CENTRAAL INSTITUUT VOOR LANDBOUWKUNDIG ONDERZOEK
AFD. DROOGTECHNISCH LABORATORIUM

GREEN CROP DRYING AT THE NETHERLANDS

FIVE REPORTS FOR THE
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THIS PUBLICATION IS A REPRINT OF THE FOLLOWING PAPERS, PRESENTED AT THE VIIITH INTERNATIONAL CONGRESS OF AGRICULTURAL INDUSTRIES, BRUSSELS 1950:

PAGE 10 GIVING THE RESULTS OF RECENT MEASUREMENTS, HAS BEEN ADDED AFTERWARDS.

I. CONSIDERATIONS ON THE TECHNIQUE OF PRODUCTION

BY

IR M.L.'T HART

THE FIRST TRIALS ON ARTIFICIAL DRYING OF GRASS WERE MADE IN 1948 UNDER SUPERVISION OF DR FRANKENA. SOON CONSIDERABLE DEVELOPMENTS WERE NOTICEABLE AND AT THE SAME TIME ALSO DRYING OF LUCERNE BECAME OF GREAT IMPORTANCE.

THE TOTAL PRODUCTION IN 1948 AMOUNTED TO 50.000 TONS, 55 PER CENT OF WHICH WAS DRIED GRASS AND 45 PER CENT DRIED LUCERNE AND RED CLOVER.

ARTIFICIAL DRYING HAS BECOME A GENERAL PRACTICE FOR TWO TYPES OF HOLDING, VIZ. FOR PURE PASTURE HOLDINGS, FOR THE SELF-SUPPLY OF FODDER DURING THE WINTER MONTHS AND FOR ALMOST PURE ARABLE HOLDINGS WITH LITTLE LIVESTOCK FOR DRYING LUCERNE FOR SALE.

ON THE PASTURE HOLDINGS ONLY A SMALL PROPORTION OF THE GRASS IS DRIED ARTIFICIALLY, USUALLY NOT MORE THAN 200 - 500 KGS PER HA OF GRASSLAND OR 3 - 6 % OF THE TOTAL GRASS YIELD. ONLY IN EXCEPTIONAL CASES THE WHOLE GRASS CROP OF A FARM IS DRIED AND SOLD; THE GENERAL OPINION IS THAT IT WILL BE VERY DIFFICULT INDEED TO MAINTAIN THE FERTILITY OF THE SOIL ON SUCH HOLDINGS IN THE COURSE OF YEARS.

IN AREAS OF MIXED FARMING, IT IS DIFFICULT TO SUPPLY THE DRYING PLANTS REGULARLY WITH SUFFICIENT RAW MATERIAL, THE CAUSE BEING ON THE ONE HAND THAT ON PASTURE TYPES OF FARMS WHERE ORGANIC MANURE IS REGULARLY APPLIED TO THE GRASSLAND, GROWTH IS MORE REGULAR DURING SUMMER AND, ON THE OTHER HAND, THAT ON MIXED FARMS MOST OF THE GRASSLAND IS PASTURE, BEING REGULARLY GRAZED AND ONLY IN SPRING AND EARLY SUMMER SOME GRASS CAN BE SPARED FOR PRESERVATION TO WINTER FODDER. ON GRASSLAND FARMS A MUCH LARGER PROPORTION OF THE GRASS YIELD IS SAVED FOR WINTER FODDER (UP TO 40 % OF THE ANNUAL YIELD) AND IT IS MUCH EASIER TO SUPPLY THE DRYING PLANTS REGULARLY WITH SOME OF THE GRASS PRODUCED.

IN PRACTICE, HOWEVER, ALSO GRASSLAND FARMS ARE RATHER SHORT OF GRASS DURING THE MONTHS OF JUNE AND JULY, AND CONSEQUENTLY ALSO IN GRASSLAND DISTRICTS THE DRYING PLANTS SUFFER FROM A SHORTAGE OF RAW MATERIAL, PARTICULARLY IF THE WEATHER IS UNFAVOURABLE FOR THE GRASS CROP.

IN ORDER TO MEET THE DIFFICULTY OF SHORT SUPPLIES DURING THE SUMMER MONTHS, SEVERAL MEASURES IN THE FIELD OF GRASSLAND MANAGEMENT CAN BE TAKEN. SUPPLEMENTATION OF THE WATERSUPPLY BY SUB-IRRIGATION (INFILTRATION) IS APPLIED IN SEVERAL DISTRICTS OF THE NETHERLANDS; SPRINKLING IS TRIED OUT IN COLLABORATION WITH ONE OF THE DRYING PLANTS. BOTH METHODS RENDER SATISFACTORY RESULTS BUT YET IN SEVERAL CASES FURTHER INVESTIGATIONS ARE NECESSARY IN ORDER TO ASCERTAIN THAT THESE METHODS ARE REALLY PAYING PROPOSITIONS. PROPER MANURIAL TREATMENT AND MORE PARTICULARLY ORGANIC MANURING ARE UNDOUBTEDLY OF GREAT SIGNIFICANCE TO A SATISFACTORY GROWTH OF GRASS DURING THE SUMMER.

IN PRACTICE IT IS POSSIBLE TO ACHIEVE 1500 - 2500 EFFECTIVE RUNNING HOURS A YEAR FOR A DRYING PLANT IN A GRASSLAND DISTRICT, ASSUMING THAT THE WEATHER CONDITIONS ARE NORMAL, BUT THE NUMBER OF EFFECTIVE RUNNING HOURS A YEAR

IN MIXED FARMING DISTRICTS IS OFTEN NOT MORE THAN 1000 - 1500.

ANOTHER IMPORTANT ITEM IS THE INFLUENCE OF GRASSLAND MANAGEMENT AND THRIVING CONDITION OF THE GRASS CROP ON THE QUALITY OF THE DRIED ARTICLE. THE DECIDING MEASURE OF VALUE OF THE GRASS IS ITS PROTEIN CONTENT, WHICH CAN VARY FROM 5 - 30 % OF THE DRY MATTER. THIS VARIATION DEPENDS TO A LARGE DEGREE UPON THE STAGE OF MATURITY OF THE GRASS, WHEN MOWN AND ITS MANURIAL TREATMENT. ESPECIALLY IN EARLY SUMMER THE PROTEIN CONTENT DROPS QUICKLY WHEN THE GRASS GETS OLDER. IF GRASS OF A 5 WEEKS GROWTH IS MOWN IN MAY, IT CAN BE ASSUMED, THAT, UNDER DUTCH CONDITIONS, THE CRUDE-PROTEIN CONTENT WILL BE 18 - 20 % IN THE DRY MATTER, IN JUNE - JULY 15 - 17 % AND AFTER JULY IT WILL INCREASE TO 20 - 25 %.

IN EARLY SUMMER A DELAY IN MOWING OF ONE WEEK CAUSED A DROP OF THE PROTEIN CONTENT OF 1,5 %. IF 17 % CRUDE-PROTEIN IN THE DRY MATTER IS CONSIDERED TO BE THE MINIMUM AIMED AT, THE CONSEQUENCE WILL BE THAT A FIRST CUT OF GRASS CAN ONLY BE MOWN UP TO 20TH MAY, AND AFTER THAT DATE RECOURSE SHOULD BE TAKEN TO A SECOND CUT OR TO GRASSLAND, THAT THEN HAS ALREADY BEEN GRAZED ONCE. IN LATE-SUMMER THE CONTENT DROPS SLOWER AS THE GRASS DOES NOT DEVELOP ANY MORE INFLORESCENCE-STALKS. BY MOWING WHILE THE GRASS IS STILL YOUNG ENOUGH ONE CAN MAKE SURE OF A SATISFACTORILY HIGH PROTEIN CONTENT, BUT A PAYING YIELD MUST AMOUNT TO APPROXIMATELY 2000 KGS DRY MATTER PER HA AND IT IS ONLY POSSIBLE TO ATTAIN THIS COMBINATION OF SATISFACTORY YIELD AND SATISFACTORY QUALITY WITH A WELL THRIVING CROP. IN SUMMER IT OFTEN PROVES IMPOSSIBLE TO COMPLY WITH THESE REQUIREMENTS AND THEREFORE THE QUALITY OF THE DRIED GRASS IS LEAST SATISFACTORY IN THE MONTHS OF JUNE AND JULY. BY APPLYING NITROGENEOUS MANURES, IT IS POSSIBLE TO APPROXIMATE THE TARGET, AS THEY STIMULATE GROWTH. BY APPLYING 40 KGS PURE N PER HA PER CUT THE YIELD OF 2000 KG DRY MATTER AIMED AT IS ATTAINED SOME 10 - 14 DAYS SOONER, AND THE GRASS CAN BE CUT AT A YOUNGER STAGE. IN ADDITION AN APPLICATION OF NITROGEN RESULTS IN AN INCREASE OF PROTEIN CONTENT (WITHOUT ALTERING THE DATE OF MOWING), BUT THIS AFFECT VARIES, AMOUNTING TO AN APPROXIMATE AVERAGE OF 1 % CRUDE-PROTEIN IN GRASS OF ONE MONTH GROWTH BY APPLICATION OF 40 KG N/HA.

THE EFFECT OF NITROGEN IS SHOWN CLEARLY BY THE AVERAGE CRUDE-PROTEIN CONTENTS DETERMINED DURING THE WAR, WHEN NITROGENOUS FERTILIZERS WERE SCARCE.

1941	17,9 %
1942	17,2 %
1943	16,2 %
1944	15,5 %
1946	17,4 %
1947	17,5 %
1948	18,1 %

IT IS COMMON PRACTICE TO APPLY THE NITROGEN AT THE BEGINNING OF THE GROWING SEASON; BY LATER APPLICATIONS E.G. 10 DAYS BEFORE MOWING, THE CRUDE-PROTEIN CONTENT CAN INCREASE MORE YET, BUT THEN THERE IS THE RISK THAT THE GRASS WILL CONTAIN SOME NITRATES WHEN MOWN, WHICH COULD ENDANGER THE

HEALTH OF LIVESTOCK. THE SAME CAN OCCUR, HOWEVER, WITH VERY LARGE APPLICATIONS AT THE BEGINNING OF THE GROWING SEASON. CONSEQUENTLY NOT MORE THAN 40 - 50 KGS PURE N PER HA ARE USUALLY APPLIED PER CUT.

AS HAS ALREADY BEEN MENTIONED, IN ADDITION TO GRASS, LUCERNE IS DRIED ARTIFICIALLY ON A LARGE SCALE. THIS CROP IS GROWN WITH THE AIM TO DRY AND THEN TO SELL IT; BUT PART OF THE CROP IS SOMETIMES MADE INTO HAY. IN THIS CASE THE DRYING PLANTS ARE USUALLY REGULARLY SUPPLIED WITH RAW MATERIAL AS THE CROP IS LESS SUSCEPTIBLE TO DROUGHT AND THE PROTEIN CONTENT DOES NOT DROP SO QUICKLY WHEN THE CROP GETS MORE MATURE. WITH THE FIRST CUT E.G. A DROP HAS BEEN NOTICED OF 1,0 % PER WEEK, AND CONSEQUENTLY ROUND 15TH JUNE THE CRUDE-PROTEIN CONTENT OF THE DRY MATTER WAS STILL 18 %.

FOUR CUTS ARE DRIED, THE FIRST CUT BEING THE HEAVIEST ESTIMATED AT AN AVERAGE YIELD OF 4000 - 5000 KGS OF THE DRIED ARTICLE PER HA, THE FOURTH ONE BEING THE LIGHTEST WITH AN AVERAGE OF 800 KGS DRY PER HA.

BETWEEN THE FIRST AND SECOND CUT A PERIOD OF A FEW WEEKS OCCUR WITH A SHORTAGE OF SUFFICIENT RAW MATERIAL OF SATISFACTORY QUALITY. IN THE AUTUMN RATHER LARGE QUANTITIES OF RED CLOVER ARE DRIED, WHICH WAS GROWN WITH A NURSE CROP OF CEREALS.

II. THE TECHNICAL ARRANGEMENT OF GREEN CROP DRYING PLANTS

BY

PROF. IR J.J.I.SPRENGER

GENERAL CONSIDERATIONS. ACCORDING TO THEIR DESIGN THE DRIERS NOW OPERATING IN THIS COUNTRY CAN BE DIVIDED INTO TWO GROUPS:

1. MECHANICAL TRANSPORTATION DRIERS. THE MATERIAL TO BE DRIED IS TRANSFERRED MECHANICALLY.
2. PNEUMATIC DRIERS. THE MATERIAL TO BE DRIED IS FLOATING IN A CURRENT OF AIR BY WHICH IT IS TRANSFERRED AND DRIED.

IN BOTH CASES DRYING IS ACCOMPLISHED BY HOT AIR, THE TEMPERATURE BEING 100 - 200° C AT THE INLET OF CONVEYOR DRYING PLANTS; BUT WITH PNEUMATIC PLANTS MUCH HIGHER TEMPERATURES ARE APPLIED (UP TO 800° C).

FOR ECONOMIC REASONS VACUUM DRIERS ARE NOT USED FOR DRYING FODDER CROPS.

IN THE DRYING PROCESS ALWAYS TWO STAGES CAN BE DISTINGUISHED VIZ.:

I. FROM THE ORIGINAL MOISTURE CONTENT UP TO THE MOMENT THAT THE VAPOUR PRESSURE DROPS NOTICEABLY (27 - 32 % MOISTURE CONTENT DRY BASIS). DURING THIS STAGE THE SURFACE WATER AND THE WATER IN THE WIDE PORES OF THE GRASS EVAPORATES; AND

II. FROM THIS STATE OF HUMIDITY TILL THE FINAL MOISTURE CONTENT (8 - 13,5 % D.B.) HAS BEEN ATTAINED. DURING THIS STAGE OF THE PROCESS CAPILLARY WATER IS REMOVED FOR WHICH MUCH WORK IS REQUIRED. THE TEMPERATURE OF THE MATERIAL ALSO RISES RAPIDLY HERE.

ACCORDING TO EXPERIMENTS PERFORMED BY AUTHOR THE RATE OF EVAPORATION DURING BOTH STAGES IS ACCURATELY EXPRESSED BY THE FORMULA:

$$-\frac{DW}{DT} = \frac{W - A}{B} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

W = MOISTURE CONTENT IN PER CENT OF DRY MATTER (DRY BASIS).
T = TIME REQUIRED FOR DRYING.
A AND B ARE CONSTANTS, BUT THEY ARE DIFFERENT FOR EACH STAGE.

BY INTEGRATION, THE FOLLOWING EQUATION WILL BE DERIVED FROM (1):

$$LN\ (W - A) = -\frac{T}{B} + C \quad \ldots\ldots\ldots\ldots\ldots (2)$$

THE VALUE OF THE CONSTANT C BEING: LN $(W_O - A)$. IN CONSEQUENCE OF HEATING OF THE MATERIAL WHEN THE PROCESS IS STARTED, SMALL DEVIATIONS OF LN $(W_O - A)$ ARE OBSERVED AT FIRST IN REGARD TO THE CALCULATED VALUE OF C.

ACCORDING TO THE DESIGN OF THE DRYING PLANTS USED, AS A RULE RESULTING FROM PRACTICAL EXPERIENCE, THESE TWO STAGES ARE SOMETIMES OBVIOUSLY SEPARATE AND IN OTHER CASES NOT.

THERE ARE DRIERS OPERATING CONTINUOUSLY BUT ALSO PLANTS ACTING ACCORDING TO A BATCH SYSTEM.

GENERALLY, HOWEVER, CONTINUITY WILL BE PREFERRED.

MECHANICAL TRANSPORTATION DRIERS CAN BE SUBDIVISED AGAIN, VIZ.

A. SIMPLE TRAY DRIERS
B. ROTATING DRUM DRIERS
C. BAND CONVEYOR DRIERS
D. TUNNEL DRIERS
E. SPIRAL TUBE DRIERS

THE DIFFICULTY EXPERIENCED WITH TRAY DRYING IS THAT FOR PRACTICAL REASONS IT IS NECESSARY TO BLOW THE AIR THROUGH THE GRASS FROM UNDERNEATH TO THE TOP. THE VELOCITY OF THE AIR CURRENT IS LIMITED AS THE GRASS TOP LAYER WOULD OTHERWISE BE BLOWN FROM ITS PLACE. THE BOTTOM LAYERS DRY QUICKER THAN THE HIGHER ONES AND THEREFORE DRYING MUST BE PERFORMED IN STAGES. THE GRASS CAN BE MIXED BY SLIDING THE PARTLY DRIED GRASS TO A LOWER TRAY AND TURNING IT OVER OR OTHERWISE BY TEDDING.

FOR MODERN GRASS DRYING SIMPLE TRAY DRIERS ARE NOW OBSOLETE.

ROTATING DRUM DRIERS CAN BE LIKENED TO A TRAY BEING ROLLED UP, THE MATERIAL BEING CONTINUOUSLY MOVING INSIDE AS THE DRUM TURNS AROUND ITS AXIS. THE DRYING AIR CAN FLOW THROUGH THE PERFORATED DRUM WALL, THE GRASS BEING REPEATEDLY LIFTED UP BY PROJECTIONS ON THE INNER DRUM SURFACE AND DROPPING DOWN AGAIN BY ITS GRAVITY.

BAND CONVEYOR DRIERS CAN BE COMPARED WITH A SLOWLY MOVING HORIZONTAL TRAY AND CONSEQUENTLY ALSO HERE SHIFTING OF THE GRASS DURING THE PROCESS IS NECESSARY BUT DIFFICULT TO PERFORM. USUALLY THE LAYER OF GRASS PUT ON IS SHALLOWER THAN ON A STATIONARY TRAY, BUT THE RISK THAT GAPS IN THE LAYER WILL BE CAUSED INCREASES. AIR WILL ESCAPE THROUGH THESE GAPS.

USUALLY THESE PLANTS ARE FITTED WITH TWO CONVEYORS MOVING AT DIFFERENT SPEEDS. HEREBY IT IS POSSIBLE TO PROVIDE BOTH CONVEYORS WITH LAYERS OF ABOUT THE SAME THICKNESS IN SPITE OF THE DECREASE OF VOLUME DURING THE DRYING PROCESS.

THE TUNNEL DRIER CONSISTS OF A STATIONARY HORIZONTAL CYLINDER WITH CLOSED SHEETING. THE GRASS IS CONTINUALLY TEDDIED BY INGENIOUSLY FITTED HAYFORKS, FIXED TO A REVOLVING SHAFT IN THE CENTRE.

THE SPIRAL TUBE DRIER IS ACTUALLY A COMBINATION OF A PNEUMATIC AND A TRANSPORTATION DRIER. A SQUARE SPIRAL TUBE IS WOUND AROUND AN OPEN DRUM, THE DRYING AIR FLOWING THROUGH THE SPIRAL. THE GRASS, BEING CHOPPED BEFOREHAND, ENTERS THE OPENING OF THE TUBE AND KEEPS MOVING OWING TO THE ROTATION. WHEN THE MATERIAL IS SUFFICIENTLY DRY, AND THEREFORE HAS ATTAINED A LOW SPECIFIC GRAVITY, IT IS CARRIED OFF WITH THE DRYING AIR.

BY APPLYING CERTAIN SYSTEMS OF DRYING, PARTICULARLY THE PNEUMATIC SYSTEM, IT IS NECESSARY THAT THE GRASS IS CHOPPED UP BEFORE IT ENTERS THE DRIER. AFTER THE DRY ARTICLE HAS BEEN SEPARATED FROM THE DRYING AIR IN A CYCLONE IT ENTERS A HAMMER MILL, WHERE IT IS GROUND INTO MEAL. USUALLY THESE HAMMER MILLS ARE EXPENSIVE MACHINES, AS THEY CONSUME MUCH ELECTRIC POWER (30 - 70 KW). A NEW DEVELOPMENT IS THAT THE DRIED MATERIAL IS MOISTENED, SOME MOLASSES BEING ADDED SOMETIMES, AND PRESSED INTO SMALL CUBES. THIS GIVES RISE TO THE QUESTION, WHETHER IT WOULD NOT BE MORE PRACTICAL TO CHOP THE GRASS UP SOMEWHAT FINER AND AFTER BEING DRIED, PRESS IT INTO CAKES OR TA-

BLETS WITHOUT SUBJECTION TO GRINDING IN A HAMMER MILL.

DRIED GRASS FROM PLANTS ERECTED IN FRIESLAND AND ELSEWHERE BY FARMERS ON THEIR OWN HOLDINGS, THE GRASS NOT BEING CHOPPED UP BEFORE DRYING, IS SOMETIMES BALED JUST LIKE HAY FOR DELIVERY. IN A FEW CASES THE GRASS IS THEN FIRST COOLED DOWN BY A FAN FITTED NEAR THE DRIERS OUTLET, I.E. BEFORE BEING BALED.

USUALLY THE AIR FOR DRYING IS HEATED IN A SIMPLE HAND-FED DUPLEX COKE FURNACE. IT IS DIFFICULT, HOWEVER, TO ENGAGE SKILLED FIREMEN IN THE COUNTRY AND THE CONSEQUENCE IS THAT MANY OF THESE FURNACES ARE SUPERSEDED BY OIL HEATERS EQUIPPED WITH AUTOMATIC OR SEMI-AUTOMATIC TEMPERATURE REGULATION, THE FIREMEN GETTING SUPERFLUOUS THEN.

ONE OF THE TECHNICAL CONTROVERSIAL PROBLEMS IS, WHETHER THE FAN ACCELERATING THE HOT AIR FLOW SHOULD BE PLACED BETWEEN FURNACE AND DRIER OR BEYOND THE DRIER PROPER. IN OUR OPINION IT WOULD BE ADVANTAGEOUS TO APPLY TWO FANS, ONE BEFORE AND ONE AFTER THE DRIER. IN THIS CASE THE QUANTITY OF LEAKING AIR IS REDUCED AND BY THIS ARRANGEMENT IT IS QUITE EASY TO ARRANGE FOR RECIRCULATION OF THE DRYING AIR.

THESE GENERAL CONSIDERATIONS MAY BE FOLLOWED BY A SURVEY OF THE SYSTEMS APPLIED FOR DRYING IN THE NETHERLANDS.

SURVEY OF DRYING PLANTS ESTABLISHED IN THE NETHERLANDS

	NUMBER		ANNUAL OUTPUT PER PLANT IN TONS		EFFECTIVE RUNNING HOURS	
	1947	1948	1947	1948	1947	1948
HUBERT-KALOROIL	76	59	104	258	712	1929
SIMPLE TRAY DRIERS	1	1	63	75	402	474
VAN DEN BROEK	12	13	672	1342	1030	2047
BÜTTNER-ROSIN	3	3	677	2160	1126	2757
DUCROBRA	5	7	193	781	659	2595
ENSINK	13	11	108	198	840	2027
SANTO	4	2	118	313	1280	2220
STORK-PEHRSON	4	3	601	720	1301	1983
WERKSPOOR	1	1	-	1952	-	4127
TEMPLEWOOD		1		615		2785
TOTAL	119	101	21780	49333	AVR.947	AVR.2041

PER EFFECTIVE RUNNING HOUR THE PRODUCTION IN 1947 AMOUNTED TO 21780 : 947 = 23,0 TONS, AND IN 1948: 49333 : 2041 = 24,2 TONS. THEREFORE THE GREAT DIFFERENCE IN OUTPUT IS MAINLY DUE TO THE EXTREMELY DRY WEATHER CONDITIONS DURING THE SUMMER OF 1947.

THE HUBERT-KALOROIL GRASS DRIERS ARE OF A NON-CONTINUOUS DESIGN AND ORIGINATE FROM THE BEGINNING PERIOD OF GRASS DRYING. THEY SHOULD NOW BE CONSIDERED AS ALMOST OBSOLETE. REPEATEDLY PLANTS OF THIS TYPE ARE CLOSED DOWN AND WILL NOT BE REPLACED BY OTHERS OF THE SAME TYPE.

A DESCRIPTION OF FOUR TYPICAL PLANTS OF DUTCH DESIGN WILL FOLLOW.

THE BAND CONVEYOR DRIER, MANUFACTURERS:
DU CROO AND BRAUNS (DUCROBRA). VIDE PLATE I, FIGURE C.

THE PLANT CONSISTS OF TWO CONSECUTIVE CONVEYORS IN A SHEET STEEL CASE, WHICH ARE CONNECTED SO THAT THE FIRST CONVEYOR HAS A SPEED THREE TIMES AS LARGE AS THE SECOND ONE. THEY ARE DRIVEN BY AN ELECTRIC MOTOR AND THE SPEED OF THE CONVEYOR CAN BE REGULATED BY MEANS OF A CONTROL. A TEDDER HAS BEEN FITTED BEYOND THE RECEIVING PLATFORM AND THE GRASS IS SHAKEN UP AGAIN AFTER LEAVING THE FIRST CONVEYOR AND BEFORE REACHING THE SECOND ONE. THE DRYING PROCESS CONSISTS OF 4 STAGES, CORRESPONDING TO HALF THE LENGTHS OF EITHER CONVEYOR. IN THE FIRST DRYING COMPARTMENT THE AIR PASSES THROUGH THE GRASS FROM BOTTOM TO TOP, IN THE OTHER COMPARTMENTS IN OPPOSITE DIRECTION. THE HOT DRYING AIR IS PROCURED IN A FURNACE HEATED BY COKE OR OIL AND IS SUCKED AWAY BY A FURNACE FAN, WHEN HAVING ATTAINED A TEMPERATURE OF 400° C, AFTER BEING MIXED WITH CIRCULATING EXHAUST GASES. IN ADDITION, THERE IS A SET OF CIRCULATION FANS. AT THE END OF THE SECOND CONVEYOR THE DRIED MATERIAL IS BALED OR CONVEYED INTO A HAMMER MILL.

WITH THESE DRYING PLANTS APPROXIMATELY 1500 KG OF FRESH GRASS CAN BE PROCESSED INTO 400 KG DRY ARTICLE PER HOUR, THE COKE CONSUMPTION BEING 170 - 190 KG IN ADDITION TO 40 KW ELECTRIC POWER USED. THE CAPACITY BY DRYING RED CLOVER AND LUCERNE IS ON THE AVERAGE 5 - 15 % MORE THAN WITH GRASS.

THE ENSINK TUNNEL DRIER.
SEE PLATE I, FIGURE A.

IT CONSISTS OF A COKE FURNACE, THE MIXTURED SMOKE GASES AND HOT AIR AT A TEMPERATURE OF 600 - 700° C BEING CONDUCTED INTO A LONG STATIONARY STEEL DRUM 6 - 7 M LENGTH WITH AN OVAL CROSS SECTION. IN FRONT OF THE INLET OF THE TUNNEL THE UNCHOPPED GRASS JOINS THE GRASS CURRENT THROUGH AN AIRLOCK. INSIDE THE TUNNEL SOME 24 STRONG STEEL HAY-FORKS ARE ROTATING AROUND A HORIZONTAL SHAFT. THE ANGLES BETWEEN THE PLANE OF THESE FORKS AND THE SHAFT IS ADJUSTABLE. AT THE END OF THE TUNNEL IS AN EXHAUST AT THE TOPSIDE, THE DRIED GRASS IS AUTOMATICALLY CARRIED BY THE AIR CURRENT AND STONES OR OTHER UNDESIRABLE SUBSTANCES ARE LEFT BEHIND, SEPARATION OF AIR AND GRASS BEING ACCOMPLISHED IN A CYCLONE. A HAMMER MILL HAS BEEN INSTALLED UNDER THE HOPPER OF THE CYCLONE AND HERE THE DRIED MATERIAL IS GROUND INTO MEAL. THE PLANT IS SUPPLIED WITH RAW MATERIAL ACCORDING TO THE TEMPERATURE OF THE EXHAUST GASES, WHICH IS KEPT CONSTANT AT 125° C AS FAR AS POSSIBLE.

THE CAPACITY OF THESE PLANTS IS ABOUT 650 KG MOIST GRASS (72 % M.C.) TURNED INTO 200 KG DRY ARTICLE PER HOUR AND THE FUEL CONSUMPTION IS 60 - 70 KG COKES. TWO MEN AND ONE BOY WANTED FOR THE RUNNING OF THE PLANT.

PNEUMATIC DRIER, TYPE VAN DEN BROEK.
SEE PLATE I, FIGURE D.

THE PRESENT OUTFIT HAS BEEN DESIGNED AFTER SUSTAINED EXPERIMENTATION. THE AIR FOR DRYING IS HEATED TO A TEMPERATURE OF APPROXIMATELY 550° C IN A FURNACE BY BURNING

COKE OR OIL, AND IT FLOWS INTO A SHORT BLOWING PIPE WHICH IS SUPPLIED WITH CHOPPED GRASS FROM AN AIRLOCK. THE DRYING AIR NOW PASSES THROUGH ONE OR MORE OF THE ROTATING DRUMS, PROVIDED WITH ALTERNATE BAFFLE PARTITIONS, THE FAN BEING ERECTED BEYOND THE DRUMS. THE SECOND STAGE OF THE DRYING PROCESS IS PERFORMED IN A SPIRAL TUBE WOUND AROUND THE CYCLONE WHICH IS ERECTED IN THE OPEN AIR. UNDERNEATH THE HOPPER OF THE CYCLONE IS THE HAMMER MILL. A SECOND BUT SMALLER CYCLONE IS USED FOR BAGGING, AS NOT ALWAYS A PERFECT SEPARATION IS ACCOMPLISHED HERE, THE WASTE AIR IS RECONDUCTED TO THE SPIRAL TUBE DESCRIBED ABOVE.

FOUR SIZES OF THIS DRYING PLANT ARE AVAILABLE:

	FRESH MATERIAL (1)	DRIED GRASS	EVAPORATION
MODEL A	950 KG/H	275 KG/H	675 KG/H
MODEL B	1900 KG/H	550 KG/H	1350 KG/H
MODEL C	3150 KG/H	900 KG/H	2250 KG/H
MODEL D	4730 KG/H	1350 KG/H	3380 KG/H

(1) 74 % M.C.

SPIRAL TUBE DRIER, TYPE HOEDEMAKER.

SEE PLATE I, FIGURE B.

THE FIRST EQUIPMENT OF THIS TYPE WAS ERECTED IN 1949. TO A CERTAIN EXTENT ITS DESIGN RESSEMBLES IN PRINCIPALE THE VAN DEN BROEK TYPE, AND THEREFORE ONLY THE TYPICAL DISTINCTIONS WILL BE RECORDED HERE.

THE CHOPPED RAW MATERIAL IS CONVEYED TO THE BLOWING PIPE BY A BUCKET ELEVATOR MORE OR LESS RESEMBLING A DREDGER. IF THE INLET OPENING HAS ATTAINED ITS UPPERMOST POSITION, A BIN OF THE ELEVATOR EMPTIES ITS CONTENT INTO IT, THE TWO MOVEMENTS BEING SYNCHRONISED. AROUND THE DRUM IS A SPIRAL TUBE WITH A SQUARE CROSS SECTION, THE DISTANCE TO BE COVERED BY THE AIR BEING INCREASED THEREBY. IMMEDIATELY BEYOND THE REVOLVING DRUM IS A TRAP FOR STONES AND HEAVY SUBSTANCES. THE QUARANTED CAPACITY OF THE PLANT IS 500 KGS DRY MATERIAL PROCURED FROM 1636 KGS MOIST GRASS (72 % M.C.); THIS COULD NOT BE ATTAINED IN PRAXIS.

LITTERATURE ON DRYING OF GREEN CROPS

REPORT TA 252 OF THE GENERAL TECHNICAL DIVISION T.N.O. SAMENVATTING VAN DE LITERATUUR BETREFFENDE DE TECHNOLOGIE VAN HET DROGEN VAN GRAS EN VAN HET DROGEN VAN HOOI IN DE SCHUUR.

PUBLICATIONS OF THE COMMITTEE FOR ARTIFICIAL DRYING OF GRASS AND OTHER GREEN CROPS:
NR.3 IR D.A.DE FREMERY. GRASDROOGAPPARATEN.
NR.5 IR D.A.DE FREMERY. PROEVEN EN METINGEN AAN GRASDROGERS IN DE ZOMER VAN 1942.

MONTHLY PUBLICATION OF THE AGRICULTURAL ADVISORY SERVICE:
SEPT. 1949. M.H.HUISMAN. RESULTATEN MET VIER DU CROO EN BRAUNS DROGERS IN 1948.
APRIL 1948. LITERATUUR OMTRENT GRASDROGEN.

THE TABLE ANNEX GIVES SOME PARTICULARS OF THE DIFFERENT DRIERS USED PRESENTLY IN HOLLAND, THE FIGURES BEING THE RESULT OF OUR RECENT MEASUREMENTS; THEY ARE GUARANTEED BY THE MANUFACTURERS.
THE WATER RATIO IS CALCULATED AS FOLLOWS:

$$\frac{\text{WEIGHT OF FRESH GRASS} - \text{WEIGHT OF DRIED MATERIAL}}{\text{WEIGHT OF FRESH GRASS}}$$

(FROM WEIGHING RESULTS AT THE PLANT, NO LABORATORY ANALYSIS BEING NECESSARY)

IF THIS RATIO IS SUBSTRACTED FROM 1 ONE GETS A FIGURE, WHICH MULTIPLIED BY THE MOISTURE CONTENT OF THE DRIED MATERIAL, GIVES THE M.C. IN THE FRESH GRASS NOT EVAPORATED. ADD TO THIS 100 TIMES THE WATER RATIO, AND THE M.C. OF THE FRESH MATERIAL RESULTS.

F.I. IF THE WATER RATIO AMOUNTS TO 0,75 AND THE M.C. OF THE DRIED GRASS IS 8 PER CENT, THE M.C. OF THE FRESH GRASS MUST BE:

$$100 \times 0{,}75 + 8(1 - 0{,}75) = 75 + 2{,}0 = 77{,}0\ \%.$$

SMALL VARIATIONS IN THE M.C. OF THE DRIED MATERIAL EVIDENTLY INFLUENCE BUT SLIGHTLY THE RESULT.

OUTPUT IN LBS/HOUR

DRIER TYPE	WATER RATIO										
	0.80	.79	.78	.77	.76	.75	.74	.73	.72	.71	.70
V.D.BROEK	838	895	951	1007	1069	1136	1191	1255	1320	1402	1466
ENSINK	287	307	323	340	357	375	393	410	430	452	474
TEMPLEWOOD II	404	423	443	463	483	503	522	542	562	582	600
DUCROBRA	652	697	742	789	836	882	926	972	1019	1065	1116

EVAPORATION IN LBS/HOUR

DRIER TYPE	WATER RATIO										
	0.80	.79	.78	.77	.76	.75	.74	.73	.72	.71	.70
V.D.BROEK	3351	3360	3369	3375	3386	3386	3395	3395	3400	3408	3419
ENSINK	1146	1146	1141	1135	1131	1124	1117	1109	1107	1107	1107
TEMPLEWOOD II	1614	1592	1572	1550	1528	1508	1488	1467	1446	1424	1404
DUCROBRA	2610	2623	2634	2646	2646	2646	2639	2630	2623	2615	2601

WHEN POSSIBLE GRASS SHOULD NOT BE DRIED WITH A WATER RATIO SURPASSING 0,75 (PREWILTING ON THE FIELD)

OIL CONSUMPTION OF V.D.BROEK AND ENSINK 1 : 10 LBS OIL/LBS EV.
OIL CONSUMPTION OF DUCROBRA 1 : 11 "
OIL CONSUMPTION OF TEMPLEWOOD 1 : 9 "
BUT IN THE LATTER CASE CONSIDERABLY HIGHER AT LOW M.C.'S

THE FIGURES ABOVE ARE FOUND FOR GRASS AND LUCERNE; CLOVER WILL GIVE A SOMEWHAT LOWER OUTPUT.

III. THE INFLUENCE OF WILTING, ARTIFICIAL DRYING AND STORAGE ON THE CHEMICAL COMPOSITION OF THE DRIED PRODUCT

BY

IR S.BOSCH AND DR W.B.DEIJS

A. WILTING.

IN ORDER TO SAVE ON THE TOTAL COST OF ARTIFICIAL DRYING, IN SOME CASES THE GRASS WILL BE LEFT TO WILT ON THE LAND AFTER BEING MOWN. UNDER FAVORABLE WEATHER CONDITIONS THE WATER CONTENT OF THE MATERIAL, BEING AT FIRST 75 - 85 PER CENT, DROPS, SO THAT THE QUANTITY OF WATER TO BE EVAPORATED BY THE DRIER WILL BE CONSIDERABLY LOWER. IN THIS WAY A SUBSTANTIAL INCREASE OF THE CAPACITY OF THE PLANT CAN BE ATTAINED RESULTING IN A CONSIDERABLE DROP IN DRYING COST. IT IS OF INTEREST, HOWEVER, TO KNOW, TO WHAT EXTENT LOSSES IN OTHER RESPECTS MAY OCCUR BY WILTING.

SOME EXPERIMENTS OF THE CENTRAL INSTITUTE FOR AGRICULTURAL RESEARCH AT WAGENINGEN (C.I.L.O.) HAVE PROVED THAT THE LOSS OF DRY MATTER IS 2 - 2,5 PER CENT PER DAY. THIS IS CAUSED BY RESPIRATION, WHICH CONTINUES DURING A CONSIDERABLE TIME AFTER CUTTING. THIS QUANTITY OF 2- 2,5 PER CENT ALMOST CORRESPONDS WITH THE RESULTS OF EXPERIMENTS ON THE RESPIRATION-INTENSITY OF CUT GRASS. AFTER KEEPING SUCH GRASS AT 25^{o} C FOR 24 HOURS A LOSS OF DRY MATTER AMOUNTING TO 5 .PER CENT WAS RECORDED. THE EXPERIMENTS FIRST MENTIONED BEING PERFORMED IN THE OPEN AIR RESULTED IN A SMALLER LOSS AS THE TEMPERATURE DURING THE NIGHT AND ALSO DURING MOST OF THE DAY WAS BELOW 25^{o} C AND THEREFORE THE RESPIRATION-INTENSITY MUST HAVE BEEN CONSIDERABLY LOWER AS WELL.

RESPIRATION AFFECTS HARDLY ANY OTHER SUBSTANCES THAN EASILY DECOMPOSING CARBOHYDRATES, THE PROTEIN, CRUDE FIBRE AND MINERAL COMBINATIONS REMAINING INTACT. IN CONSEQUENCE OF THIS LOSS OF CARBOHYDRATES THE PERCENTAGES OF THE OTHER CONSTITUENTS OF THE DRY MATTER WILL INCREASE TO A CERTAIN EXTENT.

ALSO THE LOSS OF CAROTENE DUE TO WILTING WAS RECORDED IN THESE EXPERIMENTS. IT WAS NOTICED THAT THESE LOSSES DEPENDED MORE PARTICULARLY ON THE TEMPERATURE. FOR EXAMPLE, AT AN AVERAGE TEMPERATURE OF 12^{o} C THE LOSS WAS ABOUT 5 PER CENT PER DAY AND AT 18^{o} C IT HAD INCREASED TO 10 PER CENT OF THE ORIGINAL QUANTITY.

B. ARTIFICIAL DRYING.

DURING THE DRYING PROCESS DIFFERENT LOSSES OF DRY MATTER OCCUR, WHICH MAY BE CAUSED BY THE LOSS OF SMALL DUST-LIKE PARTICLES, BY RESPIRATION AND SOMETIMES BY SCORCHING. THE TOTAL LOSS IS GENERALLY ESTIMATED AT 5 PER CENT AS AN AVERAGE. ALSO THE QUALITY MAY BE ADVERSELY AFFECTED AS A RESULT OF EXCESSIVE TEMPERATURES OR A VERY PROLONGED DRYING PROCESS. ESPECIALLY THE DIGESTIBILITY OF THE PROTEIN AND OTHER CONSTITUENTS MAY BE ADVERSELY AFFECTED BY THESE IMPERFECTIONS. THIS WAS NOTICED IN 1940,

BY ANALYSES OF SAMPLES OF FRESH GRASS AND OF GRASS DRIED IN A HUBERT-KALOROIL DRIER, DRYING AT 150 TO 200° C AND A STORK PEHRSON DRIER APPLYING MUCH HIGHER INLET TEMPERATURES (600 - 700° C). THE SAMPLES FROM THE STORK-PLANT HAD IN GENERAL (SEE FIG. 1 AND 2) A LOWER CONTENT OF DIGESTIBLE CRUDE PROTEIN IN THE DRY MATTER, THAN THOSE OF FRESH GRASS, WHEREAS THE PRODUCT FROM THE HUBERT-KALOROIL DRIER DID NOT DEFINATELY SHOW A REDUCTION OF THIS CONSTITUENT (DETERMINATION BY PEPSIN HYDROCHLORIC ACID).

LATER ON THE INFLUENCE OF THE TEMPERATURE ON THE DIGESTIBILITY WAS EXAMINED AT THE "RIJKSLANDBOUWPROEFSTATION" (GOVERNMENT AGRICULTURAL RESEARCH STATION) AT HOORN. DR N.D. DIJKSTRA WILL DEAL WITH THIS SUBJECT IN CHAPTER IV.

ALSO PART OF THE CAROTENE WILL GET LOST BY DRYING. FROM EXAMINATIONS IN LATER YEARS WE KNOW THAT THIS LOSS CORRESPONDS TO A LARGE EXTENT WITH THE CONTENT IN THE FRESH MATERIAL AND VARIES LITTLE WITH THE DIFFERENT SYSTEMS APPLIED IN DRYING. FOR EXEMPLE BY DRYING GRASS WITH A CAROTENE CONTENT OF 400 MILLIGRAMS PER KG DRY MATTER, A LOSS OF 20 PER CENT WAS RECORDED WHILST THE LOSS WAS ABOUT 40 PER CENT WHEN THE ORIGINAL CONTENT WAS 600 MILLIGRAMS PER KG DRY MATTER. THESE FIGURES RELATE TO THE VAN DEN BROEK, ENSINK AND HUBERT-KALOROIL DRIERS. IN 1949 THE LOSS WAS FOUND TO BE CONSIDERABLY LOWER WHEN DRIED GRASS OF AN EXPERIMENT WITH A BELT CONVEYOR DRYING PLANT (TEMPLEWOOD) WAS ANALYSED. BY THIS INSTALLATION THE

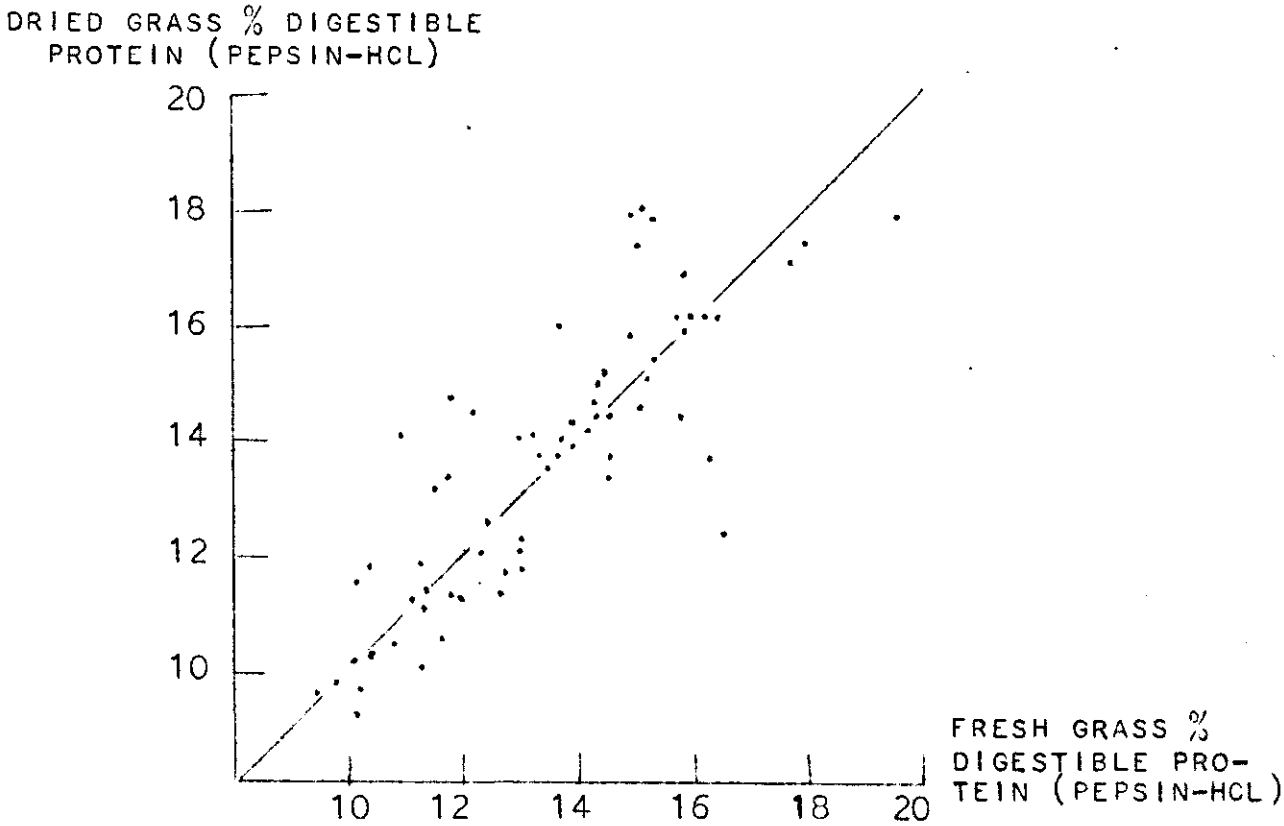


FIG. 1. GRASS DRIED BY A HUBERT KALOROIL PLANT.

GRASS IS DRIED IN A RELATIVELY SHORT TIME AT A RATHER LOW TEMPERATURE; AND SMALLER LOSSES OF CAROTENE MAY BE THE RESULT.

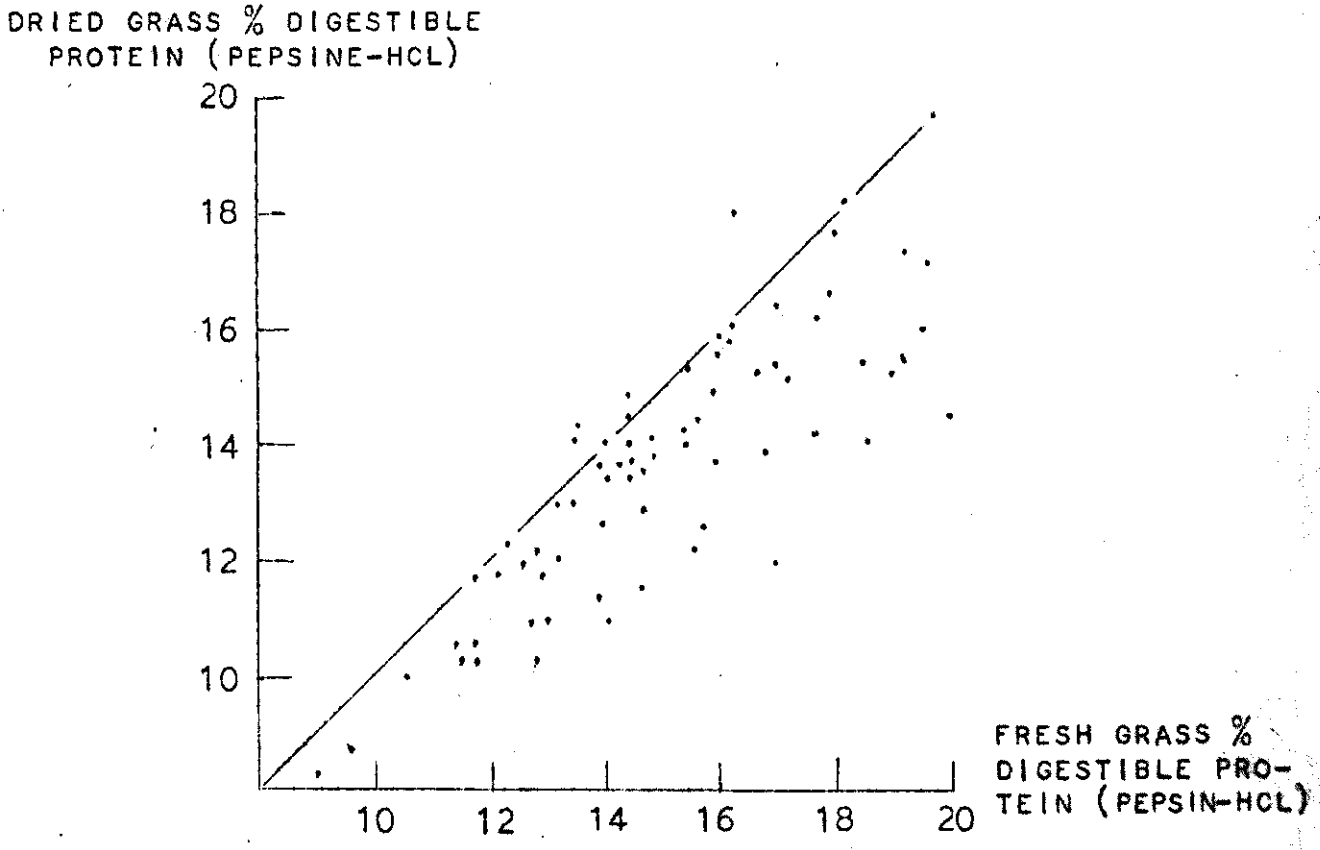


FIG. 2. GRASS DRIED BY A STORK-PEHRSON PLANT.

C. LOSS OF CAROTENE DURING STORAGE OF GRASS MEAL, LUCERNE MEAL AND CARROT MEAL.

1. THE RELATION BETWEEN THE RELATIVE HUMIDITY OF THE AIR AND THE LOSS OF CAROTENE WAS INVESTIGATED FOR DIFFERENT PRODUCTS. SMALL SAMPLES OF THE MATERIAL WERE KEPT IN DESICCATORS ABOVE MIXTURES OF SULPHURIC ACID AND WATER, PLACED IN THE DARK AT A TEMPERATURE OF 18 - 21° C.

AFTER THE EXPERIMENT WE DETERMINED THE EXACT CONCENTRATION OF THE SULPHURIC ACID AND SO WE ARRIVED AT THE RELATIVE HUMIDITY OF THE AIR IN THE DESICCATORS. AFTER VARYING STORING PERIODS, WE DETERMINED THE MOISTURE CONTENT AND THE CAROTENE CONTENT [METHOD OF V.H.BOOTH, J.SOC.CHEM.IND. 64, 162 (1945)]. THE LOSSES DURING STORAGE ARE SHOWN BY FIGURE 3.

WHEN THESE EXPERIMENTS WERE STARTED, THE MATERIAL HAD ALREADY BEEN KEPT FOR SOME MONTHS, AND CONSEQUENTLY THE CAROTENE CONTENTS WERE NOT VERY HIGH, VIZ: OF GRASS MEAL 175, OF LUCERNE MEAL 225, OF CARROT MEAL 440 MG PER KG DRY MATTER.

APPARENTLY, GRASS MEAL LOST LESS CAROTENE IN HUMID AIR (60 - 80 PER CENT RELATIVE HUMIDITY) THAN IN AIR OF LOWER HUMIDITY. THE SAME APPLIES TO LUCERNE MEAL (LOSS WAS SMALLEST AT A RELATIVE HUMIDITY OF 56 - 66 PER CENT). THE CURVES FOR CARROT MEAL ARE LESS REGULAR; IN GENERAL THE INFLUENCE OF HUMIDITY ON THE LOSS OF CAROTENE IS LESS NOTICEABLE. IT WILL BE NOTICED, HOWEVER, THAT AFTER THREE

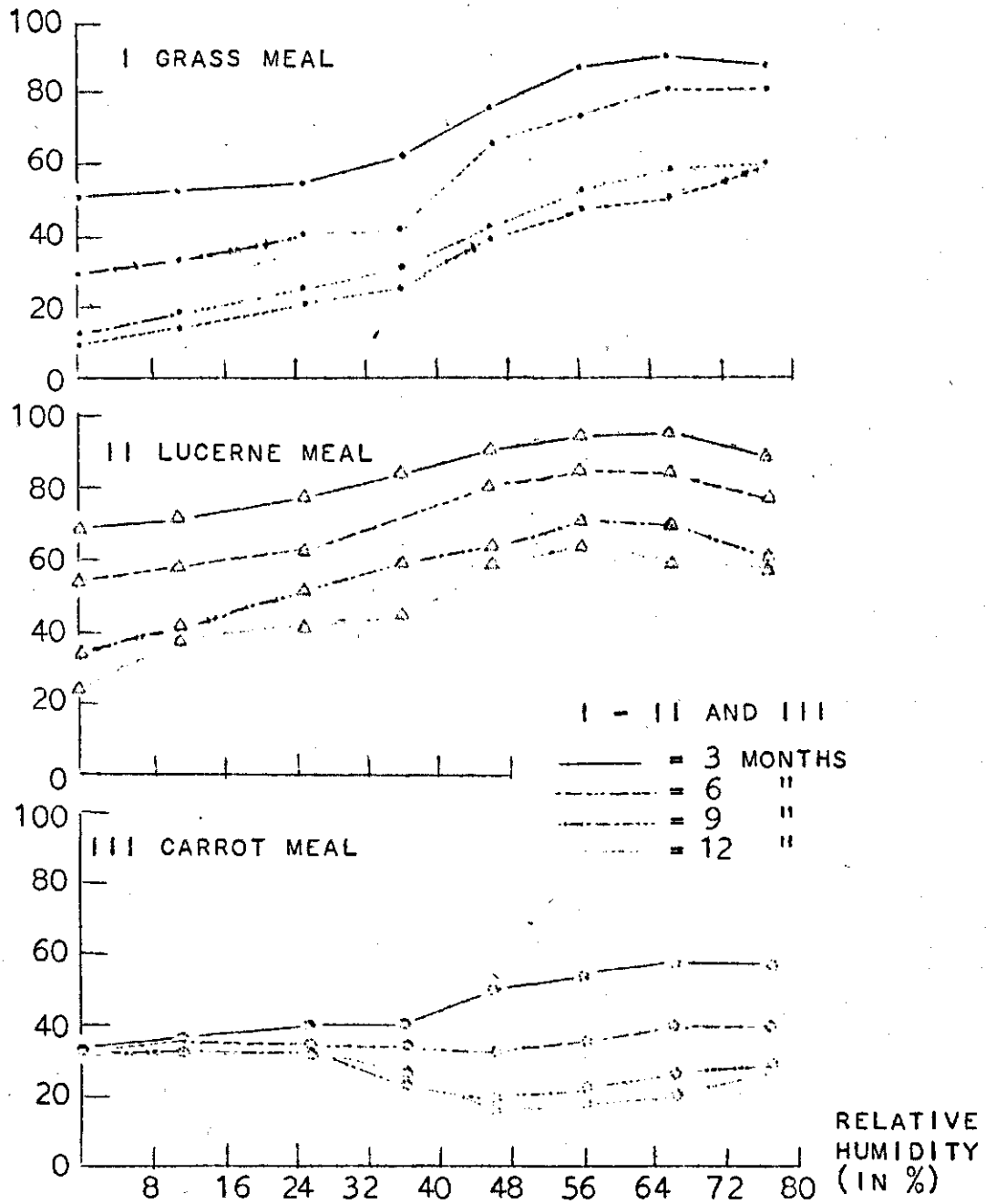


FIG. 3. THE CAROTENE CONTENT OF GRASS MEAL, LUCERNE MEAL AND CARROT MEAL AFTER STORAGE IN AIR OF DIFFERENT HUMIDITIES.

MONTHS ALREADY THE CAROTENE CONTENT OF CARROT MEAL HAD DROPPED MUCH MORE THAN THAT OF GRASS MEAL AND LUCERNE MEAL.

SIMILAR EXPERIMENTS ON STORAGE WERE ALSO PERFORMED WITH SAMPLES OF GRASS MEAL WITH A HIGHER CAROTENE CONTENT. HERE WE COULD EXACTLY DETERMINE THE RELATIVE HUMIDITY CAUSING A MINIMUM LOSS OF CAROTENE.

GRASS MEAL WITH 347 MG OF CAROTENE PER KG DRY MATTER SHOWED THE SMALLEST DECREASE IN CAROTENE CONTENT AT A RELATIVE HUMIDITY OF 60 - 70 PER CENT. A RELATIVE HUMIDITY OF 90 PER CENT STIMULATED MOULDING AND A BIG LOSS OF CAROTENE. FOR GRASS MEAL WITH 491 MG CAROTENE PER KG DRY MATTER, WE FOUND THE SMALLEST LOSS AT A RELATIVE HUMIDITY OF ABOUT 50 PER CENT.

FROM THE RECORDS OF THESE EXPERIMENTS WE ALSO DEDUCED THE VAPOUR PRESSURE ISOTHERM, I.E. THE CURVE GIVING THE CORRELATION BETWEEN THE MOISTURE CONTENT (ON A DRY MATTER BASIS) OF THE MATERIAL AND THE HUMIDITY OF THE SURROUNDING AIR AT EQUILIBRIUM (FIG. 4). THE CURVE FOR LUCERNE MEAL CLOSELY RESEMBLES THE ONE FOR GRASS MEAL. CARROT MEAL PROVED TO BE MORE HYGROSCOPIC OWING TO ITS QUITE DIFFERENT CHEMICAL COMPOSITION.

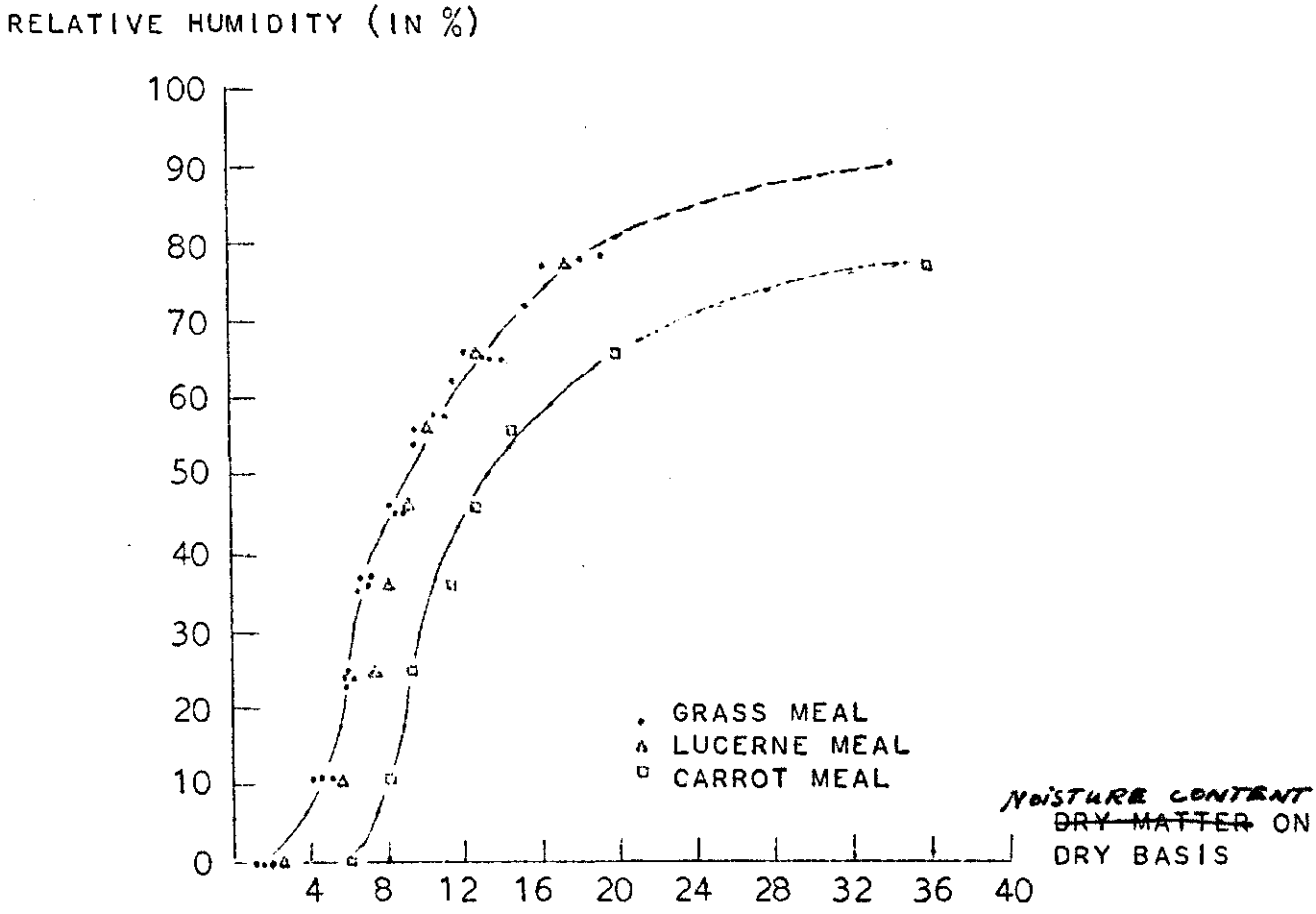


FIG. 4. RELATION BETWEEN MOISTURE CONTENT OF THE MATERIAL AND THE RELATIVE HUMIDITY OF THE AIR.

IN ANOTHER EXPERIMENT WE STORED THE ABOVE MENTIONED PRODUCTS PACKED IN PAPER BAGS IN A ROOM AT 18 - 22° C. THE RESULTS CORRESPONDED REASONABLY WITH THOSE SHOWN BY FIG. 3 FOR THE AVERAGE OF THE PREVAILING RELATIVE HUMIDITIES.

2. THE AIR-VOLUME IN THE SAMPLES ALSO PROVED TO AFFECT THE LOSS OF CAROTENE. GRASS MEAL, LUCERNE MEAL AND CARROT MEAL, PRESSED TIGHTLY INTO BOTTLES, HAD LOST AFTER STORAGE DURING A GOOD TWELVE MONTHS RESPECTIVELY 13, 4 AND 6 PER CENT LESS CAROTENE THAN THE SAME PRODUCTS ONLY LOSELY PACKED IN BOTTLES. AFTER STORAGE FOR A SHORTER TIME WE FOUND CORRESPONDING VARIATIONS.

3. THE INFLUENCE OF THE COARSENESS OF THE MATERIAL WAS EXPERIENCED WHEN STORING SLICED CARROTS AND CARROT MEAL UNDER THE SAME CONDITIONS (SEE FOLLOWING TABLE).

CAROTENE CONTENT OF DRIED CARROTS.

PERIOD OF STORAGE IN MONTHS	GROUND		NOT GROUND	
	MG/KG DRY MATTER	PER CENT OF ORIGINAL CONTENT	MG/KG DRY MATTER	PER CENT OF ORIGINAL CONTENT
0	1004	100	1004	100
3½	493	49	629	63
5½	344	34	507	51
7½	228	23	366	36

4. THE INFLUENCE OF THE TEMPERATURE WAS INVESTIGATED FOR GRASS MEAL IN PAPER BAGS STORED IN THE LABORATORY (17 - 22° C) AND IN THE CELLAR (5 - 15° C). AFTER 6, 12 AND 25 MONTHS RESPECTIVELY SAMPLES OF BOTH LOTS WERE ANALYSED FOR THE DETERMINATION OF MOISTURE AND CAROTENE CONTENT.

PERIOD OF STORAGE IN MONTHS	MOISTURE IN PER CENTS OF DRY MATTER		CAROTENE MG/KG DRY MATTER		CAROTENE IN PER CENTS OF THE ORIGINAL QUANTITY	
	LAB.	CELLAR	LAB.	CELLAR	LAB.	CELLAR
0	9,2	9,6	279	285	100	100
6	9,5	13,5	231	267	83	94
12	16,0	19,0	126	147	45	52
25	13,5	18,1	48	63	17	22

THE RELATIVE HUMIDITY IN THE CELLAR WAS APPARENTLY HIGHER THAN IN THE LABORATORY, BUT IT WAS RATHER HIGH IN EITHER CASE: IN THE CELLAR UP TO AT LEAST 80, IN THE LABORATORY UP TO AT LEAST 75 PER CENT.

IV. THE INFLUENCE OF ARTIFICIAL DRYING ON THE DIGESTIBILITY OF GRASS

BY

DR N.D.DIJKSTRA

AS SOON AS ARTIFICIAL DRYING OF GRASS WAS MORE GENERALLY APPLIED IT BECAME ESSENTIAL TO INVESTIGATE TO WHAT EXTENT THE DIGESTIBILITY AND IN CONSEQUENCE ALSO THE NUTRITIVE VALUE OF THE GRASS WOULD BE ADVERSELY AFFECTED BY THE HEAT. IN THAT WAY ONLY COULD THE POSSIBILITIES OF THE DEVELOPMENT OF THIS NEW TREATMENT OF GREEN FODDER CROPS BE PROPERLY JUDGED.

DURING RECENT YEARS EXPERIMENTS ON THIS SUBJECT HAVE BEEN CARRIED OUT IN SEVERAL COUNTRIES.

ALREADY IN 1915 HONCAMP (1) REPORTED THAT ARTIFICIAL DRYING OF GRASS AND OTHER GREEN FODDER CROPS, PROVIDED IT WAS PERFORMED WITH THE NECESSARY CARE AND AT LOW TEMPERATURES, DID NOT CAUSE REAL LOSSES OF DIGESTIBLE NUTRIENTS. WHEN, HOWEVER, ARTIFICIAL DRYING WAS ACCOMPLISHED BY HOT FURNACE GASES, AS WAS THE CASE WITH THE DRIERS USED IN GERMANY, A CONSIDERABLE REDUCTION OF PROTEIN DIGESTIBILITY OCCURRED.

IN THE EXPERIMENTS OF WATSON AND FERGUSON (2) THE GRASS WAS PARTLY DRIED IN A BAND CONVEYOR DRYING PLANT WITH A TEMPERATURE AT THE INLET OF 200° C. IT WAS FOUND THAT THIS METHOD OF DRYING DID NOT AFFECT THE DIGESTIBILITY OF THE VARIOUS CONSTITUENTS WITH THE EXCEPTION OF CRUDE PROTEIN, ITS DIGESTIBILITY BEING REDUCED IN ONE CASE BY 11 % AND IN AN OTHER BY 6 %.

ANOTHER PART OF THE GRASS WAS DRIED IN A PNEUMATIC DRYING PLANT AT A TEMPERATURE OF 600° C AT THE INLET.

WITH THIS DRIER A DECLINE WAS NOTICED IN THE DIGESTIBILITY OF ALMOST ALL THE NUTRITIVE CONSTITUENTS OF THE GRASS. THIS PARTICULARLY APPLIED TO CRUDE PROTEIN, ITS DIGESTIBILITY BEING CONSIDERABLY REDUCED (BY 24 %).

IN THE EXPERIMENTS OF HODGSON C.S. (3) GRASS WAS DRIED IN AN EXPERIMENTAL ROTARY SINGLE-DRUM DRIER AT FOUR DIFFERENT INLET TEMPERATURES, VIZ. 250, 300, 350 AND 400° F. ONLY THE HIGHEST DRYING-TEMPERATURE (205° C) HAD A REDUCTIVE EFFECT ON THE DIGESTIBILITY OF SOME CONSTITUENTS. AGAIN THE DIGESTIBILITY OF THE CRUDE PROTEIN, WAS REDUCED CONSIDERABLY (VIZ. 22 %).

FULL ATTENTION IS PAID TO THIS PROBLEM IN THE NETHERLANDS AND THEREFORE BY CO-OPERATION OF VARIOUS INSTITUTIONS SEVERAL EXPERIMENTS HAVE BEEN CARRIED OUT FOR ITS SOLUTION.

ONE OF THE FIRST EXPERIMENTS ON THIS SUBJECT, PERFORMED BY THE GOVERNMENT AGRICULTURAL RESEARCH STATION AT HOORN (4), WAS A COMPARATIVE DIGESTION TRIAL OF FRESH AND ARTIFICIALLY DRIED AUTUMN GRASS OF THE SAME ORIGIN. IN THIS EXPERI-

MENT THE GRASS WAS DRIED ON A SMALL EXPERIMENTAL WIRE NETTED FRAME. THE DIGESTIBILITY OF BOTH LOTS OF GRASS WAS DETERMINED DURING TWO PERIODS BY FEEDING IT TO THREE WETHERS.

THE RESULTS OF THIS TRIAL ARE SUMMARIZED IN THE TABLE.

COMPOSITION OF THE DRY MATTER (%) AND DIGESTION-COEFFICIENTS.

	ORGANIC MATTER	CRUDE PROTEIN	N-FREE EXTRACT	CRUDE FIBRE	TRUE PROTEIN
COMPOSITION:					
FRESH GRASS, PERIOD I	86,-	23,58	43,36	19,06	19,50
FRESH GRASS, PERIOD II	86,-	23,13	43,67	19,20	18,83
ARTIFICIALLY DRIED GRASS PERIOD I	86,-	23,55	42,83	19,62	19,52
ARTIFICIALLY DRIED GRASS PERIOD II	86,-	22,98	43,64	19,38	19,28
DIGESTION COEFFICIENTS:					
FRESH GRASS, PERIOD I	74,1	78,6	72,4	72,4	75,0
FRESH GRASS, PERIOD II	75,2	78,1	73,8	74,8	74,7
AVERAGE	74,6	78,4	73,1	73,6	74,8
ARTIFICIALLY DRIED GRASS PERIOD I	71,8	72,9	71,0	72,2	69,4
ARTIFICIALLY DRIED GRASS PERIOD II	74,0	73,7	73,7	75,2	71,3
AVERAGE	72,9	73,3	72,4	73,7	70,3

THE SAMPLES OF FRESH GRASS WERE MORE SOILED THAN THOSE OF THE ARTIFICIALLY DRIED GRASS, AND FOR THE SAKE OF AN EXACT COMPARISON WE CORRECTED THE RESULT OF THE ANALYSES OF THE DRY MATTER BY ASSUMING THAT 14 % OF THE DRY SUBSTANCE CONSISTED OF MINERAL MATTER. THE COEFFICIENTS MENTIONED IN THE TABLE ARE THE AVERAGE OF THE DIGESTION COEFFICIENTS DETERMINED FOR THE THREE WETHERS.

FROM THE MARVELOUS CONCORDANCE OF THE ANALYSES OF THE FRESH AND DRIED SAMPLES WE CAN CONCLUDE THAT IN THIS EXPERIMENT THE COMPOSITION OF THE GRASS DID NOT CHANGE BY ARTIFICIAL DRYING.

THE DIGESTION COEFFICIENTS OF N-FREE EXTRACT AND CRUDE FIBRE OF THE FRESH GRASS CORRESPOND VERY WELL WITH THOSE OF THE DRIED GRASS. THE DIGESTIBILITY OF CRUDE AND TRUE PROTEIN, HOWEVER, WAS SLIGHTLY REDUCED BY ARTIFICIAL DRYING.

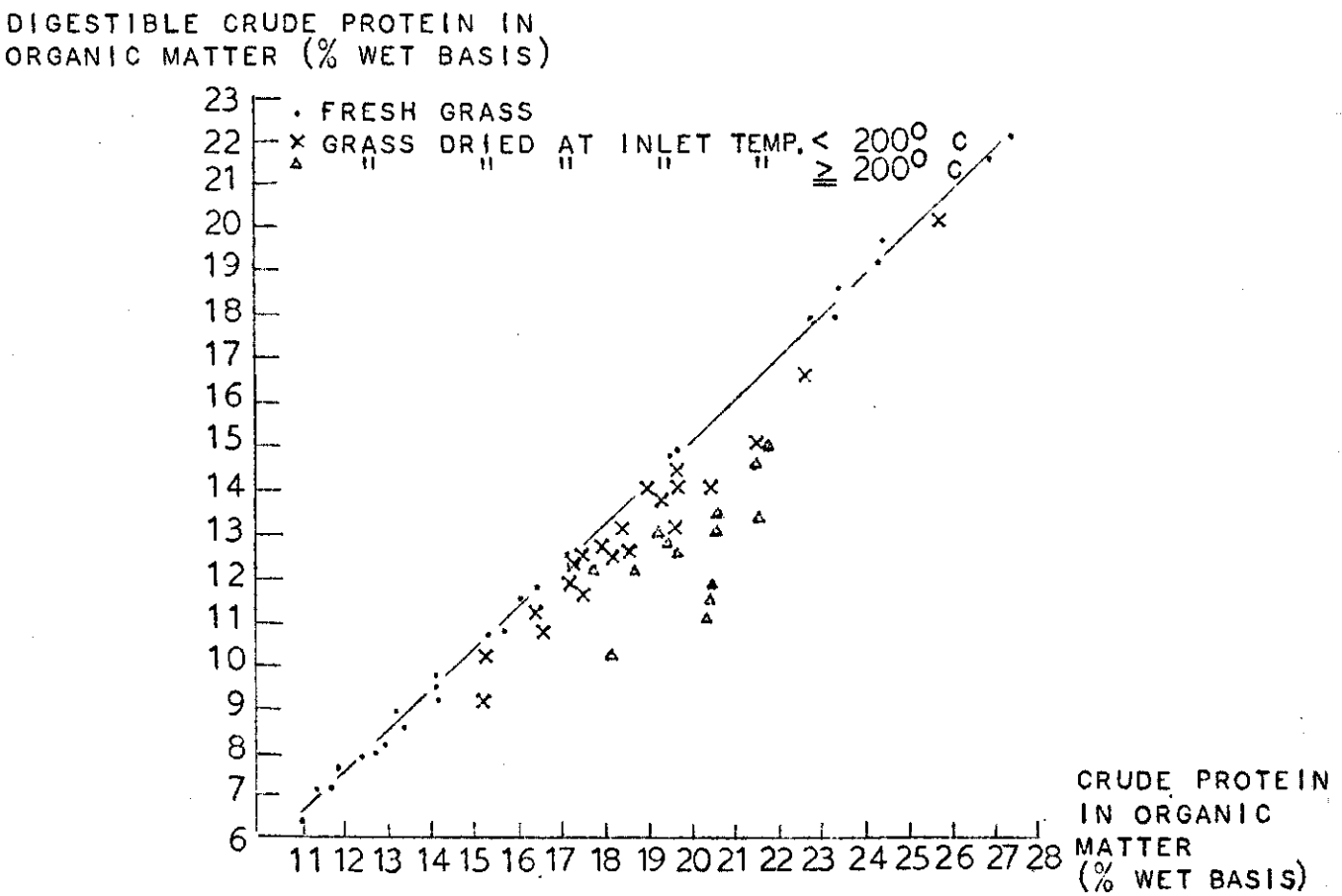
AT HOORN ALSO THE DIGESTIBILITY OF A GREAT NUMBER OF GRASS SAMPLES DRIED BY DIFFERENT METHODS APLLIED IN PRACTICE (5,6) WAS DETERMINED BY FEEDING TO WETHERS. IN ORDER TO EXAMINE TO WHAT EXTENT THE DIGESTIBILITY OF PROTEIN WAS REDUCED BY THE DIFFERENT METHODS, WE HAVE PROJECTED THE FOLLOWING DIAGRAM. ON THE ABCIS WE MARKED OUT THE CRUDE PROTEIN PERCENTAGES OF THESE SAMPLES AND ON THE ORDINATE THE DIGESTIBLE CRUDE PROTEIN PERCENTAGES, ALL FIGURES BEING CALCULATED BASED ON THE QUANTITY OF ORGANIC MATTER. WE HAVE OF COURSE COMPARED THESE FIGURES WITH THE ANALOGOUS ONES FOR FRESH GRASS.

IN ORDER TO SIMPLIFY THE DIAGRAM, THE SAMPLES TAKEN FROM FRESH AND DRIED AUTUMN GRASS ARE NOT MARKED OUT AS SUCH, BUT HAVE BEEN MADE COMPARABLE TO SPRING GRASS-FIGURES BEFORE HAND BY ADDING 0,60 % TO THE PERCENTAGES OF DIGESTIBLE CRUDE PROTEIN IN THE ORGANIC MATTER.

IN THE DIAGRAM ALL FIGURES FOR FRESH GRASS ARE REPRESENTED BY POINTS. FROM THESE POINTS IT IS POSSIBLE TO CONSTRUCT A STRAIGHT LINE BY APPLYING THE FORMULA:

$$D = 0{,}948\ (x - 20) + 15{,}13,$$

X = CRUDE PROTEIN AND D = DIGESTIBLE CRUDE PROTEIN, BOTH BEARING ON THE QUANTITY OF ORGANIC MATTER.



THE FIGURES, RELATING TO GRASS DRIED AT INLET TEMPERATURES BELOW 200° C, ARE REPRESENTED BY SMALL CROSSES AND THOSE DETERMINED FOR GRASS, DRIED AT INLET TEMPERATURES OF 200° C AND MORE, BY TRIANGLES.

THE DIAGRAM SHOWS THAT THE DIGESTIBILITY OF CRUDE PROTEIN IN ALL SAMPLES IS REDUCED BY DRYING, BUT, PARTICULARLY THAT THE REDUCTION DUE TO DRYING AT THE HIGHER TEMPERATURES EXCEEDED CONSIDERABLY THE REDUCTION EXPERIENCED WITH LOWER ONES.

WITH INLET TEMPERATURES BELOW 200° C THE REDUCTION OF DIGESTIBILITY, EXPRESSED IN PERCENTAGES OF THE DIGESTIBLE CRUDE PROTEIN CONTENT OF FRESH GRASS, VARIED FROM 1,0 TO 13,0 %, WITH 5,3 % AS AN AVERAGE.

THESE REDUCTIONS IN DIGESTIBILITY FLUCTUATED FOR THE SAMPLES, DRIED AT HIGHER TEMPERATURES, FROM 4,6 TO 29,0 %, WITH 16,0 % AS AN AVERAGE.

THE CORRELATION OF DRYING TEMPERATURE AND REDUCTION OF DIGESTIBILITY OF CRUDE PROTEIN IS ALSO CLEARLY SHOWN BY THE FIGURES OF THE SECOND TABLE, EXPRESSING THE RESULTS OF OUR LATEST EXPERIMENTS, ARRANGED IN ACCORDANCE WITH THE INCREASE OF INLET TEMPERATURES.

REDUCTION OF PROTEIN DIGESTIBILITY AT DIFFERENT TEMPERATURES APPLIED FOR DRYING

EXPERIMENT IN 1947		EXPERIMENT IN 1948		EXPERIMENT IN 1949	
INLET TEMPERATURE (°C)	REDUCTION IN DIG. CRUDE PROTEIN (%)	INLET TEMPERATURE (°C)	REDUCTION IN DIG. CRUDE PROTEIN (%)	INLET TEMPERATURE (°C)	REDUCTION IN DIG. CRUDE PROTEIN (%)
150	9,7	125-145	3,7	140-145	1,0
200	11,6	132	5,5	145-165	4,6
250	11,6	185	8,4	200-210	10,8[1])
400	24,5	200	14,2	240-260	4,6
550	29,0	400	13,6	500-520	9,5
700	25,8	600	19,3	780-820	12,2

[1]) CONTAINED SCORCHED MATERIAL.

WHEN IT WOULD HAVE BEEN POSSIBLE TO RECORD THE TEMPERATURES OF THE GRASS AT THE END OF THE DRYING-PROCESS INSTEAD OF THE EASILY MEASURABLE INLET TEMPERATURES, THE CORRELATION OF THE TEMPERATURE AND THE REDUCTION IN PROTEIN DIGESTIBILITY PROBABLY WOULD HAVE PROVED TO BE STILL MORE CONSPICUOUS, FOR IT IS AFTER ALL THE TEMPERATURE AT THE FINISH WHICH CAUSES THE REDUCTION. PRESUMABLY THE MORE FAVOURABLE RESULTS ATTAINED BY THE EXPERIMENTS IN 1949 ARE MORE OR LESS DUE TO LOWER FINAL-TEMPERATURES, THOUGH THE STARTING TEMPERATURES REMAINED UNCHANGED.

CONCLUSION

THE DIGESTIBILITY OF THE PROTEIN IN GRASS IS REDUCED BY ANY OF THE ARTIFICIAL DRYING METHODS AT PRESENT APPLIED.

WHEN DRYING IS PERFORMED WITH CARE AT INLET TEMPERATURES BELOW 200° C THIS REDUCTION IS NOT CONSIDERABLE AND AMOUNTS ON THE AVERAGE TO ABOUT 5 %.

WHEN DRYING AT HIGHER TEMPERATURES THE REDUCTION OF PROTEIN DIGESTIBILITY CAN BE VERY CONSIDERABLE AND MAY SOMETIMES BE AS MUCH AS 25 %.

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V. THE ECONOMIC ASPECTS OF ARTIFICIAL GRASS DRYING

BY

PROF.IR J.J.I.SPRENGER

THE ECONOMIC ASPECTS OF ARTIFICIAL GRASS DRYING ARE TWOFOLD VIZ. THE NATIONAL ASPECT OF FEEDING MAN AND BEAST AND THE ASPECT OF THE INDIVIDUAL DRYING PLANTS WHICH WILL GIVE RISE TO THE QUESTION HOW A PLANT SHOULD BE EQUIPPED AND RUN IN ORDER TO KEEP THE EXPENSES AS LOW AS POSSIBLE.

I. SUPPLY OF FODDER AND FEEDING STUFFS IN THE NETHERLANDS.

DURING THE GERMAN OCCUPATION OF THE NETHERLANDS FROM 1940 - 1945 THE NUMBER OF LIVESTOCK DECREASED CONSIDERABLY OWING TO SHORTAGE OF FODDER, AND TO REQUISITIONS OF ANIMALS BY THE OCCUPYING FORCES. WHEN THE WAR WAS OVER THE POPULATION HAD INCREASED AND THEREFORE IT WAS ESSENTIAL TO RAISE THE NUMBER OF LIVESTOCK AS QUICKLY AS POSSIBLE. A COMMITTEE OF EXPERTS UNDER CHAIRMANSHIP OF PROF. DR IR M.J.L.DOLS STUDIED THIS PROBLEM AND ARRIVED AT THE CONCLUSION THAT THE FIRST AIM SHOULD BE TO RESTORE THE LIVESTOCK HARD TO ITS PRE-WAR LEVEL. THE TARGET BASED UPON A POPULATION OF 10 MILLIONS INHABITANTS TO BE AIMED AT WAS:

MILCH COWS AND COWS IN CALF	1.600.000
CATTLE FOR FATTENING	100.000
OTHER CATTLE	1.080.000
SHEEP AND LAMBS	700.000
COATS AND KIDS	150.000
HORSES	325.000
PIGS	1.800.000
LAYING HENS	15.000.000

BEFORE THE WAR THREE QUARTERS OF THE TOTAL YIELDS OF ARABLE AND GRASSLAND WAS FED TO LIVESTOCK AND IN ADDITION LARGE QUANTITIES OF FEEDINGSTOFFS WERE IMPORTED, VIZ. IN ROUND FIGURES ANNUALLY:

1.100.000	TONS OF CEREALS
612.000	TONS OF OIL SEED CAKES
36.000	TONS OF ANIMAL PRODUCTS

THE PRESENT ECONOMIC SITUATION OF THE COUNTRY IMPLIES THAT IMPORTS HAD TO BE CURTAILED DRASTICALLY TO APPROXIMATELY 800.000 TONS. TO ACHIEVE THIS IT HAS BEEN NECESSARY TO REDUCE THE QUANTITY OF CONCENTRATES FED PER ANIMAL TO JUST A LITTLE MORE THAN HALF THE PRE-WAR RATION, THE NEW RATION TO BE SUPPLEMENTED BY LARGE QUANTITIES OF HOME PRODUCED FODDER. THEREFORE THE QUALITY OF THE LATTER MUST BE IMPROVED. ONE OF THE POSSIBILITIES TO ACHIEVE THIS IS TO INCREASE THE SUPPLY OF ARTIFICIALLY DRIED GRASS. THE ANNUAL SUPPLY, BEING AT PRESENT 50 - 60.000 TONS DRIED GRASS, SHOULD BE INCREASED TO SOME 240.000 TONS. AS TO PIGS IN FUTURE THEY WILL HAVE TO BE FED MAINLY ON STEAMED POTATOES AND POULTRY MAINLY ON HOME GROWN MAIZE.

THE NUTRITIVE VALUE OF DRIED GRASS CAN BE ESTIMATED AT APPROXIMATELY 75 % OF IMPORT CONCENTRATES. IF THE PRICE OF THE LATTER IS FL. 24,- PER 100 KGS THEN THE AIM

SHOULD BE TO SUPPLY DRIED GRASS FOR FL. 18,- PER 100 KGS, PRESUMING THAT ALL CONSIDERATIONS OF CURRENCY COULD BE IGNORED. IF THE PRICE OF THE QUANTITY OF GRASS TO OBTAIN 100 KGS DRIED GRASS IS FL. 7,- THEN THE DRYING COST SHOULD NOT BE MORE THAN FL. 11,- PER 100 KGS. THIS FIGURE WILL BE MORE CLOSELY CONSIDERED AT THE END OF THIS CHAPTER.

IT WILL BE A DIFFICULT TASK TO FIND THE CAPITAL FOR THE CONSTRUCTION OF 160 - 200 NEW DRYING PLANTS (APPR. FL. 160.000,- PER PLANT). IT IS HARDLY IMAGINABLE THAT THIS CAPITAL COULD BE PROVIDED FROM PRIVATE SOURCES, AND THEREFORE IT WILL BE NECESSARY FOR THE GOVERNMENT TO ASSIST IN SOME WAY F.I. BY GRANTING LOANS OR ADVANCES FOR THE PURPOSE.

IT IS OBVIOUS THAT A POLICY AS OUTLINED HERE COULD NOT BE CARRIED THROUGH IN A SHORT TIME, AS CONSIDERABLE MODIFICATIONS IN FARM MANAGEMENT WILL BE NECESSARY AND ALSO THE LIVESTOCK WILL HAVE TO GET ACCUSTOMED TO THE NEW DIET.

IT IS OF GREAT ADVANTAGE THAT BY ARTIFICIAL DRYING LOSS OF PROTEIN, AS EXPERIENCED WITH HAY MAKING, IS AVOIDED BUT NEVERTHELESS THE QUESTION ARISES WHETHER MANY RATHER VALUELESS OFFALLS SUCH AS TOPS OF SUGAR BEET NOW OFTEN BEING PLOUGHED IN, COULD NOT BE USED FOR FEEDING LIVESTOCK AFTER BEING DRIED. FURTHERMORE ATTENTION MUST BE PAID TO THE CULTIVATION OF CROPS RICH IN PROTEIN, SUCH AS LUCERNE (ALFALFA) AND LUPINS.

QUITE APART FROM THESE CONSIDERATIONS THE PROBLEM OF ENSILAGE HAS TO BE INVESTIGATED, BUT THAT IS OUTSIDE THE PROVINCE OF THE SUBJECT UNDER REVIEW.

II. EQUIPMENT AND MANAGEMENT OF GRASS DRYING PLANTS.

THE FIRST QUESTION ARISING IS: WHAT SHOULD BE THE SIZE OF A DRYING PLANT? MANY EXPENSES (DEPRECIATION, WAGES, OVERHEAD EXPENSES) DROP WHEN CAPACITY INCREASES, BUT DIFFICULTIES SUCH AS REGULAR SUPPLY OF RAW MATERIAL, OF STORING ROOM FOR DRIED STOCKS, ARISE. IT WILL BE CLEAR THAT A DEFINITE ECONOMIC LIMIT OF CAPACITY MUST EXIST BEING DEFINED BY LOCAL CIRCUMSTANCES.

IN 1948 THE PRODUCTION COST OF DRYING PLANTS OF VARIOUS CAPACITIES IN THE NETHERLANDS PER 100 KGS FINISHED PRODUCE AMOUNTED TO APPROXIMATELY:

TONS/YEAR	0-200	200-400	400-600	600-700	700-800
PRODUCTION COST	13,3	8,7	8,5	9,4	8,4

TONS/YEAR	800-900	900-1000	1000-2000	>2000
PRODUCTION COST	8,8	8,25	7,9	7,3

FROM THIS IT CAN BE CONCLUDED THAT NO PLANT SHOULD BE BUILT WITH A SMALLER ANNUAL OUTPUT THAN 300 TONS, AND THAT RUNNING COST DECLINE FOR VERY LARGE OUTFITS.

EXPERIENCE ALSO HAS SHOWN THAT THE MOST FAVOURABLE RESULTS ARE ATTAINED BY AN ANNUAL CAPACITY OF 800 - 1000 TONS DRIED ARTICLE.

THE AVERAGE NUMBERS OF EFFECTIVE RUNNING HOURS ACHIEVED WERE:

	1941	1942	1943	1946	1947	1948
HOURS PER ANNUM	1850	2027	1825	1345	947	2041

THE FIGURE FOR 1946 HAS BEEN STILL ADVERSELY AFFECTED BY THE CONSEQUENCES OF THE WAR, AND 1947 WAS AN ABNORMALLY DRY YEAR. IN A NORMAL SEASON 2000 RUNNING HOURS SHOULD BE ACCOUNTED FOR (IN 1948 SOME PLANTS ATTAINED 3000 HOURS).

THEREFORE IT IS ADVISABLE TO ERECT IN A GRASSLAND DISTRICT DRYING PLANTS WITH A CAPACITY OF 800 - 1000 TONS PER ANNUM IN 2000 EFFECTIVE RUNNING HOURS AND PROCEEDING 400 - 500 KGS DRIED ARTICLE PER HOUR.

AT DUTCH DRYING PLANTS, WORKERS ARE ENGAGED ON A BINDING COLLECTIVE CONTRACT, PROVIDING FOR 48 WORKING HOURS PER WEEK. IF NECESSARY THE WORKMEN HAVE TO WORK OVERTIME. DURING THE SEASON THE PLANT RUNS CONTINUOUSLY FROM MONDAY MORNING TILL SATURDAY NIGHT. THE WORK IS DONE BY THREE SHIFTS, THE NIGHT-LABOUR BEING ALTERNATELY SUPPLIED BY THESE SHIFTS. THE MINIMUM WAGES ARE FL. 0,68 - FL. 0,80 PER HOUR, VARYING WITH THE DISTRICT, AND IN ADDITION BONUSES, ALLOWANCES AND SOCIAL CHARGES ARE PAID BY THE EMPLOYERS.

A DRIER IS FROM A MECHANICAL POINT OF VIEW ACTUALLY AN INSTALLATION FOR THE EVAPORATION OF WATER. TO JUDGE ITS EFFICIENCY THE MOISTURE CONTENT OF THE GRASS SUPPLIED MUST BE KNOWN. IN 1947 (A VERY DRY SUMMER) IT WAS ON THE AVERAGE 73,6 % AND IN 1948 (A WET SEASON) 77,1 %. THE DIFFERENCE SEEMS NOT TO BE EXCEEDINGLY LARGE, BUT WHEN CONSIDERING THE RELATION BETWEEN MOISTURE AND DRY MATTER (DRY BASIS) THESE PERCENTAGES ARE ACTUALLY 277 AND 337 % RESPECTIVELY, AND THEREFORE IN THE LATTER CASE 22½ PER CENT MORE WATER MUST BE EVAPORED. THIS DIFFERENCE IS ACCOUNTED FOR IF A DRYING PLANT OF 400 - 500 KGS/H ATTAINS ITS MAXIMUM CAPACITY AT 500 KG/H. BY DESIGNING OR ORDERING A PLANT FOR 500 KG DRIED ARTICLE PER HOUR, A PROVISO SHOULD BE MADE THAT THIS QUANTITY MUST RELATE TO GRASS WITH, SAY 74 % OF MOISTURE.

IF WILTED GRASS IS DRIED IN THE PLANT, ITS CAPACITY WILL BE HIGHER PROVIDED THAT NO DUCTS IN THE MACHINERY WILL BE BLOCKED UP OWING TO THE NATURE OF THIS RAW MATERIAL.

AFTER BEING DRY, GRASS HAS USUALLY STILL A MOISTURE CONTENT OF ABOUT 10 PER CENT, JUST LOW ENOUGH TO BE FIT FOR GRINDING IN A HAMMER MILL. BUT FOR LUPINS OR CLOVER, BEING CROPS WITH THICK STEMS, THE MOISTURE CONTENT OF THE LATTER IS CONCLUSIVE, AS IT SHOULD NOT BE HIGHER THAN 10 PER CENT, AND THEREFORE THE AVERAGE FOR THE BULK WILL BE A FEW PER CENTS LOWER. THE EVAPORATION OF THE WATER, STILL PRESENT IN THE CROP CLOSE TO THE END OF THE PROCESS, DEMANDS A GREAT DEAL OF WORK AND CONSEQUENTLY MUCH FUEL. THEREFORE THIS ITEM REQUIRES SPECIAL ATTENTION WHEN THE EFFICIENCY OF A PLANT IS BEING JUDGED.

THE DRYING PROCESS SHOULD NOT BE CARRIED ON ANY LONGER THAN IS ABSOLUTELY NECESSARY TO BE SURE OF THE KEEPING QUALITY OF THE DRY GRASS OR ITS SUITABILITY FOR FURTHER PROCESSING.

IN CALCULATING THE DRYING COST BASED ON DATA RECORDED FOR 1949 THE FOLLOWING ITEMS HAVE BEEN TAKEN INTO ACCOUNT:

1. DEPRECIATION: BUILDINGS AND MACHINERY TO BE WRITTEN OFF IN 10 YEARS, RATE OF INTEREST 4 %, INTEREST AND ANNUITIES: 12 % OF FL. 160.000,- OR FL. 19.200,-;
2. ANNUAL OUTPUT 800 - 1000 TONS;
3. 3600 TOTALS RUNNING HOURS OF WHICH 2000 EFFECTIVE (STAGNATIONS IN SUPPLIES 19 %, BREAK DOWNS 4 %, NIGHT LABOUR 4 %, SUNDAY STOPPAGES 18 %);
4. 3 SHIFTS OF 5 WORKMEN BEING EMPLOYED;
5. PRICE OF COKE FL. 45,- PER TON.

ON THIS BASIS THE PRODUCTION PRICE VARY BETWEEN:

INTEREST AND ANNUITIES	2,4 - 2,0	CENTS	PER	KG
MAINTENANCE AND TOOLS	0,5 - 1,0	"	"	"
WAGES AND SOCIAL CHARGES	2,0 - 2,5	"	"	"
FUEL	2,0 - 2,5	"	"	"
ELECTRICITY	0,5 - 1,0	"	"	"
MANAGEMENT	0,5 - 0,75	"	"	"
OTHER OVERHEAD EXPENSES	0,5 - 1,5	"	"	"
	8,4 -11,25	"	"	"
PROFIT	1,6 - 0,75	"	"	"
TOTAL (HAULAGE NOT INCLUDED)	10,0 -12,0	CENTS	PER	KG

THESE FIGURES ARE DERIVED FROM THE DATA RECORDED IN THE BOOKS OF THE EXISTINGS PLANTS. IF IN THE FUTURE PLANTS OF LARGER OUTPUT WILL BE ERECTED, THEN IT IS LIKELY THAT THE PRODUCTION PRICE WILL DROP A LITTLE.

AT IT IS SHOWN PREVIOUSLY THAT 11 CENTS PER KG ACCOUNTS FOR NUTRITIVE VALUE COMPENSATION OF IMPORT CONCENTRATES, OUR CALCULATION PROVES THAT FOR CIRCUMSTANCES AT THE NETHERLANDS GREEN CROP DRYING IS POSSIBLE, REGARDING THE ECONOMIC ASPECTS.

FINALLY IT SHOULD BE BORNE IN MIND THAT IT BECOMES MORE AND MORE CUSTOMARY TO FIX SELLING PRICES ACCORDING TO CRUDE OR DIGESTIBLE PROTEIN CONTENT. THEREFORE IT WILL BECOME ESSENTIAL IN THE FUTURE THAT DRYING PLANTS COMPLY WITH REQUIREMENTS ON PREVENTION OF POSSIBLE DECLINES IN QUALITY DURING THE DRYING PROCESS.

ABSTRACT IN DUTCH

KORTE INHOUD

I. CULTUURTECHNISCHE GEZICHTSPUNTEN, DOOR IR M.L.'T HART (1).

HET KUNSTMATIG DROGEN VAN GRAS WORDT VOORNAMELIJK TOEGEPAST OP GRASLANDBEDRIJVEN VOOR DE WINNING VAN EIGEN VEEVOEDER, ALSMEDE VAN LUCERNE OP VEEARME AKKERBOUWBEDRIJVEN. OP WEIDEBEDRIJVEN WORDT SLECHTS 3 - 6 % DER GRASOPBRENGST GEDROOGD; MEN HEEFT DAAR IN JUNI - JULI WEINIG GRAS. ALS MAATREGELEN TER VERBETERING WORDEN GENOEMD INFILTRATIE EN BESPROEIING, ALSMEDE DOELMATIGE BEMESTING. ER IS VERBAND TUSSEN HET EIWITGEHALTE EN HET GROEISTADIUM VAN HET GRAS.

II. DE TECHNISCHE INRICHTING VAN GROENVOEDERDROGERS, DOOR PROF.IR J.J.I.SPRENGER (1).

DE GEBRUIKELIJKE DROGERS KUNNEN VOLGENS HUN INRICHTING SYSTEMATISCH WORDEN INGEDEELD. DE VOOR- EN NADELEN VAN DEZE VERSCHILLENDE SYSTEMEN WORDEN BEHANDELD. TIJDENS HET DROOGPROCES KAN MEN TWEE BEPAALDE STADIA ONDERSCHEIDEN, WAARBIJ DE GRENS LIGT BIJ CA. 23 % VOCHTGEHALTE. EEN FORMULE WORDT GEGEVEN VOOR DE DROOGSNELHEID IN DEZE STADIA.

IN HET JAAR 1948 WERD DOOR 101 DROGERS CA. 50.000 TON GEPRODUCEERD MET GEM. 2041 NETTO DRAAIUREN PER DROGER.

EEN VIERTAL DROGERS VAN SPECIFIEK NEDERLANDSE CONSTRUCTIE WORDT MEER UITVOERIG BESCHREVEN.

III. DE INVLOED VAN HET VOORDROGEN OP HET LAND, HET KUNSTMATIG DROGEN EN HET BEWAREN OP DE CHEMISCHE SAMENSTELLING, DOOR IR S.BOSCH (1) EN DR W.B.DEIJS (1).

BIJ VOORDROGEN OP HET LAND KAN HET VOCHTGEHALTE (CA. 80 %) BELANGRIJK WORDEN VERMINDERD; ECHTER TREDEN DAN DROGE-STOFVERLIEZEN OP VAN DE ORDE VAN 2 - 2½ % PER ETMAAL DOOR VERADEMEN VAN KOOLHYDRATEN. OOK DAALT DAARBIJ HET CAROTINEGEHALTE.

TIJDENS DE KUNSTMATIGE DROGING HEEFT MEN EVENEENS DROGE-STOFVERLIEZEN, VOORNAMELIJK MECHANISCHE VERLIEZEN EN VERBRANDING. BIJ HOGE TEMPERATUREN GAAT DE VERTEERBAARHEID DER EIWITSTOFFEN ACHTERUIT. DE CAROTINEVERLIEZEN VERLOPEN PROGRESSIEF MET HET AANVANGSPERCENTAGE.

PROEVEN WERDEN GENOMEN OMTRENT ACHTERUITGANG VAN CAROTINEGEHALTE TIJDENS HET BEWAREN. DEZE BLEEK HET GERINGST TE ZIJN BIJ EEN R.V.-GRAAD DER LUCHT 60 - 80 %, EEN DICHTE PAKKING EN EEN LAGE TEMPERATUUR. EEN FIJNE VERMALING (GROOT OPPERVLAK) BEVORDERT DE OXYDATIE.

IV. DE INVLOED VAN KUNSTMATIG DROGEN OP DE VERTEERBAARHEID VAN HET GRAS, DOOR DR N.D.DIJKSTRA (2).

AAN HET RIJKSLANDBOUWPROEFSTATION TE HOORN WERD VAN EEN GROOT AANTAL MONSTERS GEDROOGD GRAS DE VERTEERBAARHEID BEPAALD MET BEHULP VAN HAMELS.

WIJ VONDEN, DAT, WANNEER GRAS VOORZICHTIG IN HET LABORATORIUM WORDT GEDROOGD, DE VERTEERBAARHEID VAN DE MEESTE BESTANDDELEN NOG EVEN HOOG IS ALS DIE VAN HET VERSE GRAS, ALLEEN DIE VAN HET EIWIT IS DOOR DE KUNSTMATIGE DROGING IETS VERMINDERD.

VERDER WERD GEVONDEN, DAT BIJ HET KUNSTMATIG DROGEN VAN GRAS MET BEHULP VAN DROGERS IN DE PRACTIJK STEEDS EEN AFNAME IN DE VERTEERBAARHEID VAN HET EIWIT VALT TE CONSTATEREN.

GESCHIEDT DIT DROGEN VOORZICHTIG EN BIJ INLAATTEMPERATUREN BENEDEN 200° C DAN IS DEZE AFNAME NIET GROOT EN BEDRAAGT GEMIDDELD ONGEVEER 5 %.

BIJ DROGING BIJ HOGE TEMPERATUREN KAN DE AFNAME ZEER BELANGRIJK WORDEN EN WEL TOT 25 % STIJGEN.

V. DE ECONOMIE VAN HET GRASDROGEN, DOOR PROF.IR J.J.I.SPRENGER (1).

MEN KAN DE ECONOMIE VAN HET GRASDROGEN BESCHOUWEN ALS EEN NATIONAAL PROBLEEM VAN VEEVOEDING, DOCH OOK UIT HET ANDERE STANDPUNT VAN EXPLOITATIE VAN EEN BEPAALDE GRASDROGERIJ.

VOOR NEDERLAND IS VAN BELANG, DAT OP DEVIEZEN VOOR IMPORTKOSTEN VAN VEEVOEDER WORDT BEZUINIGD. DIT BLIJKT MOGELIJK TE ZIJN, INDIEN DE DROOGKOSTEN VAN GRAS NIET HOGER DAN OP F. 11,- PER 100 KG UITKOMEN.

AANGETOOND WORDT, DAT DE MEEST ECONOMISCHE PRODUCTIE CAPACITEIT VOOR EEN GRASDROGER ZAL ZIJN 500 KG PER UUR OF 1000 TON PER JAAR BIJ EEN VOCHTGEHALTE VAN HET VERSE GRAS VAN 74 %.

OP GROND VAN DE BEDRIJFSUITKOMSTEN VAN BESTAANDE DROGERIJEN WORDT EEN ANALYSE DER KOSTPRIJS GEGEVEN, WAARUIT BLIJKT, DAT DEZE F. 10,- À F. 12,- PER 100 KG BEDRAAGT. BIJ EEN DROGER CAPACITEIT VAN 1000 TON/JAAR ZAL HET GRASDROGEN IN NEDERLAND ECONOMISCH MOGELIJK ZIJN.

HET LIGT IN DE BEDOELING, HET AANTAL GRASDROGERIJEN IN NEDERLAND IN DE NAASTE TOEKOMST STERK UIT TE BREIDEN.

(1) CENTRAAL INSTITUUT VOOR LANDBOUWKUNDIG ONDERZOEK, WAGENINGEN.
(2) RIJKSLANDBOUWPROEFSTATION TE HOORN.

ABSTRACT IN FRENCH

RÉSUMÉS

I. POINTS DE VUE DE TECHNIQUE CULTURALE, PAR IR M.L.'T HART.

LE SÉCHAGE ARTIFICIEL DE L'HERBE EST SURTOUT APPLIQUÉ DANS DES EXPLOITATIONS HERBAGÈRES EN VUE DE L'OBTENTION DE LEUR PROPRE AFFOURAGEMENT DE BÉTAIL, AINSI QUE DE LUZERNE DANS LES EXPLOITATIONS PAUVRES EN CHEPTEL. DANS LES EXPLOITATIONS DE PÂTURES ON NE SÈCHE QUE DE 3 À 6 % DE LA PRODUCTION D'HERBE. EN JUIN ET JUILLET ON N'Y RENCONTRE QUE PEU D'HERBE. ON CITE COMME MESURES D'AMÉLIORATION DE CETTE SITUATION L'INFILTRATION ET L'ASPERSION, AINSI QUE LA FUMURE RATIONNELLE. IL Y A UNE LIAISON ENTRE LE POURCENTAGE D'ALBUMINE ET LE STADE DE CROISSANCE DE L'HERBE.

II. L'ÉTABLISSEMENT TECHNIQUE DE SÉCHOIRS DE FOURRAGES VERTS, PAR LE PROF. IR J.J.I.SPRENGER.

LES SÉCHOIRS HABITUELS PEUVENT ÊTRE CLASSÉS SYSTÉMATIQUEMENT SUIVANT LEURS DISPOSITIONS TECHNIQUES. LES AVANTAGES ET INCONVÉNIENTS DE CES DIFFÉRENTS SYSTÈMES SONT PASSÉS EN REVUE. PENDANT LE PROCESSUS DE SÉCHAGE, ON PEUT, DISTINGUER DEUX STADES DÉFINIS, DONT LA LIMITE SE PRÉSENTE VERS ENVIRON 23 % D'HUMIDITÉ. UNE FORMULE EST DONNÉE POUR LA DÉTERMINATION DE LA VITESSE DE SÉCHAGE DANS CES STADES.

PENDANT L'ANNÉE 1948, IL A ÉTÉ PRODUIT ENVIRON 50.000 TONNES AU MOYEN DE 101 SÉCHOIRS, AVEC UNE DURÉE NETTE DE ROTATION MOYENNE DE 2.041 HEURES PAR SÉCHOIR.

QUATRE SÉCHOIRS DE CONCENTRATION SPÉCIFIQUEMENT NÉERLANDAISE SONT DÉCRITS PLUS EN DÉTAIL.

III. L'INFLUENCE DU PRÉSÉCHAGE SUR LE TERRAIN DE CULTURE, LE SÉCHAGE ARTIFICIEL ET LA CONSERVATION DE LA COMPOSITION CHIMIQUE, PAR IR S.BOSCH ET DR W.B.DEIJS.

LA TENEUR EN HUMIDITÉ (ENVIRON 80 %) PEUT ÊTRE FORTEMENT RÉDUITE PAR LE PRÉSÉCHAGE SUR LE TERRAIN DE CULTURE. PAR CONTRE, IL SE PRODUIT AINSI DES PERTES DE MATIÈRES SÈCHES DE L'ORDRE DE 2 À 2½ % PAR JOUR, CAUSÉES PAR LA DESTRUCTION DES HYDRATES DE CARBONE PAR LE PHÉNOMÈNE DE RESPIRATION. LA TENEUR EN CAROTÈNE DIMINUE ÉGALEMENT DE CE FAIT.

DES PERTES DE MATIÈRES SÈCHES SE PRODUISENT ÉGALEMENT DANS LE SÉCHAGE ARTIFICIEL, PRINCIPALEMENT DES PERTES D'ORIGINE MÉCANIQUE ET DE CARBONISATION.

LA DIGESTIBILITÉ DES MATIÈRES ALBUMINOÏDES DIMINUE AUX HAUTES TEMPÉRATURES. LES PERTES EN CAROTÈNE VARIANT PROGRESSIVEMENT AVEC LE POURCENTAGE INITIAL.

DES ESSAIS ONT ÉTÉ MENÉS CONCERNANT LA RÉTROGRADATION DE LA TENEUR EN CAROTÈNE PENDANT L'EMMAGASINAGE. CELLE-CI PARAÎT ÊTRE LA PLUS RÉDUITE À UN DEGRÉ D'HUMIDITÉ RELATIVE DE L'AIR DE 60 À 80 %, AVEC UN EMBALLAGE ÉTANCHE ET UNE BASSE TEMPÉRATURE. UNE FINE MONTURE (GRANDE SURFACE) FAVORISE L'OXYDATION.

IV. L'INFLUENCE DU SÉCHAGE ARTIFICIEL SUR LA DIGESTIBILITÉ DE L'HERBE, PAR LE DR N.D.DIJKSTRA.

À LA STATION AGRONOMIQUE DE L'ÉTAT, À HOORN, LA DIGESTIBILITÉ D'UN GRAND NOMBRE D'ÉCHANTILLONS D'HERBE SÉCHÉE A ÉTÉ DÉTERMINÉE EN EMPLOYANT DES BÉLIERS.

NOUS AVONS CONSTATÉ QUE, LORSQUE L'HERBE EST SÉCHÉE PRUDEMMENT DANS LE LABORATOIRE, LA DIGESTIBILITÉ DE LA PLUPART DES ÉLÉMENTS S'ACCORDE TRÈS BIEN AVEC CELLE DE L'HERBE FRAÎCHE, SEULEMENT LA DIGESTIBILITÉ DE LA PROTÉINE EST UN PEU DIMINUÉE.

ÉGALEMENT NOUS AVONS TOUJOURS CONSTATÉ UNE DIMINUTION DE LA DIGESTIBILITÉ DE LA PROTÉINE DE L'HERBE, SÉCHÉE DANS UN SÉCHOIR INDUSTRIEL.

QUAND ON EXÉCUTE CE SÉCHAGE PRUDEMMENT ET À UNE TEMPÉRATURE AU DESSOUS DE 200° C CETTE DIMINUTION N'EST PAS CONSIDÉRABLE ET NE S'ÉLÈVE QU'EN MOYENNE À ENVIRON 5 %.

QUAND LE SÉCHAGE SE PASSE À TEMPÉRATURES PLUS HAUTES, LA DIMINUTION DE LA DIGESTIBILITÉ DE LA PROTÉINE PEUT DEVENIR TRÈS IMPORTANTE EN S'ÉLEVANT PARFOIS JUSQU'À 25 %.

V. LES ASPECTS ÉCONOMIQUES DE SÉCHAGE ARTIFICIEL DE L'HERBE, PAR LE PROF. IR J.J.I.SPRENGER.

ON PEUT CONSIDÉRER LES ASPECTS ÉCONOMIQUES DU SÉCHAGE DE L'HERBE COMME UN PROBLÈME NATIONAL DE NOURRITURE DU BÉTAIL, MAIS AUSSI AU POINT DE VUE PLUS RESTRAINT DE L'EXPLOITATION D'UNE SÈCHERIE DÉTERMINÉE.

IL EST DE L'INTÉRÊT DES PAYS-BAS D'ÉCONOMISER LES DEVISES NÉCESSAIRES À L'IMPORTATION DE NOURRITURE POUR LE BÉTAIL. CELA SEMBLE POSSIBLE SI LES FRAIS DE SÉCHAGE DE L'HERBE NE DÉPASSENT PAS 11 FLORINS P.B. PAR 100 KILOS.

IL EST INDIQUÉ QUE LA CAPACITÉ DE PRODUCTION LA PLUS ÉCONOMIQUE D'UN SÉCHOIR EST DE 500 KILOS PAR HEURE OU 1.000 TONNES PAR AN, AVEC UN POURCENTAGE D'HUMIDITÉ DE L'HERBE FRAÎCHE DE 74 %.

SUR LA BASE DES RÉSULTATS D'EXPLOITATION DES SÈCHERIES EXISTANTES, UNE ANALYSE DU PRIX DE REVIENT MONTRE QUE CELUI-CI S'ÉLÈVE DE 10 À 12 FLORINS P.B. PAR QUINTAL. POUR UNE CAPACITÉ DE SÉCHOIR DE 1.000 TONNES PAR AN, LE SÉCHAGE DE L'HERBE AUX PAYS-BAS SERA ÉCONOMIQUEMENT POSSIBLE.

IL EST PROJETÉ D'AUGMENTER FORTEMENT DANS LE PROCHE AVENIR LE NOMBRE DES SÈCHERIES D'HERBE AUX PAYS-BAS.

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PLATE I

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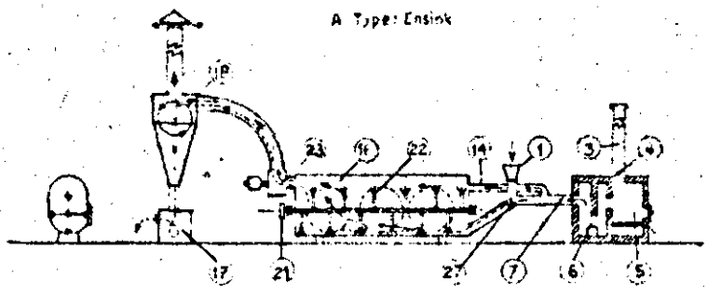

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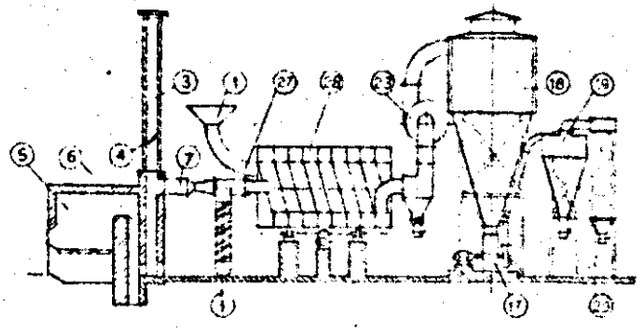

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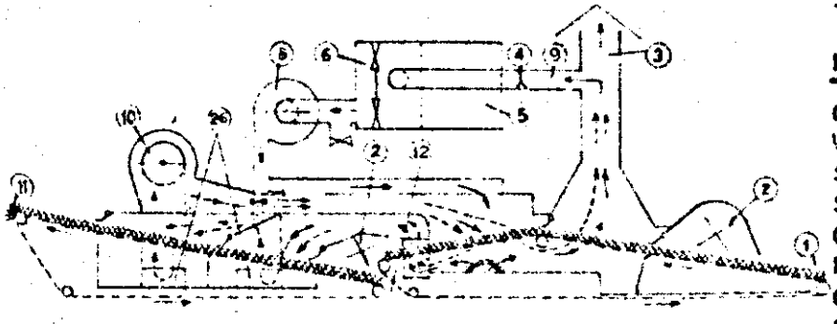

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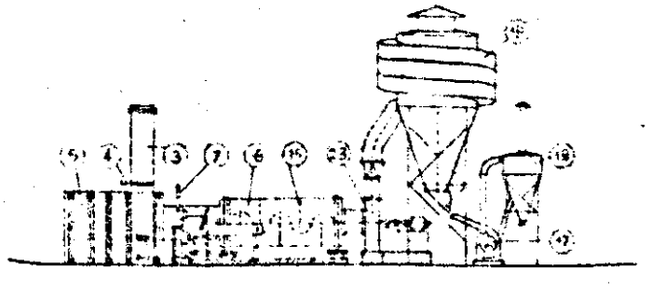

ENGLISH

1. LOADING
2. TEDDER
3. CHIMNEY
4. CHIMNEY SLIDE VALVE
5. FURNACE
6. AIR MIXING CHAMBER
7. FURNACE SLIDE VALVE
8. FURNACE FAN
9. SUPPLY AIR
10. (SECUNDAIRY) RETURN FAN
11. DISCHARGE
12. VARIABLE SPEED CONTROL
13. PRECUTTER
14. CONNECTING TUBE
15. BAFFLES
16. ROTATING DRUM
17. HAMMER MILL, GRINDER
18. CYCLONE SEPARATOR
19. BAGGING CYCLONE
20. STATIONARY DRYING DRUM
21. REVOLVING SHAFT
22. PRONGED FORKS
23. EXHAUST FAN
24. FEED HOPPER
25. INSPECTION DOOR
26. CLEANING HATCHES
27. AIR SEAL
28. SPIRAL PIPE DRUM
29. DUST FILTER

FRANÇAIS

CHARGEMENT
REMUEUR
CHEMINÉE
VANNE DE CHEMINÉE
FOUR
CHAMBRE À MÉLANGE D'AIR
VANNE DE FOUR
VENTILATEUR DE FOUR
AIR DE SUPPLÉMENT
VENTILATEUR DE CIRCULATION
SORTIE
VARIATEUR DE VITESSE
HACHOIR
TUYAU DE CONNEXION
SÉPARATIONS
TAMBOUR DE SÉCHAGE
MEULE À MARTEAUX
SÉPARATEUR À CYCLONE
CYCLONE À SACS
TAMBOUR FIXE
ARBRE CENTRAL
FOURCHES
VENTILATEUR À SUCER
ENTONNOIR DE RÉCEPTION
PORTE D'INSPECTION
CLOISONS DE NETTOYAGE
ÉCLUSE D'AIR
TAMBOUR À TUYAU SPIRAL
FILTRE À POUSSIÈRE

NEDERLANDS

OPGOOI
WOELER
SCHOORSTEEN
SCHOORSTEENSCHUIF
OVEN
MENGKAMER
OVENSCHUIF
OVENVENTILATOR
SUPPLETIE
OMLOOPVENTILATOR
AFWORP
VARIATOR
HAKSELMACHINE
VERBINDINGSBUIS
SCHOTTEN
DROOGTROMMEL
HAMERMOLEN
CYCLOON
AFZAK CYCLOON
DROOGTUNNEL
CENTRALE AS
VORKEN
EXHAUSTOR
INVOERTRECHTER
TOEGANGSDEUR
SCHOONMAAK LUIKEN
LUCHTSLUIS
PIJPTROMMEL
STOFFILTER