0.80.

Table 13. Correlation matrix showing the correlations between amino acids for the dataset of low casein diets from which observations with Feeding Levels <2.5*MEm and outliers have been deleted. *

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
CP	1																	
ARG	0.959	1																
HIS	0.196	0.334	1															
ILE	0.666	0.473	-0.138	1														
LEU	0.564	0.487	0.037	0.831	1													
LYS	0.498	0.476	0.050	0.644	0.624	1												
MET	0.296	0.225	-0.091	0.521	0.796	0.342	1											
PHE	0.610	0.406	-0.014	0.771	0.914	0.494	0.837	1										
THR	0.681	0.679	0.117	0.658	0.769	0.363	0.597	0.638	1									
VAL	0.741	0.594	-0.009	0.944	0.894	0.639	0.618	0.853	0.773	1								
ALA	0.828	0.685	0.064	0.497	0.407	0.018	0.217	0.417	0.599	0.518	1							
ASP	0.682	0.724	0.212	0.509	0.330	0.565	-0.244	-0.031	0.460	0.452	0.484	1						
CYS	0.843	0.776	0.118	0.493	0.394	0.347	0.052	0.241	0.819	0.545	0.682	0.802	1					
GLU	0.440	0.339	-0.046	0.677	0.439	0.676	-0.050	0.200	0.122	0.525	0.346	0.728	0.540	1				
GLY	0.913	0.829	0.124	0.409	0.031	0.286	-0.434	0.147	0.243	0.404	0.515	0.605	0.731	0.458	1			
PRO	0.751	0.676	0.064	0.215	-0.247	0.108	-0.507	-0.106	-0.207	0.163	0.112	0.317	0.470	0.348	0.842	1		
SER	0.852	0.713	0.140	0.482	0.282	-0.001	0.066	0.435	0.480	0.507	0.941	0.433	0.711	0.391	0.580	0.250	1	
TYR	-0.106	0.009	-0.207	0.610	0.821	0.346	0.675	0.500	0.749	0.598	0.284	0.407	0.361	0.314	-0.054	-0.365	0.102	1

In this table the colors used have the following meaning:

	R < 0.00		0.00 ≤ R <0.25		0.25 ≤ R < 0.50		0.50 ≤ R < 0.70		0.7- ≤ R < 0.80		R > 0.80

From a comparison of Table 7 and Table 13 it can be concluded that the correlations between amino acids in the dataset with low casein diets is much more scattered than in the dataset with N-free diets.
Table 14 shows that only for 5 amino acids (ARG, ILE, THR, VAL and CYS) the correlation to CP and all other amino acids is >50%, whereas for 11 amino acids the correlation to CP and all other amino acids is less than 0.50.

Table 14. Distribution of the correlations of CP and amino acids to each other. * ** ***

CP or AA	R>0.80	0.70 ≥ R < 0.80	0.50 ≥ R < 0.70	0.25 ≥ R < 0.50	0.00 ≥ R < 0.25	R < 0.00
CP	5	2	5	3	1	1
ARG	2	3	4	6	2	0
HIS	0	0	0	1	10	6
ILE	2	1	7	5	1	1
LEU	4	2	2	6	2	1
LYS	0	0	5	8	3	1
MET	1	1	4	2	4	5
PHE	3	1	2	5	3	3
THR	1	3	6	3	3	1
VAL	3	2	8	2	1	1
ALA	2	0	5	6	4	0
ASP	1	2	4	7	1	2
CYS	3	3	3	5	3	0
GLU	0	1	4	8	2	2
GLY	3	1	3	4	4	2
PRO	1	1	1	4	5	5
SER	2	2	2	7	3	1
TYR	1	1	3	6	2	4

*: Because of the low number of observations, TRP has been omitted from this table
**: The total number per row is 17.
***: In this table the colors used have the following meaning:

XXX	Less than 5 observations in the 3 columns with R>0.50 or in the three columns with R<0.50
XXX	5 to 8 observations in the 3 columns with R>0.50 or in the three columns with R<0.50
XXX	9 – 11 observations in the 3 columns with R>0.50 or in the three columns with R<0.50
XXX	12 – 14 observations in the 3 columns with R>0.50 or in the three columns with R<0.50
XXX	> 14 observations in the 3 columns with R>0.50 or in the three columns with R<0.50

In Table 14 the number of correlations of CP and amino acids in the dataset with low casein diets (without FL <2.5*MEm and without outliers) is classified according to R-classes. This Table shows that the number of amino acids with a correlation coefficient >0.70 is low, whereas the number of amino acids with a (rather low) correlation coefficient between 0.25 – 0.50 is high.
It is concluded that in the chyme of animals fed low casein diets the variations in amino acid levels are much less related to each other than in the chyme of animals fed N-free diets.

Table 14. Number of the correlations of CP and amino acids to other amino acids per class (column). * **

CP or AA	R>0.80	0.70 ≥ R < 0.80	0.50 ≥ R < 0.70	0.25 ≥ R < 0.50	0.00 ≥ R < 0.25	R < 0.00
CP	5	2	5	3	1	1
ARG	2	3	4	6	2	0
HIS	0	0	0	1	10	6
ILE	2	1	7	5	1	1
LEU	4	2	2	6	2	1
LYS	0	0	5	8	3	1
MET	1	1	4	2	4	5
PHE	3	1	2	5	3	3
THR	1	3	6	3	3	1
VAL	3	2	8	2	1	1
ALA	2	0	5	6	4	0
ASP	1	2	4	7	1	2
CYS	3	3	3	5	3	0
GLU	0	1	4	8	2	2
GLY	3	1	3	4	4	2
PRO	1	1	1	4	5	5
SER	2	2	2	7	3	1
TYR	1	1	3	6	2	4

*: Because of the low number of observations, TRP has been omitted from this table.

**: In this table the colors used have the following meaning:

	<3 observations		3-4 observations		5-6 observations		7-8 observations		≥ 9 observations

In Table 15 the significances of the correlation coefficients of CP and amino acids to each other are presented. Generally speaking, correlation coefficients with an R-value below 0.50 are not significant. With this respect there is a remarkable difference between the dataset with low casein diets and the dataset with N-free diets. In the latter case correlations with much lower R-values already were significant. This distinction must be ascribed to the large difference in the number of observations. For the low casein diets from which observations with FL <2.5*MEm, outliers and values for TRP have been removed, the number of observations per correlation coefficient varies between 11 and 22.

Table 15. Significances of the correlation coefficients between CP and amino acids to each other for the dataset with low casein diets from which observations with FL <2.5*MEm as well as outliers and values for TRP were deleted.

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
CP																		
ARG	<.0001																	
HIS	0.422	0.150																
ILE	0.002	0.035	0.540															
LEU	0.012	0.030	0.869	<.0001														
LYS	0.030	0.034	0.824	0.001	0.002													
MET	0.248	0.340	0.702	0.018	<.0001	0.140												
PHE	0.007	0.085	0.952	<.0001	<.0001	0.023	<.0001											
THR	0.001	0.001	0.603	0.001	<.0001	0.097	0.006	0.002										
VAL	0.000	0.006	0.968	<.0001	<.0001	0.001	0.004	<.0001	<.0001									
ALA	0.001	0.010	0.820	0.060	0.133	0.948	0.476	0.138	0.018	0.048								
ASP	0.015	0.005	0.448	0.052	0.230	0.028	0.421	0.917	0.084	0.091	0.068							
CYS	<.0001	0.000	0.653	0.044	0.117	0.173	0.844	0.370	<.0001	0.024	0.015	0.002						
GLU	0.152	0.257	0.870	0.006	0.102	0.006	0.872	0.492	0.665	0.045	0.206	0.002	0.070					
GLY	<.0001	0.001	0.674	0.146	0.916	0.321	0.159	0.632	0.403	0.152	0.059	0.022	0.007	0.099				
PRO	0.008	0.016	0.828	0.460	0.394	0.713	0.093	0.731	0.478	0.577	0.704	0.270	0.144	0.223	0.000			
SER	0.001	0.009	0.633	0.081	0.329	0.999	0.839	0.120	0.082	0.064	<.0001	0.122	0.014	0.166	0.038	0.410		
TYR	0.757	0.978	0.477	0.021	0.000	0.226	0.016	0.082	0.002	0.024	0.325	0.149	0.276	0.275	0.862	0.199	0.740	

3. BEL patterns determined with the regression method

In Table 16 some characteristics are presented for the complete dataset in which BEL was determined by using the regression method. In total there were 19 observations. In Table 17 the results are shown after deleting from this dataset the observations with a FL <2.5*MEm. As can be seen, almost 50% of the observations has been removed. So, many studies using this method were performed at low feeding levels. Except for CYS, the average values for BEL of CP and amino acids are higher after deleting observations with low feeding level.
In Table 18 the data are given for the dataset remaining when, in addition to deletion of observations with low FL, also outliers were removed.

Table 16. Characteristics of the complete dataset with BEL patterns determined with the regression method.

	BW (kg)	FL in times ME-m	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	19	19	19	18	17	19	19	19	17	16	19	9	19	18	18	15	18	18	17	18	13
Average	36.8	2.5	14.7	0.79	0.23	0.46	0.76	0.52	0.21	0.49	0.69	0.21	0.66	0.71	0.97	0.36	1.72	1.17	2.00	0.74	0.34
STDEV.	23.7	1.0	9.1	0.83	0.18	0.36	0.70	0.46	0.23	0.39	0.49	0.20	0.56	0.60	0.80	0.32	1.85	0.87	1.65	0.44	0.32
Min.	5.7	1.2	3.1	0.21	0.08	0.14	0.31	0.23	0.04	0.18	0.24	0.03	0.23	0.14	0.29	0.09	0.31	0.33	0.34	0.29	-0.01
Max.	86.0	4.4	46.6	3.30	0.88	1.68	3.31	2.26	0.97	1.71	2.50	0.66	2.69	2.85	3.75	1.01	7.82	3.63	5.44	2.25	1.11

Table 17. Characteristics of the dataset with BEL patterns determined with the regression method, after elimination of observations with a FL <2.5*MEm.

	BW (kg)	FL in times ME-m	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	10	10	10	9	10	10	10	10	10	9	10	5	10	9	9	9	9	9	8	9	8
Average	36.4	3.3	15.4	0.96	0.26	0.53	0.90	0.62	0.23	0.53	0.76	0.29	0.75	0.84	1.11	0.33	2.14	1.28	2.40	0.80	0.41
STDEV.	12.3	0.6	12.1	1.13	0.24	0.45	0.95	0.62	0.29	0.52	0.66	0.24	0.75	0.82	1.09	0.37	2.55	1.04	1.84	0.58	0.35
Min.	17.0	2.5	3.1	0.21	0.08	0.20	0.31	0.23	0.04	0.18	0.24	0.07	0.23	0.26	0.29	0.09	0.31	0.50	0.34	0.38	0.15
Max.	52.5	4.4	46.6	3.30	0.88	1.68	3.31	2.26	0.97	1.71	2.50	0.66	2.69	2.85	3.75	1.01	7.82	3.63	5.44	2.25	1.11

In Table 19 the correlation coefficients between CP and amino acids are presented for the dataset of the regression method from which observations with FL ≤2.5*MEm and outliers have been deleted. Because of the low number of observations, TRP has been omitted in this Table. As can be seen, all correlations are >0.50. Nevertheless, in three cases (with digits in red) the correlation coefficient was not significant.

Table 18. Characteristics of the dataset with BEL patterns determined with the regression method, after elimination of observations with a FL <2.5*MEm and of outliers (values deviating more than 2.0 times STDEV from the average value) *

a. Including one BEL pattern from the publication of Fan and Sauer (2002), that was not deleted in the outlier procedure

	BW (kg)	FL in times ME-m	Basal endogenous loss g/kg DMI)																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	9	9	9	8	9	9	9	9	9	8	9	4	9	8	8	8	8	8	7	8	7
Average	37.0	3.2	12.0	0.67	0.19	0.40	0.63	0.43	0.14	0.38	0.57	0.20	0.54	0.59	0.78	0.25	1.43	0.99	2.24	0.62	0.31
STDEV.	12.8	0.6	5.5	0.76	0.10	0.21	0.45	0.23	0.14	0.28	0.25	0.15	0.32	0.34	0.50	0.29	1.51	0.60	1.92	0.21	0.23
Min.	17.0	2.5	3.1	0.21	0.08	0.20	0.31	0.23	0.04	0.18	0.24	0.07	0.23	0.26	0.29	0.09	0.31	0.50	0.34	0.38	0.15
Max.	52.5	4.4	23.6	2.54	0.44	0.89	1.80	0.87	0.52	1.06	1.14	0.41	1.33	1.36	1.92	0.97	5.07	2.27	5.44	1.08	0.81

*: If more than 5 AA or CP were identified as outliers the complete observations was deleted. This was the case for 1 observation.

b. Without the BEL pattern from the publication of Fan and Sauer (2002), that was not deleted in the outlier procedure

	BW (kg)	FL in times ME-m	Basal endogenous loss g/kg DMI)																	
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
Number	8	8	8	7	8	8	8	8	8	7	8	3	8	7	7	7	7	7	6	7	6
Average	37.9	3.2	10.5	0.41	0.16	0.34	0.48	0.38	0.10	0.28	0.50	0.13	0.44	0.48	0.62	0.14	0.91	0.81	1.71	0.56	0.23
STDEV.	13.5	0.6	3.6	0.12	0.04	0.11	0.12	0.17	0.03	0.07	0.15	0.07	0.13	0.14	0.20	0.04	0.37	0.33	1.43	0.12	0.07
Min.	17.0	2.5	3.1	0.21	0.08	0.20	0.31	0.23	0.04	0.18	0.24	0.07	0.23	0.26	0.29	0.09	0.31	0.50	0.34	0.38	0.15
Max.	52.5	4.4	15.5	0.57	0.20	0.50	0.66	0.72	0.14	0.40	0.70	0.20	0.59	0.66	0.90	0.20	1.37	1.29	4.27	0.72	0.32

Table 19. Correlation matrix showing the correlations between amino acids for the dataset of the regression method from which observations with Feeding Levels <2.5*MEm and outliers have been deleted. * **

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
CP	1																	
ARG	0.862	1																
HIS	0.917	0.948	1															
ILE	0.935	0.932	0.908	1														
LEU	0.873	0.978	0.979	0.919	1													
LYS	0.850	0.747	0.829	0.814	0.758	1												
MET	0.839	0.980	0.949	0.857	0.973	0.676	1											
PHE	0.863	0.977	0.979	0.916	0.994	0.761	0.976	1										
THR	0.928	0.888	0.953	0.932	0.939	0.754	0.886	0.939	1									
VAL	0.941	0.971	0.965	0.982	0.971	0.828	0.927	0.965	0.949	1								
ALA	0.916	0.953	0.980	0.935	0.984	0.762	0.953	0.965	0.946	0.979	1							
ASP	0.910	0.947	0.993	0.938	0.982	0.814	0.941	0.986	0.974	0.975	0.972	1						
CYS	0.809	0.978	0.958	0.873	0.980	0.757	0.983	0.985	0.871	0.938	0.938	0.954	1					
GLU	0.896	0.994	0.966	0.960	0.980	0.795	0.964	0.977	0.914	0.990	0.967	0.965	0.973	1				
GLY	0.832	0.876	0.841	0.762	0.820	0.793	0.876	0.827	0.706	0.830	0.815	0.797	0.908	0.862	1			
PRO	0.865	0.788	0.787	0.822	0.731	0.910	0.735	0.718	0.665	0.829	0.778	0.741	0.735	0.818	0.947	1		
SER	0.947	0.924	0.923	0.995	0.921	0.767	0.881	0.913	0.950	0.979	0.945	0.937	0.862	0.950	0.758	0.796	1	
TYR	0.850	0.976	0.928	0.896	0.963	0.648	0.987	0.972	0.936	0.936	0.939	0.946	0.954	0.956	0.850	0.717	0.908	1

*: Correlation coefficients >0.80 are marked dark green, between 0.70 – 0.80 in mid green and between 0.50 – 0.70 in light green.
**: Number in red means that the correlation was not significant.

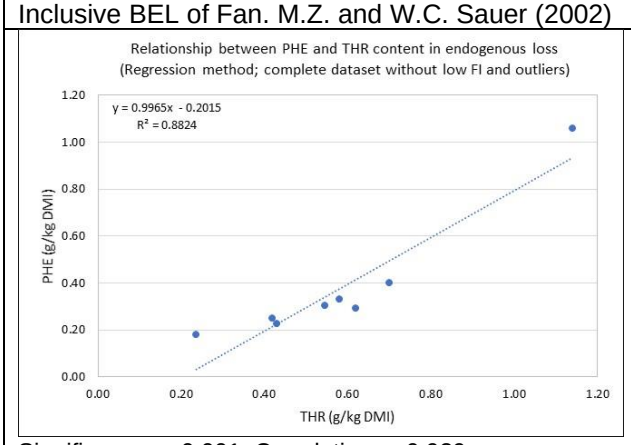
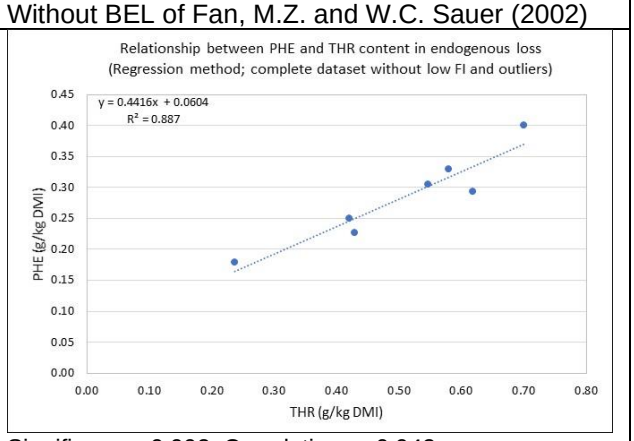
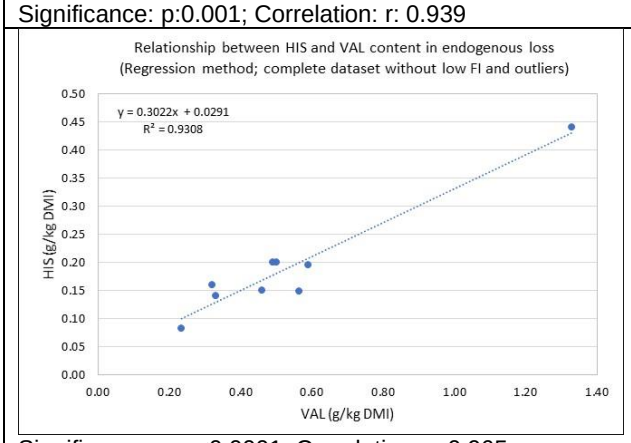
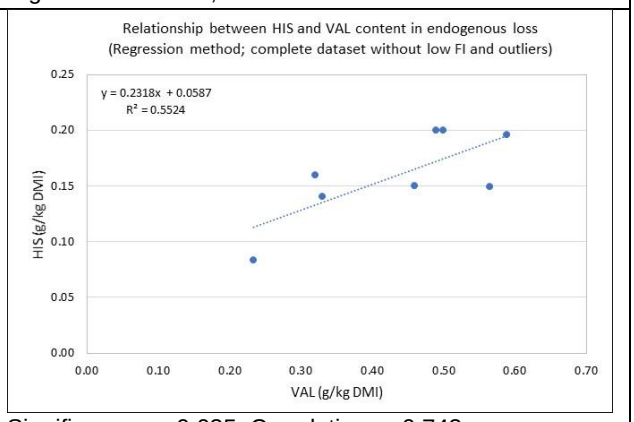
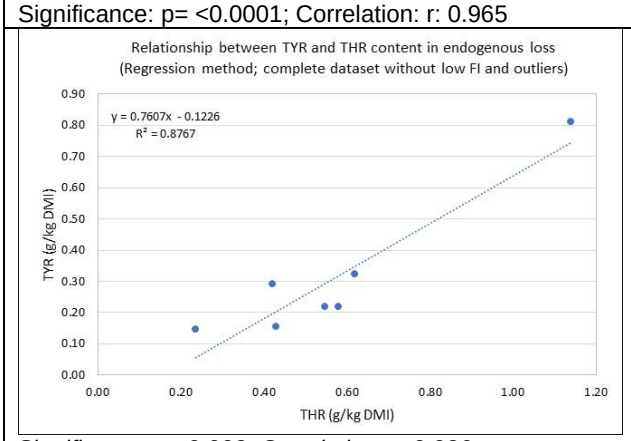
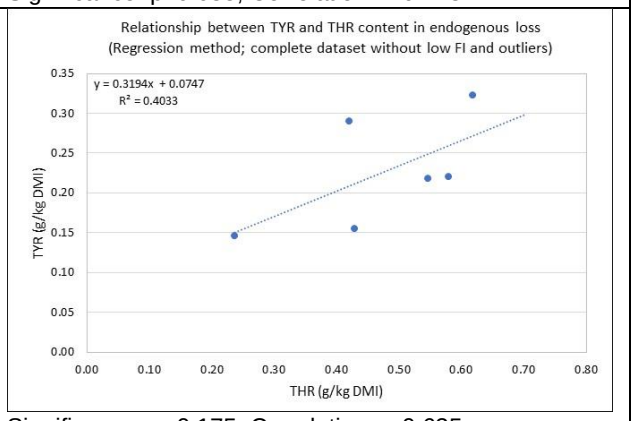
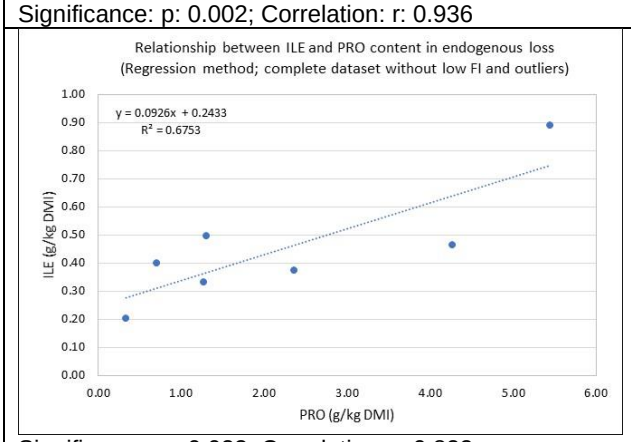
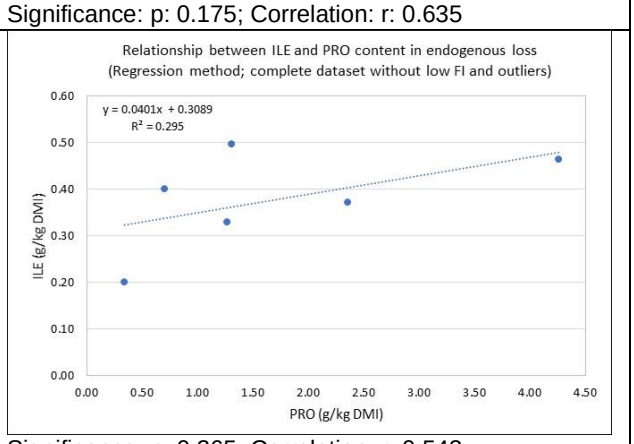
Dataset regression method after deleting observations with FL<2.5*MEm and without outliers	
Inclusive BEL of Fan. M.Z. and W.C. Sauer (2002)	Without BEL of Fan, M.Z. and W.C. Sauer (2002)
	
Significance: p:0.001; Correlation: r: 0.939	Significance: 0.002; Correlation: r: 0.942
	
Significance: p= <0.0001; Correlation: r: 0.965	Significance: p: 0.035; Correlation: r: 0.743
	
Significance: p: 0.002; Correlation: r: 0.936	Significance: p: 0.175; Correlation: r: 0.635
	
Significance: p: 0.023; Correlation: r: 0.822	Significance: p: 0.265; Correlation: r: 0.543

Figure 2. Relationship between some amino acids in datasets indicated in the heading of the figure.

When making graphs of the relationship of some amino acids to other amino acids for the dataset of which a summary is presented in Table 18.a it was found that in most cases there was one observation with high BEL levels that dominated the relationship.[3] Some examples are presented in Figure 2, showing graphs (on the left) including this particular observation and (on the right) without this observation.
In the first example in Figure 2, the relationship between PHE and THR, there is a very significant relationship between these amino acids, both with and without the data of Fan and Sauer (2002) (left and right graph, respectively). In the second example there is a very significant relationship between HIS and VAL if the data of Fan and Sauer are included, but the significance is much lower without this observation. In the third example there is a very significant relationship between TYR and THR if the data of Fan and Sauer are included (left graph), but without this data the relationship is no longer significant (p: 0.175) although the correlation coefficient still has a reasonable value (r: 0.635). In the fourth example the relationship between ILE and PRO is significant when the data of Fan and Sauer are included, although the relationship was less good than for the other three comparable examples, but after removing this data the relationship was no longer significant.
From Figure 2 it also can be seen that the slope of the relationships between the amino acids is very different in the left and the corresponding right graph.

The number of observations of the dataset in which BEL was determined with the regression method, after deleting observations with FL<2.5*MEm, outliers and the observation of Fan and Sauer, is low ($\leq$ 8). This in combination to the inaccuracy of the amino acid determination in the chyme, means that no firm conclusions can be drawn. This is also demonstrated by a combined observation of the Tables 19 and 20. In Table 19 the correlation matrix is presented for the relationships between the amino acids of the dataset where the BEL pattern was studied using the regression method. In this Table not only the observations with FL<2.5*MEm and outliers were deleted, but also the data from the study of Fan and Sauer (2002). In Table 20 the significances of the correlation coefficients are given.
In Table 19 in 42 cases the correlation coefficient was $\geq$0.80 and in 14 cases between 0.70 and 0.80. All these coefficients were significant, as could be deduced from Table 20. From the 45 correlation coefficients between 0.50 – 0.70 in Table 19, it appeared from Table 20 that only in 6 cases the coefficient was significant.

[3] This was an observation from the study of Fan, M.Z. and W.C. Sauer (2002). The values of a second BEL pattern published in this paper were even higher; this pattern was completely deleted, because for >5 amino acids the values were >2*STDEV above the average value of that amino acid.

Table 20. Correlation matrix showing the correlations between amino acids for the dataset of the regression method from which observations with Feeding Levels <2.5*MEm, outliers and the observation of Fan and Sauer (2002) have been deleted. * **

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
CP	1																	
ARG	0.895	1																
HIS	0.802	0.547	1															
ILE	0.815	0.907	0.555	1														
LEU	0.693	0.519	0.859	0.634	1													
LYS	0.667	0.433	0.646	0.563	0.390	1												
MET	0.504	0.423	0.518	0.084	0.504	-0.132	1											
PHE	0.656	0.461	0.880	0.557	0.903	0.426	0.534	1										
THR	0.791	0.681	0.847	0.749	0.900	0.405	0.531	0.942										
VAL	0.906	0.886	0.743	0.958	0.779	0.641	0.249	0.678	0.826	1								
ALA	0.795	0.687	0.859	0.678	0.932	0.392	0.610	0.737	0.813	0.846	1							
ASP	0.771	0.568	0.950	0.691	0.910	0.588	0.455	0.965	0.952	0.816	0.803	1						
CYS	0.324	-0.126	0.750	0.046	0.610	0.565	0.319	0.691	0.484	0.272	0.408	0.697	1					
GLU	0.904	0.907	0.730	0.967	0.652	0.650	0.247	0.579	0.757	0.988	0.770	0.740	0.133	1				
GLY	0.487	0.328	0.222	0.029	-0.115	0.507	0.322	-0.076	-0.073	0.140	0.099	0.006	0.193	0.203	1			
PRO	0.687	0.610	0.419	0.543	0.111	0.814	0.096	0.030	0.127	0.601	0.382	0.236	0.078	0.696	0.977	1		
SER	0.858	0.946	0.644	0.980	0.674	0.435	0.346	0.617	0.818	0.958	0.761	0.720	-0.017	0.953	0.058	0.470	1	
TYR	0.514	0.633	0.262	0.380	0.444	-0.274	0.821	0.540	0.635	0.383	0.480	0.366	-0.314	0.328	0.161	0.048	0.544	1

*: Data for TRP are omitted because of the low number of observations.

**: In this table the colors used have the following meaning:

	R < 0.25		0.00 ≤ R <0.25		0.25 ≤ R < 0.50		0.50 ≤ R < 0.70		0.70 ≤ R < 0.80		R > 0.80

4. Comparison of the average BEL patterns determined in animals fed N-free diets, (low) casein diets and the regression method after deleting observations with FL <2.5*MEm and removal of outliers (see par. 1-3).

In all three datasets there are observations where the BEL pattern is determined at low feedings levels. As the project on the actualization of the 'Table of the amino acid digestibility's of feedstuffs for pigs' will be used for the formulation and feeding of pigs under practical conditions it was decided to delete observations with an estimated feeding level below 2.5*MEm. From the dataset with N-free diets 24 out of 187 observations were removed (12.8%), from the dataset with (low) casein diets 3 out of 26 observations (11.5%) and from the dataset with the regression method 9 out of 19 observations (47.4%).

Table 21. Significances of the correlation coefficients between amino acids for the dataset of the regression method from which observations with Feeding Levels <2.5*MEm, outliers and the observation of Fan and Sauer (2002) have been deleted. * **

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
CP																			
ARG	0.007																		
HIS	0.017	0.204																	
ILE	0.014	0.005	0.154																
LEU	0.057	0.232	0.006	0.092															
LYS	0.071	0.332	0.083	0.146	0.339														
MET	0.202	0.345	0.189	0.843	0.203	0.755													
PHE	0.110	0.297	0.009	0.194	0.005	0.340	0.217												
THR	0.019	0.092	0.008	0.032	0.002	0.319	0.176	0.002											
TRP	0.929	0.962	0.385	0.906	0.246	0.971	0.212	0.060	0.047										
VAL	0.002	0.008	0.035	0.000	0.023	0.087	0.552	0.094	0.012	0.902									
ALA	0.033	0.088	0.013	0.094	0.002	0.384	0.146	0.059	0.026	0.741	0.017								
ASP	0.043	0.183	0.001	0.086	0.004	0.165	0.305	0.000	0.001	0.131	0.025	0.030							
CYS	0.478	0.811	0.052	0.923	0.146	0.186	0.486	0.128	0.271	0.039	0.555	0.422	0.124						
GLU	0.005	0.005	0.063	0.000	0.112	0.114	0.594	0.173	0.049	0.906	<.0001	0.043	0.057	0.802					
GLY	0.268	0.472	0.632	0.951	0.806	0.246	0.481	0.871	0.876	0.658	0.764	0.833	0.990	0.715	0.663				
PRO	0.132	0.198	0.409	0.265	0.834	0.049	0.857	0.955	0.811	0.595	0.207	0.455	0.652	0.884	0.125	0.001			
SER	0.014	0.001	0.118	0.000	0.097	0.329	0.448	0.140	0.024	0.773	0.001	0.047	0.068	0.975	0.001	0.902	0.347		
TYR	0.297	0.177	0.616	0.458	0.378	0.599	0.045	0.269	0.175	1.000	0.453	0.335	0.475	0.607	0.525	0.761	0.939	0.265	

*: Data for TRP are omitted because of the low number of observations.

**: In this table the colors used have the following meaning:

	0.50 < p ≤ 1.00		0.10 < R ≤ 0.50		0.05 < p ≤ 0.10		0.000 < p ≤ 0.05

From the datasets with (estimated) FL ≥2.5*MEm individual values for each AA and CP that deviated more than 2*STDEV from the average were deleted. When more than 5 amino acids (and CP) were removed the observation was completely removed. This implied that from the dataset with the N-free diets 11 observations were completely removed (6.8 %), from the dataset with (low) casein diets and the dataset with the regression method in both cases 1 observation (4.4 and 10%, respectively).

Table 22 shows that, compared to the other amino acids, the average basal endogenous losses of PRO and GLY are the highest for all three methods. In the dataset for N-free diets especially the value for PRO is very high compared to datasets of the (low) casein diets (64% higher) and the regression method (82% higher). After deleting observations with low feeding levels and the outliers the maximum value for the PRO-loss determined

with (low) casein diets and the regression method was 5.83 and 5.44 g/kg DMI, whereas the highest PRO loss in the dataset with N-free diets was 10.45 g/kg DMI. In this latter dataset for 29 out of 121 observations (24%) a PRO loss >5.4 g/kg DMI was reported.
Further, Table 21 also shows that the average loss of GLY is highest too in the dataset with N-free diets (1.45 g/kg DM versus 1.12 and 0.99 g/kg DMI for the (low) casein diets and the regression method, respectively). Looking for the maximum value for the loss of GLY it appears that the loss for the N-free diets indeed is the highest (2.62 g/kg DMI), but the difference to the (low) casein diets (2,54 g/lg DMI) and the regression method (2.27 g/kg DMI) is not large.

Table 22. Comparison of the number of observations, average values and STDEV for the 3 most often used methods to determine BEL. For all three methods observations with Feeding Level <2.5*MEm have been deleted and outliers have been removed. From the dataset of the regression method also the observations of Fan and Sauer (2002) has been removed.

	BW (kg)	FL in times MEm	Basal endogenous loss g/kg DMI) *																		
			CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
N-free method																					
Number	151	152	136	149	152	149	149	151	147	150	150	121	150	147	151	138	149	145	121	149	124
Average	43.4	2.9	**16.3**	0.56	0.20	0.33	0.55	0.43	0.10	0.36	0.56	0.12	0.49	0.61	0.81	0.20	1.00	**1.45**	**4.08**	0.54	0.28
STDEV.	23.0	0.3	4.6	0.21	0.07	0.09	0.15	0.15	0.04	0.11	0.13	0.04	0.13	0.17	0.21	0.06	0.28	0.51	2.44	0.16	0.09
(Low) Casein method																					
Number	21	22	19	19	19	22	21	22	20	21	22	8	22	14	15	17	15	14	14	14	14
Average	39.4	2.9	13.7	0.48	**0.26**	**0.44**	**0.64**	**0.46**	0.13	0.33	**0.67**	0.13	**0.55**	**0.63**	**0.88**	0.22	1.42	1.12	2.49	**0.80**	0.30
STDEV.	23.7	0.4	5.0	0.18	0.10	0.13	0.13	0.15	0.04	0.10	0.22	0.04	0.13	0.14	0.26	0.10	0.36	0.71	1.81	0.21	0.09
Regression method																					
Number	9	9	9	8	9	9	9	9	9	8	9	4	9	8	8	8	8	8	7	8	7
Average	37.0	3.2	12.0	**0.67**	0.19	0.40	0.63	0.43	**0.14**	**0.38**	0.57	**0.20**	0.54	0.59	0.78	**0.25**	**1.43**	0.99	2.24	0.62	**0.31**
STDEV.	12.8	0.6	5.5	0.76	0.10	0.21	0.45	0.23	0.14	0.28	0.25	0.15	0.32	0.34	0.50	0.29	1.51	0.60	1.92	0.21	0.23

*: For each amino acid the cell with the highest average value of the three methods is hatched light red.

Also, the average CP loss is highest in the dataset with N-free diets (16.2 g/kg DMI), which can in part be explained by the high endogenous loss of PRO. Removing the values for the CP loss for all observations with a PRO loss >5.4 g/kg DMI resulted in a decrease of the CP loss from 16.4 $\pm$ 4.6 g/kg DMI (136 observations) to 15.1 $\pm$ 4.2 g/kg DMI (108 observations). This value further decreased to 14.0 $\pm$ 3.4 g/kg DMI (82 observations) in case also the values for the CP loss were removed for observations where no PRO loss was reported. This latter value is much closer to the average values for the CP loss in the (low) casein diets (13.7 $\pm$ 5.0 g/kg DMI) and the regression method (12.0 $\pm$ 5.5 g/kg DMI).

As has been suggested earlier, it is likely that the extremely high basal endogenous losses of PRO are an artefact of the N-free method. Also, with the two other methods sometimes high(er) PRO losses are reported, but the values are not as extreme as in the case of the N-free diets.

Table 21 further shows that for 9 amino acids the highest average values for BEL are found with the (low) casein diets. For 7 amino acids the average BEL value was highest in the dataset for the regression method. Only for two amino acids (GLY and PRO) and for CP the average values were highest in the dataset with N-free diets.
Concerning this discussion, it should be noted that the dataset of BEL patterns determined with the regression method is small (maximum number of observations, inclusive the observation of Fan and Sauer (2002), for several amino acids is only 9) compared to the two other methods. Of these two last methods the dataset with N-free diets is about 7 times larger than that the dataset with the low casein diets and at least 15 times larger than the dataset of the regression method.

5. Evaluation of the relationships between amino acids in the various datasets

The Tables 1, 4 and 6 show that in the dataset in which the BEL pattern in the ileal chyme was determined by using N-free diets the level of PRO is much higher than that for the two other amino acids. Further, the variation of the level of CP in the ileal chyme is determined to a substantial extent by the PRO level. In the scientific literature it is often suggested that the high levels of PRO are, at least partially, an artefact.
To get more insight in the variation in the levels of CP and amino acids in BEL, it was examined whether the variation in one amino acid might be related to that of other amino acids. In Figure 1 the relationships of all amino acids to GLU are presented. In Table 2 the relationships of all amino acids to GLU, THR and PRO is given. In the Tables 3, 5 and 7 correlation matrixes are presented for the complete dataset with N-free diets, as well as for this dataset after deleting observations with low FL and also after removing outliers, respectively. From Table 7 and 9 (showing the significances of the correlation coefficients) it was concluded that the relationships of all amino acids to PRO were worst, indeed indicating that this amino acid showed a deviating behavior. For the amino acids GLY and ARG this also may be a point of discussion.

If the different behavior of PRO (and to a lesser degree also GLY and ARG) in the BEL of animals fed N-free diets is caused by the absence of protein, it was expected that PRO would not show this behavior in animals fed (low) casein diets or in BEL patterns determined with the regression method. The fact that these datasets are much smaller than that of N-free diets is a serious restriction to evaluate this assumption. The dataset with low casein diets includes several observations in which only the essential amino acids were analyzed in the chyme. So, the number of observations for non-essential amino acids is 6 – 7 less (approx. 33%) than for the essential amino acids.

For the low casein diets (after deleting low FL and outliers) the correlation matrix is presented in Table 13, whereas the significances of the correlation coefficients are shown in Table 15. Contrary to what was expected, the R-value for the relationships between the amino acids was below 0.50 for approx. 60% of the situations. The number of situations where the correlation coefficient was not significant was comparable. So, this dataset did not support our expectation.
Likely due to the difference in the number of observations, Table 15 shows that, except for HIS (and MET), most relationships between essential amino acids in the (low) casein dataset are (strongly) significant, whereas for non-essential amino acids (except for ALA and ASP) the relationship to essential and other non-essential amino acids is not significant. Further, it is worthwhile to mention that the situation differs largely between amino acids in the (low) casein dataset

- For HIS there is no significant relationship to CP or any other amino acid.
- For PRO and GLY there are no significant relationships to most of the other amino acids, but for CP and some amino acids the relationship is highly significant.
- Contrary, for ILE, ARG, VAL, ALA and ASP there is a significant relationship to CP and most of the other amino acids.

For the dataset with BEL patterns determined with the regression method many studies had to be deleted because of the low feeding level. After removing outliers (especially two BEL patterns from a study of Fan and Sauer, 2002), a small dataset remained. In fact, this dataset is too limited for an in-depth examination of the relationships between amino acids. From Table 20 and 21 it can be concluded that, although for several amino acids the correlation coefficient has an R-value between 0.50 – 0.70, this coefficient is not significant. So, this dataset was not adequate to evaluate the assumption that loss of PRO (and GLY and ARG) do not show deviating behavior in the chyme of animals fed protein containing diets.

6. Various calculations to obtain an overall pattern for the Basal Endogenous Loss

6.1 Option 1: First calculate the arithmetic average for each of the three methods used to determine the basal endogenous loss and subsequently calculate the arithmetic averages of these three arithmetic averages.

In Table 23 the results are presented for the calculation of an overall BEL pattern in which final mean values were calculated by taking the averages of the average values presented in Table 6 (N-free diet), 12 (low casein diet) and 18.b (regression method without the observation of Fan and Sauer, 2002). From all these datasets observations with FL <2.5*MEm and outliers were deleted.
In this option the contribution of all three methods to the final mean value is equal, irrespective the large differences in the number of observations, which implies that the limited datasets of the (low) casein diets and the regression method have a strong effect on the calculated averages.

Table 23. Overall pattern for the Basal Endogenous Loss of CP and AA, obtained by calculating the mean values of the averages obtained for the three methods after deleting the observations with low Feed Intake and after deleting the outliers.

	Basal endogenous loss g/kg DMI)																		
	CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Number	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	13.50	0.48	0.21	0.37	0.56	0.42	0.11	0.32	0.58	0.13	0.49	0.57	0.77	0.19	1.11	1.13	2.76	0.63	0.27
STDEV.	2.91	0.08	0.05	0.06	0.08	0.04	0.02	0.04	0.09	0.01	0.06	0.08	0.13	0.04	0.27	0.32	1.21	0.14	0.04
STDEV/Average *	0.22	0.16	0.24	0.16	0.14	0.10	0.16	0.12	0.15	0.05	0.11	0.14	0.17	0.22	0.25	0.28	0.44	0.23	0.13

*: Values between 0.10 – 0.20 are marked light grey; between 0.20 – 0.30 middle grey and >0.30 dark grey.

6.2 Option 2: Pool all observations of the three methods and calculate the arithmetic averages for CP and amino acids.

In this calculation the pooled observations were used of each of the three methods from which observations with low feeding levels were deleted and (subsequently) outliers were removed.
The result of this option is presented in Table 24. In this option, the calculated averages are mainly determined by the N-free diets.

Table 24. Overall pattern for the Basal Endogenous Loss of CP and AA, calculated after pooling all data of the individual datasets with N-free diets, (low) casein diets and the regression method. The datasets pooled were the complete sets for each method from which observations with low Feeding Level were deleted and from which outliers have been removed.

	Basal endogenous loss g/kg DMI)																		
	CP	**ARG**	**HIS**	**ILE**	**LEU**	**LYS**	**MET**	**PHE**	**THR**	**TRP**	**VAL**	**ALA**	**ASP**	**CYS**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Number	163	176	182	179	179	181	175	178	180	132	180	169	173	162	171	166	141	170	144
Average	15.73	0.55	0.21	0.34	0.55	0.43	0.10	0.35	0.57	0.12	0.49	0.60	0.80	0.20	1.03	1.39	3.82	0.56	0.28
STDEV.	4.76	0.21	0.13	0.10	0.15	0.15	0.04	0.11	0.15	0.04	0.13	0.17	0.22	0.07	0.31	0.54	2.43	0.18	0.09
STDEV/Average *	0.30	0.38	0.62	0.31	0.28	0.35	0.39	0.31	0.26	0.30	0.27	0.29	0.27	0.33	0.30	0.39	0.64	0.31	0.32
Min.	3.1	0.14	0.08	0.13	0.22	0.18	0.02	0.13	0.24	0.04	0.22	0.20	0.29	0.03	0.23	0.13	0.02	0.21	0.10
Max.	27.9	1.11	1.29	0.65	0.93	0.78	0.22	0.65	1.00	0.22	0.81	1.03	1.35	0.42	2.11	2.61	10.45	1.19	0.47

*: Values between 0.10 – 0.20 are marked light grey; between 0.20 – 0.30 middle grey and ≥0.30 dark grey.

6.3 Option 3: Calculation of a weighted average for the three methods.

For calculation of the weighted average the following data and steps are necessary (See Table 25):

- The number of observations per method (stap 1a, 2a and 3a).
- The weighing factor (= √ of the number of observations for each item and each method) (step 3a, 3b and 3c).
- The sum of the endogenous losses of all observations for CP and each amino acid per method (step 4a, 4b and 4c).
- Calculation of the Sum of the 'Sum of the losses / weighing factor of the three methods' (step 5): this implies first a calculation of the (Sum of losses of n/weighing factor) per method followed by summing of the data of the three methods.
- Calculation of the Sum of the weighing factors (step 6).
- Calculation of the weighted average (step 7) by dividing the result of step 5 by the result of step 6.

7. Proposal for the general BEL pattern to be used

For the project on the actualization of the ileal digestibility of feed ingredients for pigs It is proposed to use the BEL pattern based on the weighted average of the three methods for determination of BEL, as presented in Table 25. This pattern will be used for the following purposes:

- Recalculation of SID coefficients *of the diets* into SID coefficients *of the test ingredient*
- Recalculation of *AID* coefficients of the test ingredient into *SID* coefficients

As the BEL value of PRO is substantially higher than that of the other amino acids this value will be used only under the condition that the calculated SID of PRO does not deviate more than 5%-units from the average of the SID's of all amino acids except for PRO. If this is the case, the average value for all SID coefficients will be used.

Further this general BEL pattern should be used in setting the requirements for piglets and growing/fattening pigs.

Table 25. Basal endogenous losses calculated as the weighted averages of the arithmetic average values of the three individual datasets (from which in each case the observations with a feeding level <2.5 * maintenance requirement for energy and of values deviating more than 2*STDEV from the average values were deleted. For an explanation for the steps in the calculation of the weighted average see text.

Item	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
	Basal ileal endogenous loss (g/kg DMI)																		
N-free diets																			
1a. n	136	149	152	149	149	151	147	150	150	121	150	147	151	138	149	145	121	149	124
2a. Average (g/kg DMI)	16.30	0.56	0.20	0.33	0.55	0.43	0.10	0.36	0.56	0.12	0.49	0.61	0.81	0.20	1.00	1.45	4.08	0.54	0.28
3a. Weighing factor (= √n)	*11.66*	*12.21*	*12.33*	*12.21*	*12.21*	*12.29*	*12.12*	*12.25*	*12.25*	*11.00*	*12.25*	*12.12*	*12.29*	*11.75*	*12.21*	*12.04*	*11.00*	*12.21*	*11.14*
4a. Sum losses of n	2218.5	83.3	29.8	48.6	81.7	65.0	14.5	53.5	84.5	14.9	73.3	89.3	121.7	27.9	148.3	210.0	494.0	80.4	34.8
Casein diets																			
1b. n	19	20	22	22	22	22	20	21	22	8	22	15	15	17	15	14	14	14	14
2b. Average (g/kg DMI)	13.7	0.48	0.26	0.44	0.64	0.46	0.13	0.33	0.67	0.13	0.55	0.63	0.88	0.22	1.42	1.12	2.49	0.8	0.3
3b. Weighing factor (= √n)	*4.36*	*4.47*	*4.69*	*4.69*	*4.69*	*4.69*	*4.47*	*4.58*	*4.69*	*2.83*	*4.69*	*3.87*	*3.87*	*4.12*	*3.87*	*3.74*	*3.74*	*3.74*	*3.74*
4b. Sum losses of n	261.0	10.0	7.9	9.6	13.7	10.1	2.7	6.8	14.8	1.0	12.0	9.0	13.2	3.7	21.3	15.7	34.9	11.2	4.1
Regression method																			
1c. n	8	7	8	8	8	8	8	7	8	3	8	7	7	7	7	7	6	7	6
2c. Average (g/kg DMI)	10.50	0.41	0.16	0.34	0.48	0.38	0.10	0.28	0.50	0.13	0.44	0.48	0.62	0.14	0.91	0.81	1.71	0.56	0.23
3c. Weighing factor (= √n)	*2.83*	*2.65*	*2.83*	*2.83*	*2.83*	*2.83*	*2.83*	*2.65*	*2.83*	*1.73*	*2.83*	*2.65*	*2.65*	*2.65*	*2.65*	*2.65*	*2.45*	*2.65*	*2.45*
5. Sum losses/weighing factor for:																			
N-free diets (= 4a/3a)	190.2	6.8	2.4	4.0	6.7	5.3	1.2	4.4	6.9	1.4	6.0	7.4	9.9	2.4	12.1	17.4	44.9	6.6	3.1
Casein diets (= 4b/3b)	59.9	2.2	1.7	2.0	2.9	2.2	0.6	1.5	3.1	0.4	2.6	2.3	3.4	0.9	5.5	4.2	9.3	3.0	1.1
Regression method (= 4c/3c)	29.8	1.1	0.5	1.0	1.4	1.1	0.3	0.7	1.4	0.2	1.2	1.3	1.6	0.4	2.4	2.1	4.2	1.5	0.6
5. Sum three methods of 'sum losses of n / weighing factor'	*279.9*	*10.1*	*4.6*	*7.0*	*11.0*	*8.5*	*2.1*	*6.6*	*11.4*	*1.9*	*9.8*	*11.0*	*14.9*	*3.6*	*20.1*	*23.8*	*58.4*	*11.1*	*4.8*
6. Sum weighing factors (= 3a + 3b + 3c)	*18.85*	*19.32*	*19.85*	*19.73*	*19.73*	*19.81*	*19.42*	*19.48*	*19.77*	*15.56*	*19.77*	*18.64*	*18.81*	*18.52*	*18.73*	*18.43*	*17.19*	*18.59*	*17.33*
7. Weighted average (= 5/6)	**14.85**	**0.52**	**0.23**	**0.35**	**0.56**	**0.43**	**0.11**	**0.34**	**0.58**	**0.12**	**0.49**	**0.59**	**0.79**	**0.20**	**1.07**	**1.29**	**3.40**	**0.59**	**0.28**

ANNEX II: Poster presented at the 15th International Symposium Digestive Physiology in Pigs (DPP 2022) in Rotterdam (17-20 May 2022).

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Basal endogenous amino acid losses in the digestive tract are determined by experimental conditions, a meta-analysis

Machiel Blok, Wouter Spek, Paul Bikker

Poster 104

Background

Basal endogenous losses (BEL) are caused by the passage of a diet through the digestive tract. The magnitude of BEL varies substantially between studies. We hypothesized that BEL is experiment specific. Hence, AID of AA depends on the BEL of that experiment, whereas SID is independent of BEL.

Objectives

Testing the hypothesis by conducting a meta-analysis of peer-reviewed studies reporting both the AID and SID of CP and AA of corn, as well as the BEL determined with N-free diets in the same study.

Material and Methods

- Dataset: 18 peer-reviewed studies: 16 (27 observations) reporting both AID and SID; 2 (5 observations) reporting only SID. For 1 study with 9 observations and high BEL values for most AA, the averages of all observations were used (Table 1).
- BEL was determined in all studies, using a N-free diet.
- Linear regression BEL (x) and AID and SID (y) for CP and each AA.

Table 1. Some characteristics of the dataset.

	CP	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	TRP	ALA	ASP	CYS	GLU	GLY	PRO	SER	TYR
	Apparent Ileal Digestibility (%)																		
Average	62.8	73.7	76.4	72.0	82.0	61.5	83.0	77.1	61.4	70.3	58.2	74.7	68.0	70.8	81.3	36.6	35.7	71.3	74.9
Min	49.0	62.2	60.0	61.3	75.5	49.4	77.0	57.0	49.2	54.2	43.5	65.8	56.0	54.0	76.0	0.4	-71.0	57.0	65.0
Max	75.0	85.2	85.4	83.6	88.0	77.3	88.9	85.2	76.1	79.2	83.1	84.5	80.9	80.1	88.6	73.2	93.2	80.6	83.4
	Standardized Ileal Digestibility (%)																		
Average	79.8	89.6	84.8	81.2	87.2	76.2	87.1	84.9	76.7	77.3	81.0	83.9	79.7	79.5	86.9	81.2	98.3	82.1	85.3
Min	69.5	79.5	79.5	73.4	81.4	67.4	82.3	75.9	66.4	61.2	73.5	77.7	72.2	61.0	73.9	56.2	47.2	65.0	76.9
Max	90.0	100.1	92.2	90.0	92.8	87.0	91.9	92.4	88.9	95.4	90.8	91.2	89.4	90.2	93.0	107.4	193.3	91.2	93.7
	Basal Endogenous Losses for AIDC observations (g/kg DM) *																		
Average	15.6	0.6	0.2	0.3	0.5	0.4	0.1	0.3	0.5	0.1	0.5	0.6	0.7	0.2	1.0	1.4	4.8	0.5	0.3
Min	8.5	0.3	0.1	0.2	0.2	0.2	0.1	0.2	0.3	0.1	0.3	0.3	0.4	0.1	0.6	0.5	0.6	0.3	0.1
Max	25.7	1.3	0.5	0.7	0.9	0.7	0.2	0.9	0.7	0.2	0.8	1.0	1.2	0.3	1.5	2.5	14.2	0.8	0.6
	Basal Endogenous Losses for SIDC observations (g/kg DM) *																		
Average	17.0	0.7	0.2	0.3	0.5	0.5	0.1	0.4	0.5	0.1	0.5	0.6	0.8	0.2	1.2	1.4	5.1	0.5	0.3

*: Minimum and maximum losses were identical for BEL for AID observations. The were more observations of BEL for SIDC than of BEL for AIDC

Results and discussion

- A negative relationship (P<0.05) between AID and BEL was observed for CP and 9 AA (CP, ARG, HIS, PHE, THR, ALA, ASP, GLY, PRO), and a trend (P<0.1) for 2 AA (GLU, SER). The relationship was not significant for 7 AA (ILE, LEU, LYS, MET, TRP, CYS, TYR) For some AA this was due to the low level of BEL compared to the content of that AA in corn.
- The relationship between SID and BEL was not significant for CP and 13 AA (HIS, ILE, LEU, LYS, MET, PHE, THR, TRP, VAL, ALA, ASP, CYS, GLU, GLY, SER). Only for ARG and PRO this relationship was significant.

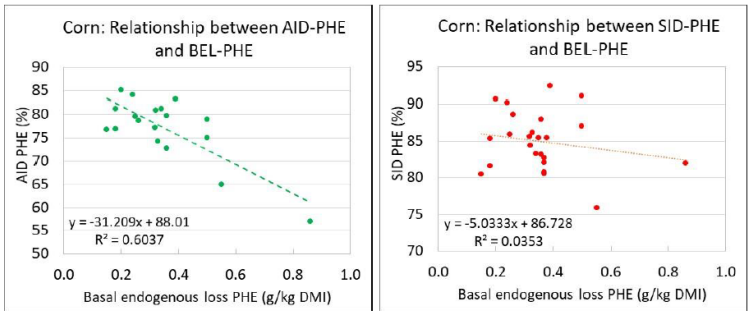

Figure 1. Example of the relationship between AID and SID to BEL. Left: Between AID-ARG and BEL; Right: Between SID-ARG and BEL.

Conclusion

These results confirm that Basal Endogenous Losses are experiment specific. Therefore experiment specific BEL rather than a fixed BEL pattern from the literature, should be used to calculate SID values from experimentally determined AID values.

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Annex III: Overview of feedstuffs included in the CVB Feed Table for which no new observations were found in the literature.

Feedstuffs in the CVB Feed Table for which no new information was found in the literature

Barley feed, high grade
Barley, mill by-product
Maize feed flour
Maize feed meal
Brewer's grains, dried
Brewer's grains, high moisture (2 qualities)
Brewer's yeast, liquid (3 qualities)
Cheese whey, fresh (3 qualities)
Citrus pulp
Corn cob mix (CCM), silage (3 qualities)
Cotton seeds (2 qualities)
Feed beans, heat treated
Maize feed meal, solvent extracted
Maize gluten feed, fresh and ensiled (2 qualities)
Maize, distillers solubles, dried
Milk powder, whole
Molasses, sugar beet
Molasses, sugarcane (2 qualities)
Niger seed
Palm kernels
Pea creme
Pea fiber
Pea protein, liquid
Potato crisps
Potato cuttings/chips, pre-fried (3 qualities)
Potato peelings, steamed (4 qualities)
Potato pulp, dried (2 qualities)
Rice husk
Rye feed
Sorghum gluten meal
Sugar beet pulp, pressed, ensiled
Sweet potatoes, dried
Vinasse, beet (2 qualities)
Wheat germ feed
Wheat gluten feed, dried (4 qualities)

For these feedstuffs either the current SIDC evaluation is maintained or a new SIDC evaluation has been proposed in Chapter 3, using the data of a closely related feedstuff.
Most of these ingredients have (very) low protein contents and/or are of little practical importance and/or are only locally available (e.g., certain high moisture feed materials).