THE

ECONOMY OF FARMING,

TRANSLATED FROM THE GERMAN OF

J. BURGER,

PROF. OF AGRICULTURE, AND MEMBER OF THE AGRICULTURAL SOCIETIES OF VIENNA, MUNICH, BRUNN, GOERZ, GRAZ, KLAGENFURT, LAIBACH, PRAGUE, &c.;

WITH MANY ADDITIONAL NOTES FROM THE GERMAN OF

THAER, VEIT, SCHWERTZ, SPRENGEL, PETRI, &c.;

AND A COPIOUS INDEX:

BY

E. GOODRICH SMITH.

"The golden middle path, which leads the inquiring, active farmer through the midst of fields of grain and fodder, and cultivated pastures, to the TRUE PROPORTION of the fruits necessary to be cultivated, and teaches him the need of the requisite beasts to be kept, is, therefore, always the best; by which we may reach, if not hastily and easily—as we have often dreamed in our youth—yet finally, though laboriously, but with profit, the end proposed, in the nearest degree in proportion to our extent of ground, and the power employed on it."—A. K. BLOCK.

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1843.

TO HON. H. L. ELLSWORTH.

COMMISSIONER OF PATENTS.

SIR:

Personal considerations might induce me to inscribe this work to yourself. You knew of the undertaking at its beginning, favored its progress, and approved of its execution, when submitted to your inspection.

I am also indebted to you for many a kindness received at your hands, which will ever be remembered with deep-felt gratitude. But aside from all this, to no one could a work on Agriculture be more fitly dedicated than to you, to whose known devotion to its great interests and enthusiasm in its success, the whole Agricultural community of this nation are under so great obligations. The valuable services you have rendered them through the public office you hold, are entitled to their warmest acknowledgments. An equal regard generally, on the part of those high in station, would do much to diffuse information, and promote this great interest of our common country. Permit me, then, to tender you this tribute of gratitude and expression of my respect for your patriotic endeavors to aid useful industry, and benefit the hardy yeomanry of our land.

With the highest esteem,

Yours,

E. GOODRICH SMITH.

NEW-YORK, July, 1843.

PREFACE.

While engaged, for the last two winters, at Washington, in preparing the Agricultural Statistics for the Report of the Commissioner of Patents, I became acquainted with Charles L. Fleischmann, Esq., one of the Draughtsmen in the Patent Office, distinguished for his versatility of talents, and an accomplished scholar in the polite arts as well as in science. This gentleman is a native of Bavaria, and was educated at the Royal Agricultural Institution of Schleisheim, then under the charge of Professors Thierl, Schonleutner, and Veit, scientific men and practical agriculturists. Mr. F. took so high a rank in his studies, that he not only gained the first premiums of his class, but was also selected, at the early age of nineteen, to be the Adminstrator or Director of the Estate of Count Joseph Erkinger Von Leinsheim, situated on the Danube, and which comprised not less than twenty-four villages, containing numerous farms, mills, brewery, &c. In this office of high trust and responsibility, Mr. F. remained for eight years, during which time the Estate, which had previously run down, became greatly improved by his management. Shortly after the death of the old Count, he left for the purpose of travel, with letters of high recommendation to Count Lasteyie, President of the Board of Agriculture, and other distinguished men of Science in Paris; and afterwards, led by the love of liberty, came to this country, where he was for some years engaged in business at the West. He has, therefore, had an opportunity to compare the modes of agriculture practised in different countries. After my acquaintance with him, he frequently expressed a wish that I would translate, for publication, some German Agricultural works, which his own comparatively limited knowledge of the English language prevented him from doing. His letter to myself, which I have taken the liberty to subjoin, will explain his views on this subject, and his appreciation of the work now presented to the agriculturists of our country:

"Washington, March, 1843.

"Dear Sir,—

"The interest which I feel for the promotion of Agricultural knowledge, induces me to make you a proposition by which you could render the agricultural community a very important service—I mean by translating that part of Burger's Manual on Land-wirthschaft, which relates to the doctrine of the Household or the Economy of Farming.

"I have not seen any French, Italian or English works on Agriculture, which contain the important information to which I allude. In perusing this work you will find it not only highly interesting for the matter, but you will also be pleased with its systematic arrangement, and to see how it leads, step by step, to the ultimate result—to obtain the highest and lasting profit from agriculture.

"Burger himself is a gentleman of education and a practical farmer; he has filled the Chair of Professor of Agriculture for so many years, his extensive correspondence, his journeys in all parts of Europe for the purpose of

acquiring information, his acquaintance with the works of so large a number of distinguished writers on Agriculture, of which you will have the evidence in his pages, have enabled him to produce a work that contains much important knowledge, not only to the learner, but to the practical farmer. These volumes of his have already passed through nine editions in Germany, and have been translated into other European languages.

"The results of practical experience and of scientific experiment well applied together, cannot fail to give the best success; but there are some practical questions of the highest importance which must be fully understood before we can attempt to apply any of the sciences, and these simple practical questions, unfortunately, cannot be answered by the mere practical farmer who boasts that he has held the plough all his life—even those simple questions upon which his whole business is based. He works his farm, perhaps, after the rules which were handed down by his ancestors, with the loss of time and money; and if circumstances should change some of these conditions, he is not able to remedy them for want of information.

"Ask a farmer, in your part of the country, who seems to be most acquainted with the general principles, how many cattle he requires to work a given number of acres? or what kind of field husbandry will be required, in the given circumstances? or how much manure he needs to keep the field in a good condition? or how many head of cattle he must procure to obtain the required amount of manure? or how much food his cattle require? and a great many such purely practical questions, and I assure you, not one will be answered according to the rules laid down by experiment. He will merely give you rough conjectures.

"This kind of questions are among the first and most important in the beginning of all farming operations; for farming is not like the business of manufacturers, where your article may be improved the next day when spoilt in the last operation. No! here a year's work is required, and your plan in the beginning is hardly laid out; not only that year is lost, but all succeeding ones, and the final result is inevitable ruin.

"I recommend to you also the works of THAER, VEIT and SCHWERTZ, on Agriculture, in which you will find a great many valuable data for your work. I have no doubt of your full success with regard to the translation, and to the manner in which you will enrich your work with notes; I shall be happy to assist you in any difficulties of technical words, and hope that your work will be appreciated as well as that of LIEBIG, which has given much information to the farmers of this country.

"With high esteem, Yours, &c.,

"CHAS. L. FLEISCHMANN."

"Rev. E. Goodrich Smith."

On examining the volumes which Mr. Fleischmann brought to my notice, I felt that his appreciation of the work was not undeserved, as it was evidently that of a master hand. The promise of my friend, too, was amply redeemed: he kindly lent me many valuable works in the German language, and by examining my manuscript, relieved me from any misgivings I had as to the rendering of particular passages. So great indeed is the difficulty, often, of translating German idioms and technical terms into English, that but for his aid I could hardly feel assured that I had always given the exact sense; but situated as I have been in this respect, I feel quite confident that there can be no material errors.

The plan of the original work is thus announced by the Author: "It was written to supply some existing deficiencies, to furnish a text-book for teachers, a manual for scholars, and a guide for the farmer."

It is composed in the form of propositions, followed up by illustrations. The

Author is distinguished for his clear, philosophical mode of treating his subjects, and has brought to bear upon them a mind well stored with the fruits of long experience, close study, and diligent research. The present volume does not do him entire justice, as in order to render it more useful, I have introduced a variety of additional matter in the form of Notes from different portions of his volumes, and from other German writers of high repute. This destroys in some degree the unity of the work, and yet I trust these additions will not be thought irrelevant. I might indeed have placed them in an Appendix, but I have chosen to throw them in where they appear as most corresponding with the design of the work. Yet many of them would have been unnecessary here, as belonging rather to another portion of the work, had the whole Manual, of which this forms a part, been published. My notes and extracts are inclosed in brackets, thus [ ], and are marked by a TR. at the end. I may have overrated the value of the work I have translated, from my own comparative ignorance of many of these practical details; I do not pretend to say that all of them are of equal value for the farmer; but I have felt Mr. FLEISCHMANN'S judgment to be a correct one, and that much valuable matter, even for our farmers, is comprised in the following pages I am confident that nowhere in our own country, and perhaps not in the English language, can there be found a book of the same moderate size which contains an equal amount of estimates of proportions, &c., relating to farming, and which may be relied on as from the best authorities. I am also confirmed in my opinion of the work, by those editors and others who have examined it.

The great distinction in German Agriculture, compared with our own, is *economy*. The question is not, whether a great crop *can* be produced, or a fine story can be told, what large animals can be raised, &c.,—but what is the whole cost, the expenditure of labor, of land, of manure, &c. For this reason computations have been made, and the proportion of all the parts and processes has been fixed. Economy compels them to weigh and measure their fodder. The minutest details have been entered into, the most difficult points examined, and the results brought out.

THAER'S great book in four quarto volumes is a beautiful specimen of a philosophical arrangement and discussion of the subject. Judge BUEL, in his Farmer's Companion refers several times to THAER. He speaks of him as one "who has not, perhaps, his superior in the practical and scientific business of farming anywhere." The Author of The British Husbandry says of him, "whose practical knowledge cannot be too highly appreciated," also, "whose great practical experience and deep science, added to the candor with which his remarks are imparted, stamp an inestimable value on his works on husbandry." He quotes always, however, from the French Translation of Baron Crud called Principes Raisonnés. THAER was a long time at the head of the Agricultural school of Mögelin in Prussia, where many experiments were tried on the various points of husbandry under his own eye; and the results embodied in his numerous works and contributions to Scientific Journals.

SCHWERTZ, also, was Director of Experiments and Professor of Agriculture in the King of Wurtemberg's Agricultural institution, and resided in the year 1837, at the age of 77 years, in Coblentz. He travelled as an Agriculturist in various parts of the continent; and is the Author of a number of works on the Agriculture of Alsace, Hofwyl, Westphalia—some of which were published in THAER'S Annals of Agriculture. His reputation is high, and he is frequently quoted by the most distinguished writers on Agriculture, in Germany. His Practical Agriculture is contained in three large volumes, to which a fourth, drawn from his papers, was to be added by a friend.

VEIT was Professor of Agriculture in the Royal institution of Bavaria, and his work is full of results of experiments and calculations at that seat of Agricultural Science.

Petri was also an honorary and corresponding member of many societies, and Agricultural Counsellor of the Prince Von Lichtenstein, and his valuable work on Sheep forms part of the German Farmer's Encyclopedia.

Of Carl Sprengel, the Botanist, Mineralogist, and Chemist, it is less necessary to speak, as he is probably more known in this country. He was, in 1837, Professor of Agriculture, and Editor of an Agricultural Journal of great celebrity, on the continent of Europe, and his works exhibit much research, as well as clear intellect and discriminating judgment.

A necessity exists, where these works are published, for much of the information contained in them beyond merely aiding the farmer in tillage. These calculations are the basis of a standard of valuations of land, &c., for the assessment of taxes. A soil or product ranks at a fixed rate, and with this all are compared and valued, and the computation readily made. All therefore feel it important to possess such information, and were there a like discrimination in our own country, in preparing the assessments, much of the present hap-hazard estimate, so productive of unequal justice, would be prevented.

Our farmers are slow to believe the importance of these things; yet much is doing by Agricultural Societies and works among us to instruct the people. A few in every section of the country are laying the results of their experience and knowledge before the public, and a great advance has been made within a few years.

The subject of manures has engaged the attention of many scientific and practical men, and a new field of mysteries has been brought under the hand of experiment, by which the most interesting and striking results are developed.

Analyses of the soils have been made, and the theory of growth and decay brought out and illustrated with great beauty and simplicity. The same is the case as respects the materials for fodder, and it was melancholy to read, the past winter, of so many cattle starving in Ohio and Michigan, when by a slight knowledge of the many substitutes and modes of preparation, their owners might have avoided the loss.

As to the present volume, it is true, that many of its details do not apply with exact accuracy to this country, as our habits, manners, and modes of farming, implements used, products and prices of labor, and standards of weight and measure, are so widely different from those in Continental Europe. Still I doubt not that even these details may answer a valuable purpose, by suggesting the application of similar rules, and that they may be so modified, that even as practical results they may be most useful. The weights and measures are mostly reduced to the English standard, and tables from the best authorities are added, by which any one may further verify them. I have added, too, an Index which may render the use of the work more easy, and thus enhanced its value.

Should this work meet with favor from the public, I hope, by availing myself of several other valuable treatises not to be found in our language, to render future portions of Burger's Manual yet more deserving of patronage by the friends of Agriculture. There is a mine of riches on this subject, on which the first stroke has scarcely yet been struck.

New-York, July, 1843. THE TRANSLATOR.

ECONOMY OF FARMING.

SECTION I.

MEANING AND NECESSITY OF THIS BRANCH OF INSTRUCTION.

1. THE DOCTRINE RESPECTING THE HOUSEHOLD, is called its ORGANIZATION, or RURAL ECONOMY.

[The German word here translated Household, "Hausehalt," is not limited as is our word Household, to the family, or the conduct of domestic affairs; but embraces the whole in-door and out-door establishment; and more especially in the present treatise, the farming operations. The word translated Rural Economy, "Landwirthschaft," might perhaps be more definitely expressed by Land-Husbandry. I shall sometimes use either term.—TR.]

2. It shows the amount and proportional employment of the different powers and means requisite for the conduct of that business, so as to derive from it the greatest gain in the given circumstances.

The object of farming is that of all kinds of business, viz., by means of labor and money, judiciously employed, to produce gain, or to acquire money:—in other words, for one so to employ his labor and capital as, by the management of his affairs, to secure the highest income.

In order to reach this object, it is necessary for a person to know not merely—on which it depends—how to rear up plants and animals, but also the expense of the powers and means of aid demanded for this purpose; so as neither to make too great an outlay for the given circumstances of his business—in which case he will not be repaid by his probable profit—nor too small a one, which would keep the whole enterprise in a crippled state.

[In Vol. I., sec. i., of his work, to which he here refers, our author defines Land-Husbandry to be "that science which teaches us how to raise up and employ usefully plants and animals," and says that "its object is double, *general* and *special*; the first, on account of which land-husbandry is generally carried on, is the production of animals and plants, serving for the food, clothing, and other conveniences of men; the particular or special is, by the conduct of land-husbandry as a business to use the capital thus employed to the greatest advantage." He also observes, that "it is not the greatest possible production of plants on a given space, or the rearing of the largest and finest animals, which is the object of the farmer in the last point of view, but how the capital may be employed in agriculture, and in rearing animals, to the greatest advantage—that is, so as to yield the highest income." This particular, it is believed, is often lost sight of in the account of very large crops, or animals raised, which are found in our Agricultural Journals. With the Germans it appears to be carried to a great nicety of calculation, as many of the following pages will show.—TR.]

3. Land-Husbandry consists in the connection of the production of plants with the rearing of cattle.

4. The essence of the doctrine of the Household (See 1.) is to unite Agriculture with the breeding of cattle, so as thus to obtain the greatest gain.

[With respect to the whole subject embraced in the preceding section, THAER, in

his Grundsatze der Rationellen Landwirthschaft, (Elements of Rational Land-Husbandry,) Vol. I., p. 62, observes, "By the word *Economy* we understand, in reference to the doctrine of Land-Husbandry, the doctrine of the proportional relations, and of the management and employment of those powers by which production is chiefly obtained; and therefore it treats of the procuring, maintaining and management of the laboring force; of the proportion of the stock of cattle, or much more of fodder and manure to Agriculture; of the divisions of the field founded thereon, or the system of operations in reference to the most perfect possible attainment of the object of this business, according to each locality; the highest possible consequent pure profit out of the whole of the business, and finally of the direction of the business, and its exhibition in books and accounts." VEIT also, in his Handbuch Landgueter-Verwaltung, (Manual of the Administration of Landed Estates,) vol. i. p. 12, thus observes on the same subject: "The chief object of this business is the highest possible surplus of the receipts of the business from vegetable and animal production, over the outlay for the same. The knowledge of the conditions of that highest and best production, or the *knowledge of production*, lies in, and will be set forth in the branch of instruction concerning the special raising of plants and animals; the aim now is to learn to know the means on which rests that highest production, their efficacy, cost, necessity, mode of acquiring and employing them. But of the means of production, it is desirable that they may give the highest possible efficacy for a certain amount, on which the surplus of the results over the expense of production may be the greatest possible. The highest development of the powers dwelling in the means of production, will follow, if they are employed at the right time, in the right measure, and in the right mode." "To know how so to place proportionately, and unite together reciprocally all the branches or parts of the organization of business, that every one may be in a situation to repay the proposed expense with a corresponding profit, and all together in their common direction, be able to reach the highest object of business, is called the KNOWLEDGE OF THE ORGANIZATION, OR THE DIRECTION OF THE BUSINESS OF LAND-HUSBANDRY."—TR.]

SECTION II.

DIVISION OF THE DOCTRINE OF THE HOUSEHOLD.

1. The Household is divided into the *outer* and *inner*.

2. The *outer*-Household teaches the knowledge and suitable connection of the relations between Agriculture and the breeding of cattle.

3. The *inner*-Household teaches the arrangement of the occupations; their general oversight and accounts, as well as the reciprocal duties of the different members of a well-ordered Household.

SECTION III.

OF THE OUTER HOUSEHOLD AFFAIRS.

1. In conducting farming operations, the *labor of men* and *beasts* is requisite, as also *articles of food* for the support of men, beasts and plants.

Though we find tracts of land in rare places which need no manure, yet even there beasts are necessary for the cultivation of such lands; and if, too, there are some regions where no agriculture is carried on, but only the raising of cattle; yet in Germany at least, winter-fodder for the cattle, and the cultivation of meadows are necessary.

[The importance of having a diversity of articles of food for cattle, has been shown during the past winter and spring in many parts of Ohio and Michigan, where we are told that many cattle have died, and many more have been killed, in

consequence of too scanty a supply of hay, and for which the farmer had neglected to provide substitutes.—TR.]

2. The labor of men is required as well in the rearing of animals, as in the cultivation of plants. Without the aid of beasts of labor we can indeed manage the garden, but not the cultivation of the field; and so too without a sufficiency of manure, the culture of plants will not repay the labor bestowed on them.

3. The doctrine of the outer Household, therefore, is divided into two parts; the *first* of which shows the amount of animal powers, the number of laboring men and beasts, required for the management of the household [or farming operations;] the *second*, the quantity of manure needed in agriculture, and how it may be provided at the least cost, and employed to the greatest advantage.

A.—OF LABOR.

1. Land-Husbandry requires the labor both of men and beasts; but in a variety of circumstances, they will repay only a definite amount of labor; hence we must first of all know what men and beasts will accomplish in a given space of time, before we fix on any particular mode of farming.

2. Where the land is cheap, but labor is dear, an *extensive* method is most profitable; where the reverse is the case, and land is dear, but labor cheap, it is best to practise the *intensive* mode of carrying on business.

The *extensive* mode of farming is that where the product depends more on the extent of land; the *intensive* on the degree of labor. The Dreifelderwirthschaft and the Egartenwirthschaft are examples of the extensive mode; the Wechselwirthschaft, without fallow and meadow, is one of the intensive method. The increase of production is always connected with the increase of labor; only the degree of increased production reaches to a certain height in an inverse ratio with the increase of labor. To determine the height to which the powers and means of aid of husbandry must reach, so as to derive the greatest profit from the increase of the product in given circumstances, is the most important acquisition for the calculating land-holder.

[The terms *Dreifelderwirthschaft*, *Egartenwirthschaft*, and *Wechselwirthschaft* are applied to different methods of carrying on farming, common in Germany. The Dreifelderwirthschaft, or the three-field or the Triennial system, as it is sometimes termed, is where the land is divided into three parts, and one part is left fallow, one part cultivated with winter-grain, and the remaining one with summer-grain. (See further on, B. 6. 24.)

The Egartenwirthschaft or, Koppelwirthschaft is where the field is left to its wild, natural growth of grass, for two or more years, and is used as meadow or for grazing. (See B. 6, 7, 27.) It is also sometimes called Drischfelder, or Dreeshweiden. The Wechselwirthschaft is the system of the rotation or succession of crops. (B. 6, 7. 10.) As the terms are convenient for use, with this explanation they will be used hereafter without translation.

On the subject of the extensive and intensive modes of husbandry, THAER in Vol. I. p. 63, remarks;—"This relation of the price of labor to the price of the ground and soil. lies at the foundation of many different systems of agriculture. In their extremes we may call these the extensive and the intensive. Where the soil is cheap but labor is dear, there a person must seek to produce a certain amount of products, on a larger extent, but with the least possible labor. Where, on the contrary, the price of the soil is high, but labor is to be had in sufficient quantity, and at an easy price, there one must endeavor to raise on a less extent of ground, the same value in products—as this is always possible—by increased employment of labor. Whoever wishes to employ a fixed capital in agriculture, must in the former of these cases, purchase a

large extent of land even if he retains only a little for the employment of labor. He must practice the extensive method with the least employment of labor. In the second case he must purchase only a small extent, not only because the land is dearer, but also, because he must retain a greater capital for the payment of more labor to be employed." The extensive system prevails comparatively more in our country than the intensive, though it cannot be doubted, that many of our farmers would find their advantage in tilling a smaller extent of land than they do to a higher degree. It is sometimes the case, and our author does not seem to have noticed it, that both land and labor are dear, as in some portions of our older states. In this case the intensive system would seem altogether the preferable one.—TR.]

3. If we know what is the proportional product of the field, under given circumstances, to the various outlay of labor and manure, and also the cash value of labor and of vegetable, and animal products; we have then the requisite data from which to estimate the gain or loss of any proposed method of husbandry.

A.—OF THE LABOR OF MEN.

1. The laborers in farming operations are divided into *domestics*, (Dienstboten,) *day-laborers*, *laborers by the job*, and *soccage-men*. (Froehner.)

[For the explanation of the term Froehner or soccage-men, see below, 12.—TR.]

2. Domestics (Dienstboten,) are those laborers who engage to work for their board and certain wages for a whole year.

3. They receive their board either at the common table, or they have an allowance of provision for their support, and themselves take the charge of preparing it. The first mode is usual in smaller, the latter in larger farms.

Though the allowance-system has apparently great advantages for the man who hires laborers, because he can thus form an easy and correct estimate in his farming accounts, and also avoids the discontent of laborers, as to the quantity and quality of food; yet, on the other hand, it has the disadvantage of the loss of labor, since one man can easily cook for thirty others; but in the preparation of the allowance not more than five or six are joined together, and there will thus be more men engaged in cooking a great part of the day; and so this portion will be lost to labor in the field, &c.

[THAER, Rat. Landwirth.—Vol. I. pp. 88, 89, speaks of the Dienstboten, whom he calls *Gesinde* as "those who have hired out their services exclusively for our business, and whom we board and pay wages." These, he also says "dwell either in the farm-house, are there boarded, and in all respects provided for, and such are unmarried; or they receive a certain allowance (Deputat,) for their support, and dwell then, for the most part, in separate buildings, and are married. The former mode is unquestionably the most profitable in respect to the cost, and the closer oversight one can have over the men. The greater their number so much the more will the board of each one be lessened, while with respect to their lodging, fuel, light, and even food, with a greater number more may be spared. Where the number of servants are but few, it is probably more advisable to give to all an allowance." "In most countries, some day of the week, or time of the year, and many holidays they have their particular food, and the people would not be contented unless they have on such days what they probably do not eat on ordinary days."

VEIT, also, Vol. I. p. 134, gives a similar account of the system in Bavaria. Under the head of laborers who condition their power of labor on a definite time, and for this receive wages and board; he makes the following divisions:—

"1. those who dwell in the farm-house where they receive board and yearly wages. These are termed *Dienstboten*, and are usually unmarried persons.

2. Such as dwell in separate houses, or in particular parts of the farm-buildings

and in place of board receive a certain quantity of means or support, with a year's wages, who keep their own stock, and for the most part are married. These are called *gebroedte Dienstleute*, or *Deputatists*.

3. Those who dwell in the farm buildings, and receive yearly wages, but instead of board, have daily an equivalent in money.

4. Those who have board and day's wages but do not dwell in the farm-house.

5. Those who receive a year's wages and money for support but do not dwell in the farm-house.

6. Those who dwell in the farm-house, and have board, but instead of a year's wages have only day's wages, and are reckoned with every week, according to the number of their day's work."

Leaving out the sixty-eight sundays and feast days, and also shrove-tide, passion-week, the anniversary of the consecration of the church, harvest-home, and cases of sickness, at least seven other days; there remains, says VEIT, only two hundred and ninety days for labor, in the year. The wages of the Dienstboten are usually paid once in a quarter, and vary according to their occupations, but the general average is about forty-five florins, or about twenty-three dollars a year. The cost of board also varies in different countries. VEIT has given some estimates on this subject, which may be added as acquainting the reader with the condition of the laborers abroad. He says " in many farms it is usual to allow:

For breakfast one-half to two-thirds of a maas, (a maas is nearly a quart) of skimmed sour milk, with barley meal at the rate of one pound, (nearly a pound and a quarter English.) for 8 persons; or, with bread in place of meal, porridge, or water gruel with black bread, half a pound per head.

For dinner—dumplings, (Rohrnudeln) of wheat flour, two persons to two-thirds of a pound, or boiled balls or dumplings of wheat flour, barley meal, and white bread, with skimmed milk, or baked pellets of a portion of rye meal, from one-half to three-quarters of a pound of meal to a head, and half a pound of wheat bread with pulse, peas, potatoes, plums, beets, cabbage, &c. If meat is given three-quarters of a pound is reckoned to a head, with pulse, with bread, either with or without soup, or meat dumplings of white bread, and one-third of a pound of meat to the head."

Howitt, in his Rural and Domestic life in Germany, mentions the peasants near Heidelberg, dining under the trees in the fields, and says—" The dinners seemed principally contained in two large pans or dishes, one of soup, and one of small puddings called noodles, (Knœdel.) floating in sauce, or something of a pudding kind in a fluid state. Some of these puddings were little balls of flour and potatoes, dotted with little lumps of fried black bread, and which to a fanciful eye looked like raisins."

For supper.—Meal soup in skimmed milk to two pounds of wheat-meal, for ten head; then one-half to three-quarters of a quart of skimmed milk, and about a pound and a half of potatoes to a person; or water gruel and potatoes; or a soup of skimmed, sour milk, with black or white bread, also a spoon-meat, or meat one quarter to one-half a pound the person.

On a feast day, for the evening meal, also, usually broiled pork or veal, one pound to a head, with sallad and a quart of brown or white beer."—TR.]

4. As many domestics (Dienstboten,) are necessary in a household as can be constantly and usefully employed by the business of the farm throughout the year.

5. Those kinds of occupations only are exclusively fitted for the domestics (Dienstboten,) which continue the same throughout the year, to which belongs the care of beasts of labor, and other domestic animals

The foddering and careful attention to the beasts necessary for the management of husbandry, is a species of labor which remains the same throughout the whole year, which keeps busy always in the same manner the laborers appointed to it: on which account in England, where there is a surplus of day-laborers, or in any country where the whole labour of a nobleman's estate is performed by soccage men, (Fröhner) domestics are employed, particularly in taking care of domestic animals.

6. The whole household will be carried on by domestics (Dienstboten,) where the soccage principle does not prevail, and the land is not divided into too large or too small possessions.

In England, all estates that are larger than what a single family can take care of, are cultivated by day laborers, and men who work by the job :—in the South of France and in Italy the land is so divided that Dienstboten are rarely found, and the small farms held by lease are cultivated simply by the family of the lessee. But in Germany, where the division is not carried so far as in the two last countries, and where we do not usually meet with such large estates as in the first of them, agriculture in all the estates which are not cultivated on the soccage principle is carried on by the Dienstboten.

7. The number of persons in service (Dienstvolk) depends on the mode of husbandry adopted; on the amount of labor which one can accomplish by day-laborers, and those who work by the job; and on their diligence.

In the Egarten and Dreifeld modes of husbandry, with a fallow which must first be broken up in June, one needs the least number of hands, but he also produces the least. In such circumstances we allow eight men to one hundred yokes (about one hundred and forty-two acres) of plough-land, if we call in extra help of day-laborers, for mowing the meadows and threshing. In the system of rotation of crops, the number is not unfrequently doubled.

In Upper Austria in a very well-managed husbandry of one hundred yokes of plough land, and thirty yokes of meadow, I have found four hostlers, one house servant, two boys, four day-laborers, and seven maids; thus allowing thirteen men to one hundred yokes of plough-land. The rotation is, 1 Fallow, 2 Wheat, 3 Barley, 4 Clover, 5 Wheat, 6 mixture of Vetches, Oats and Barley, &c. The people were very industrious.

In Carinthia it is otherwise. There they number more people for service because they cultivate a greater variety of fruits, have no fallows, and because, too, the laborers are of a more indolent disposition. It is sometimes quite usual to employ on the estates from twenty to twenty-five men and women, Dienstboten, on one hundred yokes of plough-land, with which are connected from forty to fifty yokes of meadow-land. The cutting of the grain is here done, in a great measure, by day-laborers, and those who labor on the soccage principle, (Froehner). The rotation is, 1 Potatoes, Millet, Corn or Maize, 2 Wheat, 3 Rye, 4 Barley, manured, 5 Clover, 6 Wheat, 7 Rye. The farms of the peasantry (Bauern) in Carinthia are small, from ten to twelve yokes of plough-land, and three to four of meadow. On these are usually the peasant, his wife, and three laborers. Schwertz found the proportion similar in Alsace, for he says that they number on the great farms as many laborers as they have horses. But he mentions elsewhere, that for fifteen and a half acres is allowed one horse, which is 18.6 for one hundred yokes. Farms of forty acres, = 13.8 yokes, have four horses and also four laborers.

That a man in land-husbandry, as in any manufacture, needs so much the fewer laborers in proportion to its extent, and that great farms on this account, must yield the greatest pure profit, because the cost always lessens of management and cultivation, without necessarily injuring the quality of the work, is a fact universally acknowledged, and easily seen.

[It is difficult to reduce the German measures to English measures. A yoke (Ioch) of land, which is a common measure in Austria, is equal to about 1.422 acre English measure, from which the computations above given may be reduced to their value in our measure. Thus one hundred yokes of land are equal to one hundred forty-two and two tenth acres. It will be convenient sometimes to retain the terms employed for measure, without translation, though in the more important cases the equivalent will be given in our modes of computation. There are many estimates, both in Thaer and Veit, of the number of laborers required for the different species of labor. Some of these will probably be given hereafter.—Tr.]

8. The cash value of a day's work of a Dienstboten, may be obtained by computing the cash value of his cost or board, lodging, clothing and wages, taken together, and dividing the sum by the number of days' work.

That the day's work of a Dienstboten must be higher or lower according to the different countries and years, must be self-evident. Podewill, has examples of such

estimates, Mayer also. Haser in Thaer's Annals of Improvements, Luerzer Moellinger, &c., &c.

[According to Veit's estimates, the cost of keeping a Dienstboten in Bavaria, are:—

Besides wages.	For the year.		$ cts.	For the day.		cts.
1. Not including the expense of keeping a cook, - - - - - - - - - -	86	florins =	41,28	14	kreutzers =	10.5
Including that expense, - - - - -	98	"	47,04	16	"	12
2. With wages of 45 florins, = $21,06, average per head, without the cost of keeping a cook, - - - - -	131	"	62,98	21.5	"	16.2
Including that cost, - - - - - -	143	"	76,64	23.5	"	17.6
3. With cost and wages for 290 days work, not including the cost of a cook, - - - - - - - - - -				27	"	20.25
Including that cost, - - - - - -				29.8	"	22.12

Some things which enter into his estimates of the cost of board, are affected by the question whether the articles supplied are bought or are furnished on the estate, &c.—Tr.]

9. Day-laborers are those who work by the day; job or piece-laborers, are those who agree to do a piece of work for certain wages.

10. Where the latter are found, the practise of farming is much easier and cheaper, for one can lay hold of any work with greater force, and complete it in a proportionate time; and their own profit urges the job laborers to work quicker, so that their labor is always cheaper than that of one's own serving people (Dienstleute) or the day-laborers.

11. That work is particularly adapted to day-laborers which cannot be so well let out by the job; as hay-making, weeding, hoeing. For piece or job-work, the cutting of grain, threshing, getting wood, &c

In England nearly all kinds of work are hired out by the job. They employ in their husbandry but few serving people, (Dienstboten); only as many as the fodderring of the domestic animals makes necessary. All other kinds of labor, even plowing and harrowing, are performed by day-laborers or those who work by the job. Begtrup relates, that Mr. Green in Suffolk, with whom he resided for a time, on a farm of plough land of one hundred forty-three and a half yoke, with a herd of twenty cows, some oxen, and forty sheep, employed only two servants and two boys, and in the summer two maids, in the winter but one. The harvesting and threshing were done by men who work by the job.

These people have such skill that for a small sum they will agree to hoe or harvest a particular extent, and gain a support by it.

[The advantages and disadvantages of the different kinds of labor above mentioned are considered by the various German authors. Thus Thaer Rat. Landwir. Vol. I. p. 88, says:—"Whether a person should employ more laborers of the first or the second class will differ according to the circumstances of the place, which often leave no choice, often also a very limited one, and seldom one entirely free.

For domestics (Gesinde or Dienstboten) there is the advantage of attachment, participation, and fidelity which one may expect from them as members of his family, (but not always freely rendered,) also the safety with which a person may count on unretarded and daily advancing work, the closer inspection which they are brought under, the dependence and obedience which he may justly demand of them, and their responsibility for any business entrusted to them. Day-laborers, and those who work by the job, demand on the other hand less care; can be engaged and dismissed again when one wishes, as the work and their industry may require. Their activity is greater, since they have to take care of their families, and if they do not perform their work well, they will lose all their reputation."

Veit, Vol. I, p. 135, after mentioning that the Dienstboten are employed as hostlers, to take care of oxen, &c., says,—"But it belongs to the character of their service

that they must also be employed in other services, and out of the time commonly fixed on for the usual day-laborer. They reside in the farm house, are under the domestic oversight of the proprietor, and with suitable treatment will do more for him, and the interests of his husbandry, than the other laborers. If they will but use their collective force and time, their exertion will far outweigh that of all other laborers.

But three things lie heavy in the opposite scale, and in many cases counterbalance these advantages:—

1. The almost universal corruption of morals common among them, and which renders the regulation of the household difficult.
2. The great burden of care in providing for them, and
3. The difficulty of keeping them at work for the whole year."

Of day-laborers, VEIT also remarks, p. 146, "This kind of laborers possess great advantages where one can have them according to his need, in any number and time, and can dismiss them at his pleasure, if he wishes for their service no longer. Since the greatest part and most important labors of farming are dependent on the state of the weather, therefore they are very unequally divided as to time and necessity. In favorable periods of time for sowing and harvesting, all kinds of labor press together into a few days, whilst with sudden unfavorable weather, or in time of rest, scarcely no labors are undertaken in the field.

It is indeed charged on day-laborers that they spare themselves more in work than other laborers, seek to cut short the time in every possible way, and daily labor only a certain number of hours, whilst often the pressure of work calls for all the powers of labor the whole day, in order to use the favorable moment offered; in which case, also, either the employment of day-laborers over the usual time of labor must be reckoned at a higher rate, or every moment in part must be lost."

Of the men who work by the job, called by VEIT, *accord-arbeiter*, or accord-laborers, he observes, p. 151, "In order to give out labor by the job so as not to suffer injury by determining the time of completion, one must accurately know the expenditure demanded if it were to be performed by day's works.

For such an agreement those works are usual, the results of which especially depend on the amount of labor to be performed in a certain time, as is the case in harvesting. The advantage of the gain of time here is especially important to the husbandman; because the security of the fruits are so much the more necessary, the shorter time in which the works dependent on the state of the weather may be completed."

"One may either make as a condition the time of completing a particular work, or the particular quality of work to be done in a certain time."

"The advantage of the gain of time by the earlier completion of any work, is not only for the advantage of the proprietor, but also to the man who works by the job, because the shorter the time in which he completes the work undertaken, so much the earlier can he go upon another."

"The eminent advantage of job work over others consists in the peculiarity of its nature, according to which the advantage of the laborer increases with the increased profit of the employer, and this gives a spur to this species of labor for wages, and not by outward burdensome means, as by oversight, &c.; consequently the most difficult task in the employment of labor, namely, to be able to put the engaged laborer to the best use, is accomplished."

The amount of wages for a Dienstboten in Germany, has already been given. The wages by the day will of course vary according to circumstances. Among the causes affecting it, VEIT enumerates, as enhancing it:—

Neighbourhood of wealthy farmers; of cities and manufactories; thinly settled regions; countries where the price of means of living is high; labors which require unusual strength; longer time for the day's work, &c. Among those causes which contribute to lessen wages, he mentions:—

Vicinity to poor places; where there are many who engage to work by the year, &c.; where the necessary means of living are cheap, &c; where there are few persons who prefer to employ day laborers.

The usual time of labor for a day-laborer he gives in Germany on most estates:—"in the Summer, or from the 24th of April to the 29th of September, from 5 to 11 A. M., and from 12 M. to 6 P. M., and in time of harvest even till 8 P. M.

In Winter, or from the 12th of November to the end of February, from 7 or 7½ to 11 A. M., and from 12 M. to 4½ or 5 P. M.

In the intervening periods, from the 1st of October to the 12th of November, and

from the 1st of March to the 24th of April, from 6 to 11 A. M. and from 12 M. to 5½ or 6 P. M.—In many regions it is customary in the summer and winter to have a resting time or bread hour (brod-stunde) as it is called, from 8 to 8½ A. M. and from 3 to 3½ P. M.

The average of a day's wages of many parts of Bavaria, according to the duration of time—is for the mean number of hours, in summer 24 to 40 kreutzers (about 18 to 30 cents); in winter 18 to 22 kreutzers (about 13½ to 16½ cents); females receive about 3 or 4 kreutzers (2 or 3 cents) less. For an hour over in the morning or evening they are allowed 3 or 4 kreutzers (2 to 3 cents); of course the labor is higher where the greater skill is required, as in different branches of artisanship connected with farming operations.

The general results of his experiments VEIT sums up in the following principles to be adopted:

"1. All those kinds of work which from their nature can be given out by the job, should be set over to the accord or quota or share-laborers.

"2. All other work which cannot be so performed; or those which especially depend on the state of the weather, require no peculiar skill, and can be easily overseen, should be performed by day-laborers, when these can be had for easy wages, and engaged or dismissed at necessity or pleasure.

"3. The number of domestics (Dienstboten) for taking care of the domestic beasts required for the farming operations, should be engaged either with wages, but without cost (or board); or this last charge be not assumed if there is any option." "A distinction," says THAER, p. 67, "is to be made between the price of wages and the price of work; the power, activity and skill of men is very different, and is governed frequently by the nourishment, and mode of life. A laborer for 40 kreutzers per day can often perform twice the work of another for 20 kreutzers per day."

It is very evident, that many of the above remarks apply less to the state of things in this country; but still the principles on which the calculations are founded, and the results, are not unimportant even with us.—TR.]

12. Those laborers are called Fröhner, or Roboter, who, either real, or emancipated, or modified bondmen of their masters, or of the estate itself, must perform either a definite or undefined amount of labor without wages, or for a very small compensation.

[VEIT thus describes this class of laborers, p. 152: "There are yet some estates on which many stand in the relation of subjects to their lords, and are under obligation for a certain number of days in the year to labor at the call of the lord of the estate, either with or without a team, for no compensation or for very small wages, or only for their keeping." Fröhner, Fröhnden, or Roboter, therefore appear to be a kind of serfs, who are bound to the lord of the manor by a feudal service, or on the principle of soccage. This tenure of property is scarcely known in our country, and is gradually disappearing on the continent of Europe.—TR.]

13. Since the Fröhner can be made to work only by compulsion, and has not the least interest to perform it well and rapidly, therefore the production of all estates cultivated by means of such laborers is the least and worst. But because the labor, bad as it always is, is disproportionately less costly in cash-value, such estates yield a large nett profit.

This feudal tenure (Fröhne), is the original reason why the products of the cultivated land in a very large part of Europe is so small. The estate of the lord of the manor is cultivated in the most wretched manner, and the peasant's own land as badly in the (Nebentagen) days in which he works for himself. The coarse insolence of the one; the poverty, stupidity, and indolence of the other, in a great degree proceed from this feudal relation.

[Similar to the above are VEIT's observations, p. 152: "The effect of the labor of this kind of laborers is usually small, rarely worth the smallest wages. The feudal service (Fröhn-Dienst), of certain feudal laborers (Fröhn-Arbeiter) bound to the State, is either changed into a fixed sum yearly, or is wholly remitted."—TR.]

14. He who must employ the Fröhner, will do well to cause every species of work in which he can receive damage, either to be executed by

his own people and teams, or to agree with the Fröhner, as to the quality of the work, and recompense them for the greater exertion of their powers by lessening the day's work. Less important work must be done by them until a just legislation has broken these bonds.

[In the preceding division of laborers, our Author has not mentioned *slaves* held as the property of their masters, of which there is so large a class among the laboring force in our country. There are also other species of laborers, such as *indentured* ones; which, with the exception of wages, and the usually longer term of residence, seem to resemble the Dienstboten, as in some respects do the slaves of our country, except that the Dienstboten are freemen. There is another mode of labor which may fall under the class of those who work by the job, or the Stückarbeiter of our Author. I refer to those who cultivate land on shares, or who undertake to gather the harvest, or perform any other piece of work on the same principle. The common mode of hiring laborers in our country is by the day, the week, month, or year; and as in Germany, either with or without board. Those who are indentured are usually taken at an early age, and are bound over, as it is termed, by certain indentures to the master; at the age of twenty-one, they are at liberty to go, and if they have not broken their indentures by bad conduct, are usually entitled to receive money or clothing, as the agreement may be. It is frequently part of the stipulation where this practice prevails, that the boy shall go to school a portion of his time in his earlier years. They are also usually entitled to good treatment, instruction in the business of the farm, and their support and clothing while the indentures last; though in this last respect there is a difference of practice. The exchange of labor among farmers, can perhaps hardly be considered as a particular mode of labor.—Tr.]

15. If we know the amount of labor which domestics (Dienstboten) and day-laborers can perform in a given case, their number in the household can be easily fixed beforehand.

16. If horses are used for labor, for every team, if it consist of two animals, one domestic is necessary; though this one can, not only fodder but also plough with and drive the same. Should the team consist of four or more animals, one domestic will still answer for foddering and taking care of them, as well as for driving them, but he needs an assistant in ploughing and harrowing.

[Veit says:—"For taking care of horses for labor, one domestic is necessary for four or five head, who likewise performs the day's work with a team. The preparation and weighing of hay, bundles of straw for the horse, and the chopping of straw, &c., are usually assigned to another who works by the job, or for a smaller number of horses is done by the man himself." He elsewhere gives as a computation, that one man can in a day bind and weigh out hay, in the usual bundles of 10 or 12 lbs., about from 15 to 25 cwt., or from 150 to 250 bundles, equal to from 1800 to 3000 lbs.—Tr.]

17. If oxen are kept for labor, it is reckoned that one man should prepare the fodder for from 16 to 20 oxen, and could suitably attend to the same. In ploughing with 2 oxen only, one man is needed; with 4 or 6 oxen, 2 men are necessary.

[Veit's estimate respecting the number of oxen differs somewhat from the preceding one; he says, p. 156, "Of working oxen, one man can usually attend eight head, who is likewise employed during the day with a one-yoked team. If there are 12 to 20 head or more, one assistant is needed to take care of them, who also is engaged with one spare team during the day. As with the working horses, so too it is profitable with working oxen, if one can so divide them among a suitable number of men for the care and employment of them in labor, that the good keeping and safety against injuries may be placed under the special responsibility of the same man who usually labors with them." Thaer says, p. 89, "For working oxen on some

farms, lads are kept, and only for 24 to 30 oxen one herdsman, if there is one boy beside."—Tr.]

18. If horned (or black cattle) are pastured according to the different locality of the pasture. one man can take care of from 50 to 100 head of cattle.

[With respect to pasture, Veit observes, p. 157, "As to the herdsmen on the pasture, it must depend on the condition of the pasture. In enclosed grazing fields, one person can take care of a great herd. In open unencumbered extended pastures, one herdsman can take care of from 50 to 100 head, and with one assistant from 200 to 300 head. In wood pastures not enclosed or of narrow limits and not surrounded with cultivated fields, or on field-pastures divided into portions, one herdsman with only a herd of from 30 to 40 head needs an assistant."

So Thaer, p. 89, says, "One cowherd will answer for from 50 to 60 head of cows not only in the pasture—where with the assistance of a good hound one can keep 200 head in order—but also in the stall, if in the cutting of straw, &c., in winter he has some help, and in summer too, but in this last case the green fodder must be mowed and brought."—Tr.]

19. In stall-foddering in the summer, for 100 head of horned cattle, cows and oxen of the middling kind, three men and one team are required to cut, gather, and carry home the fodder, and also to litter and clean out the stalls.

If one head of full grown cattle needs every day in the summer 100 lbs. of clover, for the whole 100 head, 100 centners, or cwt. are daily necessary; this is five or six double-spanned cart-loads, which would employ one team the whole day. Now if we suppose that of clover and vetches, of a fourth of a klafter, 12 lbs. of green fodder should be obtained; then one needs for 100 cwt. 883 square klafters, for which a half day's work for mowing, and for raking and loading another half day's work would be required. A third man therefore must be fully occupied in littering and foddering and cleaning out the stalls.

[A klafter is about $4\frac{1}{2}$ square yards, so that 883 klafters are equal to 3973 square yards, nearly 1000 yards less than an acre of English measure. One centner, or cwt., is equal to about 123 lbs. English avoirdupoise weight.—Tr.]

20. In winter-foddering it depends on the kind of fodder whether a greater or less number of persons must be employed. Where we fodder out hay and uncut straw, few men are needed; where chopped straw, &c. (Häcksel) is fed out, a greater or less number of people will be required according to the fineness of the chopped fodder. See Special Breeding of Cattle, A. c. 21.

[Our Author here refers to a previous portion of his Manual, mostly included further on in the present treatise: he there says, "Hay as a shorter, thinner and moister body is not usually cut; and whoever fodders hay in the winter, as is the case in Italy, in many parts of Switzerland, and Holland, has the least trouble in taking care of his beasts. Straw should always be cut, in order to mix it more easily with hay, and to spare the beasts the breaking to pieces of the long stalks. In our mountains in Upper Stiermark, Tyrol, and Salzburg, where the breeding of cattle is the principal object of husbandry, straw constitutes a very essential part of the winter-fodder of cattle. It is cut from one to two inches long, which causes trouble that one must count on. Gericke estimates that one man in 8 hours can cut $31\frac{1}{5}$ metzen of Häcksel at $8\frac{1}{2}$ lbs.:—[a metzen in Austria is about 1.69, bushel.] In Bohemia, it is estimated that in 8 hours the fodder-chopper will prepare 300 lbs. of long straw ready for seething. In Mecklenburg, one herdsman must take care of 24 head of oxen or cows, and cut the necessary Häcksel for them, which must be not longer than a half an inch. An industrious man who works by the job there, can cut in the shortest days 45, and in February and March 60 metzen. But the Häcksel machines, driven by water will give in 1 hour 315 lbs., $\frac{3}{4}$ of an inch long." See p, 27.

21. For milking ten heifers, an hour is allowed; of larger ones which

give more milk, not more than seven or eight can be milked in an hour. Hence the necessity of men for this work may be estimated accordingly.

We usually assign one milkmaid to 10 cows, who can be occupied only part of the time, and will therefore be at hand for other work of the household. In the great milk establishments of Lombardy, one man is allotted to 15 cows, who milks them, takes care of their fodder or pastures them, and keeps the stall clean. Cheese-making is assigned to another, and in this country is a separate business or profession.

[In the Bath papers, Vol. V., Art. VI. p. 73, some experiments of Dr. Anderson are mentioned, by which it appears that the last of a milking or "afterings," "strippings," or "stroakings," as they are termed, contain more cream than the first, in the proportion of in some cases sixteen to one, and never less than eight to one; thus showing the great importance of the cows being thoroughly milked. Besides the difference in quantity, also the difference in quality was still greater, and the same was the case of the milk remaining after the cream had been separated from it.—TR.]

22 The care of young cattle requires less labor, because one man can oversee a greater number of them at pasture; and in stall-foddering less food is necessary than for full-grown cattle.

23. Sheep cause the least labor, because they pasture all the summer, and in the winter the clearing out of their stalls is not necessary. One shepherd with one hand can easily tend 500 sheep, and will also be sufficient in the winter if he has an assistant at the ewing time.

So small is the profit which a single sheep yields, that it is usual to have only large flock which gives a considerable profit, because pastures on fields left as fallow, on the common and on the Alps, costs little; and because too, in proportion to their size, they need less hay in the winter than cows, and so few men are required to take care of them. If the rams are foddered at home, or separate inclosed pastures be allotted to them, a single shepherd can tend the whole flock, even if it exceeds 500. If the pasture ground is not too bushy, he might with a dog keep even 700.

[On the subjects above-mentioned, the following remarks from THAER, Vol. IV., pp. 272, 273, may be quoted: "The quantity of hay which is given (to sheep) is very different. In poor sheep-folds it is considered much to allow 3000 or 4000 lbs. of hay to 100 sheep for a wintering. In better conducted ones 7500 lbs. is considered the minimum for 100 sheep: 3½ lbs. of dry fodder for a sheep daily are necessary, and the greater proportion of this in nutritious hay, compared with dry straw the better. Where hay is not plenty, it is usual to have recourse to grain-fodder; oats, rye, and barley are equally good; where peas, beans, vetches are largely cultivated, these may be used. The grains are given them either threshed or unthreshed; more frequently they have the rough grain mixed with chaff and somewhat moistened. It is customary also, especially with the kernels of the leguminous fruits to soak them; others prefer to fodder with the pods strewed on Häcksel, &c."—"Sheep which have daily 1¾ lbs. of hay, and 1 lb. of potatoes, or 1 lb. of hay and 2 lbs. of potatoes, and straw enough with it, can be kept in a well-fed, wool and milk-producing state."—"Acorns and horse-chestnuts give a very nutritious fodder for sheep afflicted with the rot. They are given 1 lb. a day, either raw or after being soaked some days, and then dried in a bake-oven, when their shell cracks off and they lose their sharp taste."

Burger in p. 284 of his 2d volume says, "In summer stall-foddering, one sheep of 80 lbs. weight must have 12 to 14 pounds of clover-grass or vetches." "In winter-foddering, we reckon for the same animal 2 lbs. of hay, or its equivalent in other means of fodder. The experiments of Schlieffen made with fodder of hay and rye-straw, potatoes and straw, and potatoes and hay, prove that sheep produce as much wool, if they have 1¾ lbs. of hay and straw, or 1¾ lbs. of hay and straw Häcksel, and 0.11 metzen (about 1½ gall.) of potatoes. Petri gave a sheep in the morning 1¾ lb. of barley-straw; at noon, 1 lb. of hay; and in the evening 1¼ lb. of rye or wheat straw. According to his latest experiments, he holds that 33 lbs. of hay, and 66 lbs. of straw chopped fine, with half a metzen (about 27 quarts) of clover, and a half metzen of oats and 1 lb. of salt, is sufficient daily for 100 sheep

gelded sheep also should have, with 100 lbs. of chopped straw (Häcksel), 18 lbs. of corn-meal and 1 lb. of salt. In most sheep-folds they reckon 100 to 150 lbs. of hay to a head for winter fodder," (beside other fodder, to be supplied by straw or husk-fruit.)

VEIT also gives similar statements. He says, Vol. I. p. 157, "One shepherd can take care of 200 to 300 full grown ewes with their lambs, or 4 to 600 gelt sheep, with the foddering of the same with hay and straw. But if it consists in part of roots and knob-plants, which must be cleaned and made finer, he needs for such a number of sheep one assistant. The size of a sheep-fold depends on the pasture for them, its condition, and on the species of sheep. In inclosed or large, connected, wholesome pasture, one shepherd with a well-trained dog, can keep 500 to 700 sheep, easier than he could keep 200 or 300 head on narrow ways and divided pastures, between unfenced cultivated fields and meadows, or in pastures with many places endangering the sheep."

In Vol. II. p. 481, he says, "The need of fodder is proportioned to the live-weight of the sheep, and two and a half pounds of the value of hay is required daily for every 100 lbs. live-weight, to keep the animal in a profitable state. Hence the following amount of fodder is required:—

	Need of Fodder.			Of which.	
	Live wt. of.	Daily.	Yearly.	In Summer.	In Winter.
For a long wool German sheep, .	100 lbs.	2.5 lbs.	912 lbs.	532 lbs.	380 lbs.
Do. rich wool infantado, } . .	88 "	2.2 "	803 "	473 "	330 "
" with coarse wool, }					
" " moderately fine, . .	80 "	2 "	730 "	426 "	304 "
" " electoral species, .	75 "	1.87 "	682 "	402 "	280 "
" " Escurial electoral, .	62 "	1.55 "	566 "	334 "	232 "
" " 8th electoral, . .	66 "	1.65 "	602 "	355 "	247 "

On p. 490, he observes: "One person will wash clean in one hour 5 to 6 full-grown merinos, and 6 to 7 coarse German sheep; therefore, in a day of 9 hours, of the first kind 45 to 54, and of the latter from 54 to 63 head. In shearing, on an average, one person without particular skill will shear of merinos in a day: of lambs, 35; yearlings, 30; full-grown, 20 to 25."

BURGER'S estimate for shearing is not as high as VEIT'S, as he says, "It is estimated that a practised man can shear daily 20 common or 15 merino ewes, and half as many full-grown rams or wethers."

PETRI'S valuable work, "The keeping, care, and breeding of Sheep," (Die Wartung, Pflege und Zucht der Schafer,) a portion of a German Farmer's Encyclopedia, to which BURGER refers above, contains much information on the subject of sheep. As to the value of the different kinds of fodder, he enumerates not less than 252 plants which sheep seek out and eat, also 39 others which are injurious to them. The capacity of nutriment of various kinds of fodder for sheep, he gives in the following table of equivalents:—

				Nutritious matter.
100 lbs. of aromatic meadow hay			100 lbs. of which contain	50 lbs.
are equal to 90	"	clover hay	"	$55\frac{5}{9}$
90	"	tender vetch hay	"	$55\frac{5}{9}$
90	"	tender lentil hay	"	$55\frac{5}{6}$
360	"	wheat straw	"	14
500	"	corn straw	"	10
180	"	barley straw	"	$27\frac{1}{2}$
200	"	oat straw	"	25
200	"	pea straw	"	25
200	"	lentil straw	"	25
200	"	vetch straw	"	25
190	"	millet straw	"	$26\frac{6}{19}$
200	"	horsebean straw	"	25
190	"	artichoke stalk	"	$26\frac{6}{19}$
300	"	heath straw	"	$16\frac{2}{3}$
180	"	chaff	"	$27\frac{1}{2}$
200	"	potatoes	"	25
200	"	cabbage turnips	"	25
200	"	yellow turnips	"	25

				Nutritious matter.
100 lbs. of aromatic meadow hay, 100 lbs. of which contain				50 lbs.
are equal to 400	"	white turnips	"	12½
300	"	beets	"	16⅔
500	"	white cabbage	"	10
82	"	maize	"	95
82	"	wheat	"	95
55	"	rye	"	90
61	"	barley	"	82
64	"	buckwheat	"	78
71	"	oats	"	70
54	"	peas	"	93
54	"	vetches	"	93
54	"	horse beans	"	93
83	"	wheat bohl. (chaff?)	"	60
86	"	rye "	"	58
105	"	wheat bran	"	48
109	"	rye bran	"	46

PETRI gives the following as examples of average of fodder for an old sheep in the month of January, when the ewing time commences in March:

1. In the morning, ¾ lb. of good oat straw.
   noon, ½ " of good hay or clover.
   evening, ¾ " of good winter or barley straw.
2. morning, ¾ " of millet straw.
   noon, 2 " of potatoes with 4 oz. (8 loth,) of straw Häcksel, and 8 loth (4 oz.) of oats.
   evening, ¾ " of straw. (Barley straw.)
3. morning, ¾ " of hay.
   noon, ¾ " of hay.
   evening, 1 " of straw, (wheat, corn, oat, barley, or buckwheat straw.)
4. morning, ¾ " of summer straw.
   noon, ½ " of straw Häcksel, with 6 loth (3 oz.) oats, and 6 loth, (3 oz.) of bran or groats, moistened with water.
   evening, ¾ " of winter straw.
5. morning, ¾ " of hay.
   noon, 2 " of potatoes with ⅓ lb. of Häcksel.
   evening, ¾ " of winter straw.
6. morning, ¾ " of hay.
   noon, as in No. 4.
   evening, 1 " of straw.

In the early lambing time, PETRI also gives, as fodder:

1. Morning, ¾ lb. of hay, or second mowing.
   About 10 A. M., ½ lb. of potatoes (or substitute,) mixed with ¼ lb. of Häcksel of straw.
   About 2 P. M., ¾ lb of hay, clover, or second mowing.
   Evening, ¾ lb. of good straw fodder.
2. Morning, ½ lb. of good mixed fodder.
   About 10 A. M., 2 lb. of potatoes, with ¼ lb. of Häcksel, or mixed with clean oats.
   About 2 P. M., ¾ lb. of hay.
   Evening, ¾ lb. of winter straw.
3. Morning, ½ lb. of millet straw.
   About 10 A. M., ¾ lb. of hay.
   About 2 P. M., ¾ lb. of hay.
   Evening, ¾ lb. of winter straw.
4. Morning, ½ lb. of hay.
   About 10 A. M., 2 lb. of potatoes, with Häcksel.
   About 2 P. M., ¾ lb. of hay.
   Evening, 1 lb. of winter straw.

5. Morning, ½ lb. of hay.
About 10 A. M., ½ lb. of Häcksel, with 8 loth (4 oz.) of oats, and 8 loth of bran, or groats moistened with some water.
About 2 P. M., ¾ lb of hay.
Evening, 1 lb. of straw.

He has likewise given p. 89. the following table of Variations of Fodder, which may be practised successfully with sheep:

Day.	Lbs.	Loth, equal ½ oz.	Morning.	Lbs	Loth, equal ½ oz.	Noon.	Lbs.	Loth, equal ½ oz.	Evening.
1		21	hay		21	hay		21	hay
2	1	1	rye straw	1	22	hay	1	1	rye straw
3		23	bean straw		26	vetch hay		23	bean "
4	1		wheat "	1		sainfoin	1		wheat straw
5	1	6	oat "		21	hay	1	6	oat "
6	1	6	artichoke stalk	1	19	red clover	1	6	artichoke stalk
7	1	8	turkey wheat	1	12	luzerne	1	8	turkey wheat str.
8	1	8	b'kwheat straw	1	16	hay	1	8	b'kwheat straw
9	1	6	oat "		7	horse beans	1	6	oat "
10		19	red clover		19	red clover		19	red clover
11		18	sainfoin		18	sainfoin		18	sainfoin
12	1	6	millet straw	1	6	millet straw	1	6	millet straw
13		30	lentil straw		21	hay		30	lentil "
14		30	pea straw		21	hay		30	pea "
15		30	barley straw	1		artichoke stalk		30	barley "
16	1	10	horse bean "	1	10	horse bean straw	1	10	horse bean "
17	1	1	rye "	1	11	oat "	1	1	rye "
18	1	3	wheat "	1	9	" "	1	3	wheat "
19	1	6	rye "	1		turkey wheat	1	3	" "
20	1	6	oat "	1		" "	1	6	oat "
21	1	3	wheat "	1	22	artichoke stalk	1	6	" "
22		30	lentil "		30	vetch straw		30	lentil "
23	1	6	oat "	1	6	wheat "	1	6	oat "

Petri allows on an average to a sheep, of hay, 3 to 3½ lbs. per head, and says: "In the winter a full grown sheep of 70 lbs. live weight, eats, in fattening-fodder, 3 lbs. of hay, or with some hay 3 to 4 lbs. potatoes, or 14 to 18 lbs. of cabbage leaves, by which he weekly gains 1½ lbs. of flesh and wool." "The following example, of a slaughtered sheep weighing 116 lbs., gives the proportions of the parts:

Flesh and tallow	54 lbs.
Fat taken from the entrails . . .	7½ "
Liver, lights, and milk	5 "
Blood	3 "
Head, paunch, and other entrails . .	42½ "
	112
Leaving for blood and waste	4
Total	116

24. Few swine are kept on the usual farms which have not marshy or woody pastures, or breweries or distilleries, and only then, when the number of full grown year-old, or more, of swine amount to thirty, beside pigs, will a man be occupied the whole day in feeding and taking care of them.

Our Author in the 2d vol. p. 327, speaks thus of the mode of feeding swine; "The summer feeding of swine consists either in pasture, or in stall-foddering with green fodder plants (soiling), or slops from the dairy, brewery and distillery."—And, "If swine only gain sufficient nourishment, as they run wild in the pastures, they must grow well; and they need water, a pool in which they can roll themselves in hot weather." "If there are no pastures for them, or not sufficient, they must be foddered in their yards with young clover, luzerne, vetches, and buckwheat." "Where they

are nourished only with slops, their number must be limited to the quantity of this food given."

VEIT, Vol. I. p. 158, says: "In most cases, only so many swine are kept as may be fed from the slops of the dairy, kitchen, garden, and brewery, and can be taken care of by the domestics of the kitchen or of milch-cow-stalls. With a greater extension of this kind of stock, a keeper is needed for from 30 to 50 half-grown and full-grown swine, and with an assistant he can keep from 60 to 100. For pasture, one swine-herd according to the quality of the same, can drive 20 to 40 and yet more head." He says also, on p. 516 of Vol. II.; "In respect to the quality of fodder, one head of swine for 100 lbs. of live-weight, uses 3 lbs. of hay-value to retain his present state or as conservative-fodder; therefore 3.7 to 4.5 lbs. remains of the corresponding results of its use for the gain, and 6 or 7 lbs. are operated on with profit."—TR.]

25. The amount of labor which is required in the culture of plants, has already been mentioned in the general culture of plants. Every person who has a rotation of crops can compute how many domestics (Dienstleute) he needs, and what will be the cost, when he knows what amount of labor the sowing, hoeing, hilling, harvesting, threshing, cleaning, mowing, drying, and carrying home of the different kinds of plants for grain, for fodder, or for trade demand.

[VEIT, Vol. I. p. 163, has a large number of particular estimates on the number of laborers and time required for certain quantities of land supposed to be tilled, &c., some of which it may be useful to subjoin: "For breaking woodland with a single or double yoke, one man can scarcely prepare $\frac{1}{2}$ a morgen in a day. (A Bavarian morgen is about $\frac{5}{6}$ of an acre.) On newly broken up land one can go over with a roller from 6 to 8 morgen (5 to $6\frac{2}{3}$ acres) in a day. In harrowing it, he can accomplish 3 morgen ($2\frac{1}{2}$ acres) per day. Digging with a spade $\frac{3}{4}$ to 1 foot deep in loose soil, 1 morgen ($\frac{5}{6}$ acre) will require 30 to 40 days' work: in a tight soil 40 to 50 days' work: For digging land to the depth of two spades' length, or one and a half to two feet, it will at least double the labor; hoeing up with a potato-hoe, to the depth of four to six inches for a morgen, will take from 16 to 20 days' work. To prepare holes for trees, &c., according to the firmness of the soil and the depth and circumference, but of the depth of two schuh (not quite two feet English measure), and one and a half to two and a half schuh diameter, 30 or 40 of them is a day's work. In paring turf to the depth of two to two and a half inches, a laborer with a paring spade can do, for a day's work, 5000 to 6000 square feet. With a common harrow, a man will go over in a day, of average soil 6 to 7 morgen (5 to $5\frac{5}{6}$ acres). Of manure, one can break up with a beetle about 1 morgen (or $\frac{5}{6}$ acre) per day.

In mowing, in an even situation, one man, in a day, of 10 hours work, will mow $1\frac{1}{2}$ to 2 morgen ($1\frac{1}{4}$ to $1\frac{2}{3}$ acre), in a richer growth or on uneven surface, or with interruptions, $\frac{3}{4}$ to 1 morgen, ($\frac{5}{8}$ to $\frac{5}{6}$ acre): In spreading hay, one person can spread in a half a day, what three men can mow in a day: for turning the same $\frac{1}{2}$ day's work is necessary; for raking it up and putting it in heaps a $\frac{1}{2}$ day's work; for opening it $\frac{1}{4}$ day's work; for spreading it out, $\frac{1}{4}$ to $\frac{1}{3}$ day's work; for raking up ready for loading, $\frac{2}{5}$ day's work; for a lesser growth usually three swaths are raked up in a row: for this for 1 morgen (or $\frac{5}{6}$ an acre) there is needed for raking up and dividing the swaths $\frac{5}{6}$ day's work; for turning, $\frac{1}{4}$ to $\frac{2}{3}$ day's work; for raking in winrows and cocking it $\frac{2}{3}$; for spreading it out again $\frac{1}{3}$; for raking up for loading $\frac{1}{4}$ to $\frac{1}{3}$ day's work.

The labor of loading depends on the hay, whether it is long or short. It is customary to have two persons for pitching up the hay, and two for placing it on the load, and two to rake after, for each cart. These should load one cart-load of hay, from 18 cwt. to 20 cwt., in a good harvest, in 45 minutes; in a moderate one in 1 hour; in a smaller one from 1 hour 12 minutes to 1 hour 15 minutes. If only half the force is used it will take from $1\frac{1}{4}$ to $1\frac{3}{4}$ of an hour. The number of loads carried must depend on the distance, &c., close by, 12 to 16 in a day, at a moderate distance, 8 to 12, yet further off, 6 to 7 loads.

In unloading, much depends upon the height, &c. If it is to be placed on a high loft, there must be two men to unload 18 cwt. to 20 cwt., of heavy hay in 4 to 45 minutes, or if there be but one man he will unload it in from 50 minutes to $1\frac{1}{4}$ hour,

whilst on a mow or high-raised floor two men will unload 1 cart-load in 20 to 25 minutes, and one man will do it in from 25 to 40 minutes. For stowing away the hay and making it in bundles and binding it, four, six, ten and yet more persons are needed. If it is thrown off into a mow, two or at the highest three persons are sufficient for the purpose. Of well-arranged heaps of short-prepared manure, one man can easily load in a day 12 cart-loads of 1800 to 2400 weight; of that which consists of long straw, scarcely from 9 to 10 cart-loads. The labor of carrying it out must depend on the distance, &c.; near by 10 or 12 cart-loads of one yoke can be carried in a day; at a moderate distance 6 to 8 cart-loads; or 6 to 8000 feet off, 3 to 4 cart-loads. For unloading, one man can unload 30 to 45 loads in a day, when he can keep steadily engaged in this labor. If the manure is placed in rows 20 feet from one another, and the heaps in each row the same distance from each other, and there be 8 heaps to a 20 cwt. load, there will be 100 heaps on a morgen, or 12½ loads or 250 cwt." (It is mentioned in the British Husbandry that of heaps of manure there are

at 5 yds. distance,	193 per acre.	at 7 yds. distance,	98 per acre.
at 5½ yds. "	160 per acre.	at 7½ yds "	86 per acre.
at 6 yds. "	134 per acre.	at 8 yds. "	75 per acre.
at 6½ yds. "	114 per acre.		

Allow a cubic yard to contain the solid contents of 27 bushels, and the computation is easily made.) "To spread these heaps of short manure, one person will spread in a day 14 to 18 two-yoked cart-loads, and of the less perfectly prepared strawy or cloddy kind, 10 to 12 cart-loads. Of compost, marl, and earthy manure, on account of the greater weight, there is needed for one morgen as many as 25 to 30 two-yoked cart-loads. One person will load in a day 8 to 10 cart-loads, and spread about 8 loads. Of the dust or powdery kinds, as gypsum, ashes, lime, &c.—which must be spread broadcast—a man will spread 4 to 6 morgen (=3⅓ to 5 acres). If stall manure or compost is to be laid in holes made for seed, there will be from 10 to 16 000 holes for 1 morgen (or ⅝ of an acre), and for this two and a half to three and a half persons are requisite in a day. For filling water-vats or holes by pumps one laborer is allowed for 75 to 100 eimers in a day (one eimer is about 15 gallons). A vat full of water containing from 10 to 12 eimers for a one-yoked load weighs 14 to 16 cwt., and one of 16 eimers for a two-yoked load 20 to 23 cwt.

"For laying potatoes in planting five or six persons are required for three-horse ploughs; for ox-ploughs which are less expeditious, four to five persons are sufficient for the same purpose. One person in laying potatoes will average 1 morgen (⅝ of an acre) with 2½ to 4 schäffel of potatoes (a schäffel in Bavaria is about 6¼ bushels). One person makes the holes, another drops the potatoes, and the first covers them: two persons in this way will plant 0.4 morgen (⅖ an acre), or five persons one morgen (= ⅝ acre). Of the seeds of maize, beets, poppy and sunflower, laid in holes made with the hand-hoe and manured with compost, three to four persons will sow in one day 1 morgen (= ⅝ acre). In sowing the usual grains, one man will sow in a day, with a cast of suitable breadth, say of from 11 to 16 schuh (= about as many feet), from 12 to 16 morgen (= 10 to 13⅓ acres) with 6 to 9 schäffel (= 37 to 56 bushels); on 10 or 12-furrowed beds with a cast of 7 to 10 or 12 schuh, 9 to 12 morgen (= 7½ to 10 acres), with 5 to 8 schäffel (=31.115 to 49.8 bushels); at a less cast 7 to 9 morgen (5⅝ to 7½ acres) with 4 to 7 schäffel (= 25 to 43⅘ bushels), and with less sized seed, as of turnips, clover, cabbage, &c., broadcast, 8 to 10 morgen (= 6⅔ to 8⅓ acres). In marking out the breadth of the casts one man will mark out in a day from 30 to 40 morgen (= 25 to 33⅓ acres). In hoeing plants with a hand hoe in a day six to eight persons are necessary for 1 morgen (= ⅝ acre).

"If plants that were sown broadcast require to be weeded, sixteen to twenty persons are needed for 1 morgen (⅝ acre) in a day. If in rows of fallow fruit, or such as are to be weeded in only particular parts, four to eight persons will be sufficient for a morgen (⅝ acre). Thinning out grain, one person in a day can do from 1 to 2 morgen (⅝ to 1¼ acre). In reaping with a sickle, one person can cut in a day with hinderances during his work, from its being lodged or in a very thick state, or when the grain falls out easily, 0.25 to 0.30 of a morgen (¼ to ¼ of an acre); and in a proper state of the grain without hinderances, 0.50 to 0.75 (½ to ⅝ of an acre; on an average, 0.40 to 0.50 morgen (⅓ to ½ of an acre). To 1 morgen, therefore (⅝ acre), are required, at the least rate, 1⅓, at the highest 4, and on an average 2¼ reapers. With a scythe, in one day, a mower for grain must be allotted to from 1¼ to 1¾ morgen (1 1/16 to 1 11/16 acres.). Of the leguminous fruits, peas, vetches and

lentils, one man cannot mow in a day more than 0.75 of a morgen ($\frac{5}{8}$ of an acre). Of the harvest of grain, one person in a day can turn on an average 3 morgen ($2\frac{1}{2}$ acres). In binding the sheaves, if one person braids the bands, eight persons in 1 hour can make up 240 sheaves, and thus in a day of 10 hours' labor, 2400; and one person can make up 300, or 5 shocks of 60 sheaves each. The bands are usually made of winter rye, (which is best and longest,) and for want of this, of summer rye or wheat straw. One person in a day can prepare from 15 to 20 shocks, and from each shock of rye-straw can be made bands for 30 to 40 shocks =1800 to 2400 bands. In setting up 7 to 9 sheaves together, and covering with a larger sheaf, binding the whole with a band, one person can set up 400 to 600 sheaves, or 6 to 10 shocks in a day; or in *weather-housing*—i. e. laying sheaf on sheaf horizontally, with the stubble-end westward—10 to 20 or more together, covered with an out-spread sheaf; or in *cross-heaping*, laying it crosswise, so that the ears of the sheaf may be always towards the middle, and covered one by another, and protected on top by a sheaf—one man can arrange thus in a day's work from 600 to 800 sheaves. In stacking up the sheaves regularly, 200 to 300 sheaves so arranged will make one day's work. In loading up grain, 1 cart with two persons to pitch on and two to place the sheaves received on the cart, from 5 to 6 cart-loads, or 650 to 780 sheaves are a day's work. In carrying in, according to the distance of the field from the barn, 8, 12, 16 cart-loads of from 120 to 150 sheaves may be considered a day's work. For unloading grain, 12 to 15 cart-loads can be unloaded by one person in a day. For threshing, including cleaning and storing away the grain, allowing 8 to 9 hours for work per day, one man may prepare of winter-wheat, vetches, summer-wheat, or rye, or millet, or buckwheat, 2 to 3 metzen: (as a metzen of Bavaria is 1.037, or a little more than 1 English bushel, therefore equal to 2 or 3 bushels;) of winter-speltz, from 8 to 9 metzen; of winter-barley, summer do., peas, 3 to 4 metzen; of oats, 3 to $4\frac{1}{2}$ metzen; of lentils, $1\frac{1}{2}$ to $2\frac{1}{2}$ metzen; of beans, 4 to 5 metzen; of maize or Indian corn, from 6 to 8 metzen; of rape-seed, 5 to 6 metzen." LOUDON says, that one man will thresh in England from 1 to $1\frac{1}{2}$ of a quarter of barley, from $1\frac{1}{2}$ to 2 quarters of oats, or about 2 in a day. This probably does not include cleaning, &c., and the amount of labor of a laborer in a day in England, is greater than in Germany. It is also possible that the metzen above referred to, is the Austrian one, equal to $1\frac{2}{3}$ bushel. The above computations of labor have been made by persons of great accuracy, from numerous experiments, and show the degree of labor required in Germany in the economical conduct of their farms, where this forms a branch of the science of husbandry; but they may not be entirely accurate for this country, where the implements of labor are more perfect, and the physical power as well as skill are considerably greater. I have been unable to find in LOUDON or other English works at my command, scarcely any similar estimates, though they form a part of all the German agricultural Manuals. LOUDON speaks of their utility, but furnishes next to none. THAER includes in his estimates females, who are also out-door laborers in Germany. Thus he says, Vol. I. p. 92: "In spreading manure, one woman will spread daily $\frac{7}{16}$ to $\frac{9}{16}$ of a yoke (about $\frac{3}{5}$ to $\frac{4}{5}$ of an acre), one man $\frac{5}{8}$ to $\frac{7}{8}$ of a yoke ($\frac{4}{5}$ to $1\frac{1}{4}$ acres). One man will sow daily $6\frac{1}{2}$ to 7 yokes ($9\frac{1}{4}$ to 10 acres). In harvesting, one person will mow $1\frac{1}{5}$ yoke (equal to $1\frac{7}{10}$ acre), and one woman will gather and bind $\frac{7}{9}$ yoke (equal to about $1\frac{1}{4}$ acre). With a sickle, one person will reap on an average $\frac{4}{9}$ of a yoke (equal to $\frac{5}{8}$ of an acre). In mowing clover, if the ground is even, one man will mow $1\frac{1}{3}$ yoke, (equal to $1\frac{7}{10}$ acre), which another can make into hay at the rate of $1\frac{7}{9}$ yoke (equal to $2\frac{1}{2}$ acres) per day." It should be recollected that in these estimates neither the minimum nor the maximum is attempted to be given, but the general average which may be considered an economical expenditure of labor.—TR.]

26. The amount of labor which the support of fences requires, is very different according to the kind of fencing, as well as that of the procuring of litter, if taken from woods, bogs, or heather.

[In Germany much of their land is unfenced, the lots being separated only by lines or spaces marked out, or by the different crops. This is owing in many places to the want of proper material; in others it is adopted from choice. Their writers have discussed the disadvantages and advantages of fencing, in an economical point of view. THAER, gives the former, in substance as follows: 1. They take up some room, which on a good soil is worth considerable. 2. They hinder the drying of the soil and cause that it be less early planted. 3. They occasion snow-drifts in

winter, which remain long and hinder cultivation. 4. They furnish a bed for weeds, which cannot be eradicated under them, and thus are propagated in the fields. 5. They furnish a resting-place for insects and birds, &c. 6. They are in the way of cultivation in ploughing, &c. 7. They hinder the passage from one field to another, so that often a great circuit must be made to get at fields bordering on them. 8. If made with ditches, they are often injurious from the standing water, &c. On the other hand he points out the benefits: 1. Universal experience shows that inclosed fields have the greatest fertility; this is owing to a number of reasons; fences keep in the warmth, &c. 2. They protect cattle as well as plants from rough winds. 3. They retain moisture, which is more beneficial than prejudicial. 4. The space they occupy as hedges, is more than counterbalanced by furnishing wood, &c. The result of the comparison, he states to be:—1. In moist soils, the soil may be injured by fences, from the long retention of moisture; for all dry sandy soils they are very advantageous. 2. If the land is to be continually kept under the plough and yearly planted, their advantage is less, and may be overbalanced by the lodgment they give to weeds, &c. 3. If the field is to be used as a pasture or fodder-field for a number of years, their advantages far outbalance their disadvantages, as they protect the cattle, &c. The different kinds are *living* and *dead* fences: dead, are walls in whole or part of stone or earth, rails and posts, &c.; living fences, are hedges, trees planted and rails inserted, &c. Various plans have been suggested as to fencing the prairie lands of our country most economically, both as regards outlay of labor and money, &c., but none seems to promise equal success with that proposed by the Hon. H. L. Ellsworth, Commissioner of Patents, and described in his last Report, for the year 1842. By this plan, there is a great saving of timber, and the mode practised is one which requires no peculiar skill, while the implements are simple and cheap. It has also been tried and found to answer the purpose.—Tr.]

b.—of the labor of beasts.

1. Our usual beasts of labor are *horses* and *oxen;* less so *bulls* and *cows.*

Why bulls are rarely employed for labor, and in what circumstances they may serve for this purpose, we have already indicated while treating of the use of horned cattle. Asses are sometimes indeed employed in Germany on farms, but nowhere for the cultivation of land, but only for drawing or carrying moderate loads.

[Our Author's remarks, to which he alludes, in Vol. II. p. 252, are as follows: "Besides being employed for breeding and for her milk, the cow is also used for draught, but only as a helper in need, and not for any length of time; the laboring cow must have more fodder than others, and will give less milk." "The employment of the cows for ploughing and other labors of draught, appears to be profitable only in very small farms, which beside two cows are able to keep no other cattle; there the loss of the milk may be made up by the labor afforded, but the labor must be reckoned higher than on great farms, because horses or oxen must be hired, and they are not always to be procured when desired." Of the bull also he speaks on p. 253: "The bull cannot be used to advantage as a beast of draught, because in the early period, when employed as a coupling bull, he is too young and too weak for hard work; but later when no more employed as a coupler, he might render good service as a beast of draught, being first castrated to make him tamer, and easier afterwards for fatting. The bull is usually of a very lively, and if not used with care and kept tame, of a wild temperament, which cannot be yoked and will not be guided at pleasure."

Howitt, in his Rural Life of Germany, as well as other travellers, speaks of the employment of the cow as a beast of labor. Veit. in Vol. II. p. 404, says, "Cows are employed in Bavaria for work only on farms which are too small to keep and employ fully a single yoke of cattle for labor. In Austria, they are used for labor on many large farms with the best results. They perform not much less than working oxen, and in respect to the loss of milk, by being strengthened in labor, it is of far less consequence than many imagine, and not less or not much less than is the case on remote or lean meadows without labor, if otherwise they have the necessary indulgence, and food, and care; especially if they are used in a team which is changed, and as far as possible for the lighter kinds of work."

2. Whether it is better to use horses or oxen in prosecuting the business

of the farm, one can determine for himself, if he knows the cost of their keeping, and the amount of labor which they will perform in a given time.

3. Those beasts of labor are for the time the most profitable which yield for the business of the household the necessary labor at the least expense of keeping them.

4. Since the support of horses and oxen occasion not equally great expense, and the nature of the soil and climate is better adapted sometimes to one and sometimes to the other kind of beast, therefore it is most profitable sometimes to keep horses and sometimes oxen.

5. In dry plains, where there is less growth of grass, no pastures, or poor ones, or short grass, and only a few sour meadows, it is more profitable to use horses than oxen.

[By *sour* meadows, are meant those where the water saturates the soil without covering its surface, and where instead of sweet grasses the coarse bog-grass, &c., takes their place; and that hay which thus grows on bog-land is called *sour* hay.—Tr.]

6. Where the growth of the grass is favored by the climate and soil, with a sufficient extent of pasture and meadow, the labor of oxen costs less than that of horses.

Horses will do well on sour hay, but oxen poorly: horses need only some sweet hay, if they are also furnished with straw and grain; oxen require a greater quantity, and where hay is costly, to feed them in the stall over the summer with fodder, as regards the labor it requires, is dearer than that of horses. Where one has suitable pastures, and the oxen can be kept cheaply on them after the spring sowing, or where one has sufficient meadows, and the raising of plants for fodder yields a sure and great product, oxen will furnish the given labor at the least cost.

[In regard to the points embraced in the preceding paragraphs, and the question of the comparative cheapness of horses for labor, there seems considerable diversity among different writers. The amount of labor is a subject which will be considered by and by, as also the difference of original cost, &c. The cost of keeping, &c., has been examined closely by Thaer, Veit, and others. The points here are, Which requires the most costly food in kind, which the greatest amount, and which the most care and labor in feeding? &c. I shall quote somewhat largely on these and collateral points from these authors, and the more so as they have never been translated into English, and many of their experiments have been unknown among the farmers of our country. With reference to the keeping of horses, Thaer, Vol. I. p. 76, says, "In respect to the cost of keeping the horse, the following things are to be considered. The usual grain-fodder is oats, and many hold, that it only will answer. But it is certain that any other grain, given in the proper way, in proportion to its nutritiousness, is useful and healthful. The husk-fruits, peas, beans, and vetches, are unusually well adapted to the nature of the horse, and surpass, on account of their preferable nutritiousness, even the grains. The most profitable fodder for horses, therefore, is that which in proportion to its nutritious power is cheapest at any given time. They stand in the following proportions: Oats = 5; barley = 7; rye = 9; wheat = 12; husk fruits = 10 or 11. Together with grain, horses should have hay, which is very nutritious, and chopped straw, which serves only for the demand of mastication and filling the stomach, but in a dry state very little for special nutriment. Accordingly, as the hay is increased, the grain may be diminished, and *vice versa*. In more rapid and stronger labor, an increase of grain fodder compared with hay is desirable; but in more enduring labor an increase of hay, according to experience, is more profitable. In the whole, grain makes the horse stronger, hay makes him more fleshy. A moderate-sized, common working-horse, needs on an average through the whole year, daily $9\frac{1}{6}$ lbs. or $2\frac{3}{4}$ messen (= about $7\frac{1}{3}$ quarts) of good oats. Together, with this he requires $9\frac{1}{6}$ lbs. of hay, in order to keep him in usual strength for continuous labor. Further, strawhäcksel is given between the grain, which one increases or diminishes according as he gives more or less hay.

The yearly fodder therefore is:

62 metzen of oats, = 105 bushels.
3350 lbs. of hay.

There is no doubt that a horse may be kept in full power without any grain by such means of fodder as cost the farmer less; in the summer, with green clover, vetches, &c.; in the winter, with potatoes, carrots, and other different nutritious root-plants. The success of this method of feeding is by many great experiments placed beyond all doubt; and according to its introduction the question between oxen and horses will probably become the more important."

Again Vol. IV. p. 236 he says on the same subject: "The most common and principal food for horses is grain, and usually oats is the most suitable. When other grains are fed out in proportion to their nutritiousness with fine Häcksel which takes the place of pulse with oats, a careful observer cannot see the slightest difference. Most usually rye is used as a substitute for oats. The unground barley, is decried by some because it is in a great degree voided undigested; but by others it is very much praised. Wheat, we rarely meet as food for horses, and some have found it very injurious where they have been forced to use it but on closer investigation this appears to me to be owing to their not using it mixed with Häcksel, without which indeed it very easily sticks up (verkleistert) the stomach. I have fed it out—but mixed with Häcksel—with the best results." "With good oats for a farm horse of moderate size, we reckon daily 3 mässl (= 9¾ quarts) or 8 lbs. of oats if he has also 7 lbs. of hay; and this on an average will keep the horse in a fair condition; in unusual labors it must be increased; smaller horses need only 2 mässl, and a large one at least 4 or 5 mässl (or nearly 13 to 17 quarts)."

"The greater part of horses have hay with grain feed and some hay entirely."—"For the most part we consider 7 lbs. of hay equal to one mässl (or 3¼ quarts) of oats, and so as to weight they are as 8 : 3."—"The very nutritious low-meadow hay, as also young clover, luzerne, and sainfoin-hay, is doubtless stronger, and is as 7 : 3; the coarse stalk as 9 : 3. But it is generally observed that if corn-fodder is supplied by more hay, the horse will be in better flesh and more enduring for labor." "Whether green stall-fodder of clover, &c., is good for a horse all do not agree.—I am convinced that if properly managed the horse will be kept sound and in full power. The change from dry to green-fodder must be gradual. At first clover must be cut up with straw, one portion a day then two portions given in the place of oats, then clover if it is in full blossom, as much as he will eat, and withdraw the grain altogether. To give grain between green-fodder, is very poor management, because it is voided without being digested. If any one wishes to connect grain as food with green-fodder, it should be given the first thing in the morning; and during the whole forenoon give him nothing green and no more grain during the day."—"The most suitable and beneficial root-fodder for horses are carrots, which have been washed, and pounded or cut coarsely at the rate of 12 mässl (equal to 39 quarts), with about 7 lbs. of hay per day, and sufficient straw."

Veit's opinions are found in his 2d volume, pp. 351-358, &c. He says: "To decide the relative value of the domestic beasts for farming operations their individual peculiarities must be estimated in respect to their possible performance for the objects of the husbandman and on the conditions or requirements of their corresponding support, because, from their peculiarities are derived their use and necessity; and frequently their nature is opposed to the localities of the farm; hence observation must be directed partly to employ the natural peculiarities of the beasts according to the highest use of the demands of the husbandman, and partly to modify them according to the same; therefore to find the medium course, or the most profitable relation between the highest result of their use and the least expense." "The nourishment of horses demands the greatest expense because the cost of the fodder comprises the largest part of the expense of the keeping of the domestic animals, and because especially horse-fodder is very costly on account of the usual choice of the grain-fruits."

"By means of his masticatory organs, indeed, the horse can work over and prepare for digestion, the nutritious matter in the mouth more than the ruminating animals; but he uses also for it more saliva to the richer secretion of which, therefore, the more solid materials of food must be provided for the horse, during the mastication of which the salivary glands of the mouth furnish the necessary saliva for mingling with the food. Too moist and especially too watery articles of fodder diminish the excitement of the salivary glands, and too greatly dilute the other juices of the organs of digestion. Fodder with too great volume agrees least of all with him, because the

stomach of the horse is in proportion smaller than in the ruminating animals, and because in consequence of their natural eagerness to take all the means of nutriment, the more voluminous and harder-digested materials of fodder have not time for digestion. Hence it is that such fodder is little prepared, and goes off again as the excrements show. Of the different materials of fodder, the preference is given to,—

1. The Grains, because they are nutritious, easily digested, solid, and have a small volume. Among these are highest,

(a.) Oats, the solid husk of which requires a stronger grinding, and which contain little adhesive substance, is therefore more easily digestible, and possesses a peculiar and acceptable taste.

(b) Beans.

(c.) Vetches and lentils. Less usual are

(d.) Barley, buckwheat, maize and rye.

2. Hay, must be given with the richer grain-fodder to fill the stomach. Yet rarely is the whole need of fodder obtained from hay, because the volume therein for nutriment is too great for the stomach of the horse. To the voluminous materials of fodder must be given at least a third part of fodder of the value of hay in less voluminous grains, or juicy plants.

3. Since the nourishing power of straw is contained in a greater volume than in hay, and it is also hard to dissolve, therefore, as contrary to the peculiarity of the organs of digestion of the horse, it should rarely be given for the principal fodder, but always as an auxiliary fodder, cut small (Häcksel) with hay. Where the grain is good and the hay has not sufficient consistency, the straw Häcksel serves especially, for establishing the requisite proportions of the solid and voluminous nutritious matter, to the moist and more powerful with less volume. How hardly otherwise the horse digests straw his excrements show, in which the straw Häcksel is very often found unconsumed. Of the different straw, oat is best.

4. The green fodder has opposed to it the disadvantage of the large volume, the want of consistency, and the long time which working horses need to take a sufficiency for their nourishment. But as, if it consists of meadow grass and clover, it belongs to the cheapest materials of fodder, therefore one employs with the greatest advantage $\frac{3}{5}$ to $\frac{2}{3}$ of the demand for nutriment of it with Häcksel, and makes up the remainder with cheap grains, and old hard-stalked hay.

5. The root and knob-plants, have in common with the green fodder the peculiarity of too great wateriness, and the want of consistency, but prove a valuable aid in the mixture of nourishing stuff of opposite qualities, and they can in a dry state supply the place of the grains, and are cheaper. Their employment as fodder deserves therefore the notice of all. Carrots are the most useful and agreeable to horses. Yellow Swedish turnips follow next, then beets, then white Swedish turnips, then white turnips. Potatoes foddered green to horses are not so agreeable on account of their sharp taste, as turnips, but in a dry state, and then coarse broken, or soaked and mixed with Häcksel, &c., they are very nutritious and acceptable. A strong, sound horse, and kept daily at work, uses much fodder. Luzerne hay is three times cheaper than oats, and one may give of it $\frac{2}{3}$, of turnips, mixture of grains, lentils, or maize $\frac{1}{3}$, of the fodder needed in the worth of hay; then the horse fodder is not only suitable but also cheap, scarcely 20 kr.—15 cts. per cwt.

It follows from the above explanations, that the fodder for horses must be easily digestible, not too voluminous, of proper consistency and made fine, that it must also be masticated, so that it can be easily and soon swallowed and digested, and will not fill the stomach too much. Accordingly the grain should be ground coarse, hay and straw cut to Häcksel as fine as possible, roots and knobs made fine and dried or moistened or baked. But the most successful, digestible and powerful fodder for the horse, is bread which is made out of meal of grains and potatoes, and from bran baked, broken fine and fed out. If a person chooses for such a purpose the cheaper grains, this species of food will be very cheap. The mixture of the different materials of food must be so made that the more solid shall stand in corresponding relation with the moist, the juicy with the dry, and the more nutritious with the less nutritious, so too that the better cannot be sucked out from the less so, or the light be blown away from the heavier; and so that especially the cheapest possible fodder may be obtained by the mixture.

According to the before determined quantity of fodder for the different domestic animals on the farm, a horse of moderate strength with a live-weight of 11 cwt. must have as his need of nutriment, i. e. conservation-fodder, $2\frac{3}{4}$ lbs. for every 100 lbs., therefore in a day 30 lbs. worth of hay, and in a year 109.5 cwt.

This need of fodder can be provided for out of different materials of fodder, as follows:

NECESSITY OF FODDER.

	Quantity.					Worth in Hay.	Cost.
	In a day.	In a year.		Daily.	Yearly.	Per cwt. of worth of hay.	In the whole.
	lbs.	Schäffel.	cwt.	lbs.	cwt.	fl. kr. cts.	fl. kr.
With the usual fodder,							
of oats, ...	7	14, or 87 bush.	25.55	14	51.1	— 50 = 37½	42 35 = $20,43
" hay, ...	13.5	—	49.27	13.5	49.27	— 22 = 16½	18fl. 3kr. = $8,66
" straw, . . .	5	—	18.25	2.5	9.12	— 40 = 30	6fl. 4kr. = $2,91
With much cheaper fodder, of a mixture of maize, lentils, vetches, then roots and knobs, . . .	5	—	93.07	30	109.5	—36.5=27	66fl.42kr. = $32,00
			18.25	12.5	45.62	30 = 22½	22fl.48kr. = $10,92
of hay, ...	16.5	—	60.2	16.5	60.22	22 = 16½	22fl. 4kr. = $10,59
" straw, ...	2	—	7.3	1.0	3.65	40 = 30	2fl.26kr. = $1.03½
	—	—	85.75	30	109.5	25.9 = 18½	47fl. 18kr. = $21,69½

The Schäffel is 6.223 bushels English.

According to a five years' average of foddering horses, from the year 1825 to 1829, the following quantities are required to a head:—

	Of Oats.			Hacksel of 5 parts Hay, and 3 Straw.		
	Weight.	Worth in Hay.	Of Hay.	Weight.	Worth in Hay.	Worth of whole in Hay.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Work horse for a heavy team, .	10	20	12	4	3¼	35¼
" " " light " . .	7.5	15	10	4	3¼	28¼
Stallion, ...	6.5	13	10	4	3¼	26¼
Chaise horses, ...	6.5	13	10	4	3¼	26¼
3 — 4 year old, ...	4¼	9	10	4	3¼	22¼
2 — 5 " "	3.75	7.5	8	3	2½	18
1 — 2 " "	2.5	5	7	3	2½	14½
½ — 1 " "	2	4	5	2.5	2	11

Litter, rye straw, cut twice or thrice, for a work-horse which requires 30 lbs. worth of hay in a day, 3 to 5 lbs. daily, and in a year 11 to 18 cwt.

The pound here is that of Bavaria.

BURGER also makes the following remarks on the kind of food for horses: "Where a man requires much and hard work of horses, dry hay and green or dry fodder plants are not sufficient, but grain must also be given. What grain shall be given must depend on the price, compared with their nutritious power. In the North of Europe, it is usual to take oats as the universal grain for horses, because this is cheapest proportionately. But, because this is fed out so universally, the belief has spread abroad, that oats only will answer; and if at any time any one feed out other grain and the horse should be sick, it is attributed to this food. Yet we see in a great part of Italy, maize, in the East, barley, in England, beans are used as food for horses with the best success. I have fed out beans, maize and rye the year long to my horses, when these kinds of grain were cheaper, and have incurred no damage. I must here observe that a very experienced farmer has informed me that the oil cake of beech-nuts is deadly to horses. Farm horses need daily, of dry stall fodder,

12 lbs. of hay, of oats 3 mässl, (=10 quarts,) of which the bushel weighs 50 lbs., and 3 lbs. of chopped mixture of rye-straw and clover. Coach horses need 10 lbs. of hay, and a like quantity of oats and chopped mixture; saddle horses 8 lbs. of hay, and a like quantity of oats: horses for carrying loads with 15 lbs. of hay, use 6 to 8 mässl (= 20 to 26 quarts,) of oats if they drag daily 12 to 15 cwt. 4 miles = 12 English miles. DICKSON says, that a man must give his working horses daily, 10 lbs. of hay; and for the week 1.16 metzen of oats (= about 1 bushels,) and much as chopped mixture. Gericke gives for a work horse ¼ metzen of oats (= bushel,) measen of 1 ach sel o. oat and rye-straw (= 1¹ bushels, and 4 to 5 lbs of hay daily. One horse ration in the Austrian army consists of ¼ metzen of oats (= 6.72 quarts and 6 to 10 lbs. o. hay. Cavalry horses have 8 lbs., and drag horses 10 lbs. of hay." LOUDON, Vol. II., pp. 974, 975, has some remarks respecting the horse which are not appropriate to this place:—"The horse has one stomach only, and that a very small one. The situation of the stomach is immediately contiguous to the diaphragm or great breathing muscle; from which we are at no loss to understand why a very sulmeal obstructs respiration, and why it is so very imprudent to gallop a horse very hard after drinking or eating very freely." "It is evident that too full feeding must derange it (the stomach), not only by keeping it constantly distended and thus weakening its capacity but by entrenching too much on its secreting office, and requiring an inordinate quantity of gastric juice to saturate an undue quantity of farinaceous matter." "The exertions of the horse require that he should eat largely and nutritiously:—a horse will eat 2 or 3 pecks of corn, or 10 lbs. of hay at a meal and yet in a natural state his stomach will not hold half of either. As an animal destined for quick as well as great exertion, his wants prompt him to take in a moderate portion of food only at a time which his peculiar digestive powers peculiarly fit him to convert it to nutriment quickly and efficaciously." On p. 1005, he says: 'Hay should never be given in large quantities at a time; horses breathe upon it, become disgusted and waste it." 'As substitutes for hay the straw of wheat barley, oats and rye are used; but these are much less nutritive, and rather serve to excite mastication by mixing them with other matters, than are to be depended upon for animalization." Oats is said to contain 748 parts of nutritious matter out of 1000. Among the pulse mentioned, beans are never to be given alone on account of their heating or astringent qualities but are to be mixed with straw or hay cut into chaff, either whole or broken. Among the roots, carrots stand deservedly high, are highly nutritious generate good flesh are favorable to the action of the lungs, and frequently a course of them will remove the most obstinate cough. Parsnips Swedish turnips and beets also are good. Of mixed food, one of the best is of "a chaff made of one part of the best meadow or clover hay, and two parts of wheat straw; to 3 bushels of this mixture add one of oats. The importance of bruising or flattening the oats is very great." Corn (grain) should be bruised when used alone. "A horse in full work, of whatever kind will require according to his size, a peck of sound oats in twenty hours." "The quantity of hay required for saddle horses which are corn-fed, is from 6 to 8 lbs. in 24 hours. For wagon and farm horses, from 15 to 20 lbs. may be requisite." "It should be divided into 4 portions, the largest portion both of hay and corn (grain) should be given at night, the next largest in the morning, the other two at noon and evening." On p. 1011: "The general management of farm horses in the improved districts of the North, may be presented as a good example. There, for about 4 months in summer, horses are fed in pastures, or on clover and rye-grass and tares cut green, and brought home to the stable or fold-yard; the latter method being by far the most economical and advantageous. For the other eight months, they are kept on the straw of oats, beans and peas, and on clover and rye-grass hay. As soon as the grass fails, toward the end of Autumn, they have hay for a few weeks; and when the days become so short as to allow of no more than from 6 to 8 hours' work, they are very generally fed with different kinds of straw, according to the circumstances of the farm: in the month of March, they are again put to hay till the grass is ready for being cut. Throughout all the year they are allowed more or less corn (grain) when constantly worked and during the time they are on dry fodder, particularly when on straw, they have potatoes, yams, or Swedish turnips, once a day, sometimes boiled barley, and in a few instances carrots. A portion of some of these roots is of great importance to the health of horses, when succulent herbage is first exchanged for hay at the end of Autumn, and it is no less so towards the latter end of Spring, when hay has become sapless and the labor is usually severe." "Such horses are fed with oats sometimes with beans, 3 times a day for about 8 months, and twice a day for the other four when at grass, and at the rate of 8 feeds a bushel each horse will eat 15 quarters = 120 bushels

in the year. When on hay he will require 22 lbs. daily and 5 lbs. more if he does not get roots. One English acre of clover and rye-grass and tares may be necessary for 4 months' soiling, and a quarter of an acre of potatoes, yams, or Swedish turnips during the eight months he is fed with hay and straw." "The expense of feeding a horse throughout the year may therefore be estimated in regard to quantity as follows:

"Oats, 15 quarters = 120 bushels: Soiling 1 acre of clover and rye-grass and tares: Hay, part of October and November March, April and May, $1\frac{1}{4}$ ton: Straw, for 4 other months half the price of hay: Potatoes, yams, or Swedish turnips, $\frac{1}{4}$ acre."

On the subject of feeding horses, we find in the British Husbandry, a work of acknowledged merit the following statements, Vol. 1. p. 126: "The late Mr. CURWEN, who tried more experiments than most men in feeding cattle, kept nearly 100 of his colliery and farm horses during the winter upon equal quantities of *cut* straw and potatoes steamed together, in lieu of hay; and found that some which were worked in the same manner, but fed with hay instead of potatoes were not in equal condition with the others."—(See Hints on the Economy of Feeding Stock, by J. C. Curwen, M. P.) His mode of feeding as detailed by the Carron Company, who have adopted his plan is thus: "They have three tubs steaming at a time; two of potatoes and one of chopped straw, chaff or dusting seeds; they empty one tub of potatoes into a large mash tub by way of bottom layer; then the tub of chopped straw, and last the remaining tub of potatoes; the whole is wrought up and mixed with a large wooden pestle; and to this they add a small quantity of salt. A bucket is brought for each horse with his feed of corn (bruised oats) in the bottom, and his proportion of the mash is filled in above; when it is emptied into the manger, the corn is of course uppermost, and the horse-feeder puts his hand through to mix it. They feed warm. The quantity of food and calculation of expense are as follows: (which may be reduced to federal money at the rate of 22 cts. for 1s.)

FARM HORSES.

$1\frac{1}{2}$ stone of potatoes at 3d. = 21 lbs.		0s.	$4\frac{1}{2}$d.
7 lbs. of cut straw and cutting	1d. 1d.	0	2
Steaming		0	$0\frac{1}{2}$
7 lbs. long straw			1
8 lbs. of oats		0	8
		1	4 nearly 30cts.

COLLIERY HORSES.

8 lbs. of hay and 8 lbs. of straw cut together	0s.	$5\frac{1}{2}$d.
Cutting	0	1
7 lbs. of steamed potatoes	0	$1\frac{1}{2}$
6 lbs. of carrots	0	$2\frac{1}{2}$
12 lbs. of oats	1	0
	1	$10\frac{1}{2}$ about $37\frac{1}{2}$cts.

After several years experience of the comparative merits of steamed potatoes and straw or hay, Mr. CURWEN gave a decided preference to the former." It is also mentioned in the same work, on high authority, that "working horses have been kept throughout the winter entirely on steamed potatoes, to every 300 lbs. of which there was added half a pint of salt and occasionally a small portion of sulphur, and that "fed in this manner they performed with the greatest ease *all the common* labor, of the farm without either hay or oats." The difference of expense of a team of 5 horses during half a year, calculating the potatoes as worth 40s. (= to about $9) per ton, and hay and oats respectively at £3 (= about $13) per load, and 24s. (= to about $6 per quarter of 8 bushels—would stand thus:

HAY AND OATS.

5 horses, 182 days at 24 lbs. hay 21 840 lbs., or $10\frac{5}{8}$ loads at £3.	£32	10s.	0d.
Ditto 26 weeks at 2 bushels each of oats, $32\frac{1}{2}$ quarters at 24s.	29	0	0
	£71	10	0 = $315

POTATOES.

5 horses, 182 days at 50 lbs. each, 45 000 lbs., or 18 tons at 40s.	£36	0s.	0d.	
Washing and steaming at 2d. per 100 lbs.	3	15	0	
3 bushels of salt at 2s.	0	6	0	
Sulphur,	0	2	6	
	£40	4	6	= $177
	71	10	0	
Balance in favor of potatoes,	£31	5	8	= $138

Another estimate is, that 42 lbs. of potatoes and about 10 lbs. of straw without any oats is sufficient, except when the horses are employed on the road.

Respecting carrots as a food for horses, Mr. CURWEN says that, "when from 8 to 12 lbs. of oats are allowed to a work-horse per day, according to its employment, 4 lbs. may be deducted for 5 lbs. of carrots, and the spirit, condition, and ability of the horse be improved by the same." "Other accounts state a bushel of carrots to be given daily instead of oats." Again, elsewhere, "horses are fed on carrots with sometimes hay, and sometimes corn, and sometimes with only straw; viz.,

6 horses; 2 loads of 40 bushels per week, no corn, and little hay.
" " 1 load with corn in the spring-time, and little hay.
" " 72 bushels per week, no oats, and half the usual allowance of hay.

The horses are said to be in a superior condition than when fed on oats." "In Surrey, where carrots are extensively cultivated, a team of 4 good horses gets about 60 bushels per week until Christmas, with plenty of chaff or clover-hay but no corn, and after that 40 bushels are given with 2 bushels of oats, and a sufficiency of chaff." A mixture of 4 lbs. of boiled potatoes and 4 lbs. of bran, at each feed is also recommended.

As respects the boiling or steaming food, its importance is seen from the fact, that "it takes a horse from three to four hours to masticate one stone of hay, but a mash of potatoes of double that weight may be eaten in 40 minutes." Potatoes it is said lose about $\frac{1}{5}$ of their weight by the evaporation of the water when steamed, or about $\frac{1}{6}$ if kiln-dried or baked. It is even said that it has been ascertained, that a bushel of oats boiled will maintain a horse in better condition than two in the common way. In another instance, the estimate for horses is daily in winter 15 lbs. of hay, 10 lbs. of straw, and 8 lbs. of oats, and after every feed a bucket of water richly whitened with rye or oatmeal. The cavalry allowance for horses in barracks in the British army daily, is stated to be 12 lbs. of hay and 10 lbs. of oats; but it is said that a common cart-horse required not less than 28 or 30 lbs. of the same food. The following is recommended, the ingredients being divided into 4 classes, as food for horses:—

	1st.	2d.	3d.	4th.
Bruised or ground beans, peas, or white corn,	5 lbs.	5 lbs.	10 lbs.	5 lbs.
Hay cut into chaff	7 "	8 "	10 "	8 "
Straw " " "	5 "	10 "	10 "	8 "
Steamed potatoes	5 "	5 "	—	—
Malt dust or ground oil-cake	—	2 "	—	—
Brewer's grains	6 "	—	—	—
Bran	—	—	—	7 "
And 2 oz. of salt to each.	30	30	30	30

The following food is said to answer well for 8 horses daily: 1 bushel of beans; 1 bushel of oats; 1 bushel of hay and straw, cut into chaff. Of several farm-horses also it is stated, "When no beans are grown, their winter food is oat-straw or hay; but in all other cases, bean-straw alone forms their winter provender, from grass to grass; with a mess every night of bean-chaff, potatoes or turnips, and a little small-corn, all boiled together and seasoned with salt, and two feeds of oats per day, but only when hard worked."

Mr. STEPHENS, Editor of the Quarterly Agricultural Journal, and Author of the Farm-Book, mentions that a large coach-proprietor in Edinburgh, supports his coach-horses on 8 lbs. of chopped-straw, and 16 lbs. of bruised oats; and that another

person gives 10 or 12 lbs. of chopped hay, and 16 lbs. of bruised oats to large horses; and the following mixture is also given as a good one, by yet another:

In the day	8 lbs. of bruised oats, 3 " of " beans, 4 " of chopped straw. 15 lbs.	At night	22 lbs. of steamed potatoes, 1½ " of fine barley dust, 2 " of chopped straw, 2 oz. of salt. 25½ lbs.

The advantages of the entire provender as manger meat, are the following:

1. It requires more mastication, and thus assists digestion, and promotes the nutrition of the animal.
2. It consumes less time.
3. By mixture, an equal consumption of the whole is secured; part of which if separately given, might be refused.
4. It may be more readily weighed and measured, and thus avoids the injury done by unlimited allowance.
5. It prevents waste; the saving is estimated as high as $\frac{1}{3}$, or even by some $\frac{1}{2}$ of the rack meat; but probably these are too high, and it may fairly be put at about $\frac{1}{6}$.

Respecting the utility and comparative advantage of soiling, we find it stated in the same volume, that it consists in a more economical consumption of grass, whether natural or artificial, than by grazing; in the accumulation of manure; in the quiet and coolness which cattle enjoy under sheds, or in the stable, and in their being always ready when wanted.

"A medium-sized farm-horse, at customary labor, consumes from 84 lbs. to 100 lbs. of green food daily, with the usual allowance of corn or grain; 20 horses have been supported for three months on 6 acres of tares or vetches; 51 head of horses, cows, and oxen, on 15½ acres of mixed herbage, equal to ½ a perch per day; in another instance, about ¾ of a perch per day is allowed for each. As to soiling on luzerne, 2 horses have been kept at hard work on ¼ of an acre, for 4 months; and again, 25 horses for 20 weeks on 11 acres; and yet again, 3 roods have kept a horse 19 weeks. In Holland and Flanders, where soiling is conducted to great advantage, the usual estimate is half an acre of meadow-grass, from the middle of May to the middle of June, and from that time to the end of August, ⅙ of an acre of clover is added, with 2 lbs. daily of beans.

Thus much with respect to feeding, as regards *horses*.

On the other side, as regards *oxen*, we may also quote from the same authors: Thus BURGER, Vol. II., p. 256, says: "The ox does not bear the heat well, and needs more time for eating than the horse, because he ruminates. In great heat, oxen tire unusually soon. One must therefore work with them in the cool time of the day, or change them often. In Friuli, in the summer from 2 past midnight till 8 in the morning, they frequently plough with lanterns. In the great farms of North Germany, they change the oxen every 4 hours. Since the ox is a ruminating animal, he must have time not only to eat, but also to ruminate the fodder given him. At labor the ox must have more nutritious food, not only because he uses more strength, but also because with food not so nutritious, he loses more time of the day for eating. In winter, the ox will be satisfied with straw, mixed with a little hay. He labors not at all or little, and can take his time for eating, ruminating and digestion. But when he labors much in the summer, he needs, to be strong, much and strong nourishment; and because he cannot have much time for eating and rumination, the nutritious parts must not be contained in too great a volume; that is, not be mixed with too great a portion of unnutritious substances. While employed at labor, therefore, the ox must either have a very good rich pasture, or sufficient green clover, vetches, &c., in stall-foddering, or a sufficiency of good hay, or in lieu of all these, salted-chopped-mixture, with grain."

Of fodder he says, as partly quoted on p. 11: "The winter fodder of cattle consists of hay, straw, roots, plants, with knobs and grain. The earlier these materials of nutriment are cut fine, or are made easily digestible by scalding or boiling, the more successfully can they be given to animals and the less of them will be needed. Hay as a shorter, thinner and moister body is not usually cut, and whoever fodders hay in the winter, as is the case in Italy, in many parts of Switzerland and Holland, has the least trouble in taking care of his beasts. Straw should always be cut in order to mix it more easily with hay, and to spare the beasts the breaking to pieces of the long stalks. In our mountains, in Upper Stiermark, Tyrol, and Salzburg, where the breeding of

cattle is the principal object of husbandry, straw constitutes a very essential part of the winter fodder of cattle. It should be cut from 1 to 2 inches long, which causes trouble that one must expect. Guericke estimates that one man in 8 hours can cut 31 metzen of Häcksel at 8½ lbs. In Bohemia, it is estimated that in 8 hours the fodder chopper will prepare 300 lbs. of long straw ready for seething. In Mecklenburgh one herdsman must take care of 24 head of cows, and cut the necessary Häcksel for them, which must not be longer than ½ an inch. An industrious man who works by the job there can cut in the shortest days 45, in February and March, 60 metzen. But the Häcksel machines driven by water, will give in one hour 315 lbs., ¾ of an inch long.

"That one should wash and cut up roots and knobs before giving them out to cattle, is evident to any one: equally needful also is it to reduce grain to meal and boil it before it is fed out; whether it is best to steam Häcksel, and boil roots and knobs, not only for swine but also for cattle, many doubt, partly because it occasions too great expense of wood and kettles, as well as labor, partly because it makes the animals too effeminate and liable to sickness. As to the first objection this is well grounded in regions where there are but few laborers, or where the means of fuel are dear; as for the other, I have found that neither with cows in the mountainous countries of South Germany—as also it appears from Schwertz's account of the Netherlands—which are fed with steamed fodder, nor with sheep which are fed with steamed potatoes, has any injury resulted.

"To fodder to milch-cows in the winter, Häcksel soaked with warm or even with cold water, and which had lain in the vat in a warm place 3 days, I have always found profitable. More recently it has been found to be a great sparing of fodder to let the Häcksel lie in a well-closed tub, exposed to the steam of boiling water some hours, whereby the straw is rendered much more digestible for the beasts, and thus a smaller quantity is required for the same nutriment."

Veit observes on this subject: "The particular labor of preparing fodder, is for the most part limited to the cutting of Häcksel. In a smaller number of cattle than occupies the keeper constantly it is customary to have him prepare the Häcksel but in a quarter where he is fully busied in taking care of them, it is customary to have the Häcksel cut by the job. Of the usual short-chopped stuff for horses, one man can cut in a day 7 to 8 cwt., and of a longer kind for cattle, 10 cwt., which allowing 20 to 24 kreutzers (or from 15 to 18 cts.) for a day's work, would give the cost of labor in cutting of 1 cwt.; for horses, at 3 kreutzers (or about 2¼ cts.), and for cattle from 2 to 2 kreutzers. But this work is usually assigned to one man, and in a week for 1 horse at 8 lbs. Häcksel for a day or 56 lbs. for a week, it amounts to from 1½ to 1 kreutzers per week: for a working-ox at 20 lbs. of Häcksel per day or 140 lbs. per week, it comes to 2¾ to 3 kreutzers per week." Speaking of the different kinds of straw as materials of fodder, he also remarks that they should be ranked in the following order:

"1. The straw of the usual *leguminous fruits*, and especially of lentils, vetches, and peas, is more nutritious, than the straw of seed-clover. The greener the tips are, the less it is lodged the better can it be dried and brought in, the more nourishing it is. The straw of lentils and seed-clover is the most preferable. The fine stalk vetch straw is also very nutritious, behind which stands somewhat the pea-straw, with its thicker stalk. All straw of leguminous fruit is particularly a welcome fodder to sheep on which account therefore it is greatly prized by many sheep-owners, and considered equal to hay.

"2. *Oat* and *barley* straw, is the straw for fodder of the cereal fruits. *Oat*-straw is most agreeable, and also most nutritious, on account of its peculiar taste for all species of cattle, because on the tips of the panicles are usually found unripe grains, and oats are generally cut before they are fully ripe. *Barley* straw has, on account of its moisture, and short period of vegetation, a high value as fodder, and other things being equal is as nutritious as oat-straw, if it were not, as is the case, fully ripe before reaping. Yet it is more liable to injure than oat-straw, because after reaping it imbibes more moisture from the air and soil.

"3. Straw of *summer-wheat*, *summer-speltz*, and *summer-rye*, for fodder, stands after oat and barley-straw; but in many farms, where the straw of the usual species of winter-grains supplies the need of litter, it is employed for especially the moister straw of summer-wheat and summer-speltz. That of summer-rye is less nutritious.

"4. The *stalk of maize* (Indian corn) contains much saccharine matter, and therefore is very nutritious and fine, and agreeable to all kinds of cattle. The cobs, after the corn has been taken off, ground up, are likewise a very nutritious fodder, and the

hard stalks may be chopped up for the purpose. Taking all these things into view, it stands next to the straw of summer-rye in value as fodder.

"5. *Millet*-straw has a hard stalk, but contains at least as much nutritious matter as the straw of the winter-cereals, at the same time that millet is cut before it is fully ripe.

"6. *Buckwheat*, on account of its quantity on a field of less fertility, and if of fine stalk, in which case its value as fodder from its straw being rich with leaves, is enhanced, is as good as the straw of the winter-grain.

"7. The straw of the usual *winter-grain* fruits, as of barley, wheat, speltz and rye, has less value as fodder, and is therefore employed more for litter. Rye-straw is the least valuable for fodder of the straw of all the cereals.

"8. *Bean*-straw, in case its leaves have not fallen off or are decayed, and the ends of the stalk are green when it is cut, as many experiments have shown, have a much higher value as fodder than is usually supposed. If the very hard stalks are chopped fine, and scalded with juicy fodder mixed with it the nutritious quality of it is little inferior to that of the straw of other leguminous plants. The average of many experiments as to the proportion of straw to the grain of the usual straw-fruits, is to 100 lbs of straw and grain as follows:

"Winter-wheat 47 lbs.; winter-rye 40 lbs.; summer-wheat 55 lbs.; summer-rye 45 lbs.; oats 63 lbs.; barley 66 lbs.; peas 43 lbs.; vetches 48 lbs.; beans 42 lbs."

Thaer has given some estimates of the comparative amount of nutritious matter in different substances used for feeding cattle which may be suitably introduced here: He says that according to experiments, it has been found that 100 parts of good hay, contain 50 parts which may be reckoned as easily adapted for nutriment. "Of 100 parts of potatoes reduced to the same degree of dryness as the hay, there are dry 30 parts, of which 25 are nutritious; therefore 94 lbs. of potatoes are equal in nutriment to 47 lbs. of hay. Beets have 8 per cent., which a person may consider certainly nutritious, and 4 per cent. of harder digestible fibre; their nutritious power may therefore be set down at 10 per cent.—Ruta baga contains 12 per cent. nutritious matter, and 3 per cent. of more difficult fibre. The same is the case with turnips."

Veit, Vol. I. p. 260. has also some tables showing the equivalents of many plants, &c., to hay, by which it appears from many experiments that the following ratio exists:

NAME OF MATERIALS OF FODDER.

100 lbs. of hay are equal to—	lbs.
I.	
Mealy Grain Fruits.	
1. Good kernels—	
a. Of the usual grain fruits—	
Wheat,	30
Speltz,	45
Rye,	40
Barley,	44
Oats,	50
Maize, or Indian corn,	36
Millet,	36
b. Of the leguminous fruits.	
Pease,	50
Vetches or tares,	36
Lentils,	33
Beans,	40
Buckwheat,	50
2. After-grains.	
Wheat,	50
Rye,	60
Barley,	64
Oats,	70
Leguminous fruits,	50

100 lbs. of hay are equal to—	
II.	
Root, Knob and Cabbage Plants	
Potatoes,	200
Artichoke,	230
Red Beet,	300
Swedish turnips or cabbage turnips,	300
Carrots,	270
White turnips,	400
Cabbage	600
Stalks of root and knob plants in a green state,	500
III.	
Fodder-Plants and Grasses.	
Luzerne sainfoin red clover, and all kinds of clover, with various species of grain and leguminous plants used green for fodder.	90
Good meadow-hay,	100
Moss-hay, and other poor kinds of hay,	150
Grasses and herbaceous cabbage plants in a green state,	450

100 lbs of hay are equal to—

IV.

Straw with Chaff, of—

	lbs.
Winter wheat, " speltz, " rye, " barley,	300
Summer wheat, " speltz, " rye, ' barley,	230
Oats,	200
Maize, or Indian corn,	275
Millet,	300
Peas,	190
Lentils,	160
Vetches, or tares,	180
Beans,	400
Buckwheat,	300
Seed clover,	150
Rape, Mustard, Gold of pleasure,	400
Poppy, Sunflower,	500

100 lbs. of hay are equal to—

	lbs.
Chaff and husks, without straw, of—	
Wheat,	150
Rye, speltz, and barley,	170
Oats,	150
Rape,	200
Gold of pleasure and mustard,	230
Seed clover,	100
Flax seed,	130
Leguminous plants, as peas, vetches and lentils,	150

V.

Refuse in business.

After meal,	50
Wheat bran, Rye "	75
Oil-cake, from poppy, flax, rape seed,	60
Skimmings of barley in preparation of malt,	60
Malt-shoots of barley,	125
Barley beer refuse,	300
Brandy refuse,	900 maas, = 121½ gall.
Sour milk,	200lbs.
Whey,	350
From the forest,	
Acorns, chestnuts, beech nuts,	75

A. K. Block, who is referred to by Schwertz as a very distinguished writer gives the following table of equivalents:—

600 lbs. wheat straw,
" " rye "
" " oat "
580 " barley, "
560 " seed clover straw.
" " rye or barley chaff.
500 " pea straw.
480 " wheat, pea or barley chaff, or vetch straw.
326 " clover, 2d mowing: usual meadow hay, 2d mowing.
300 " clover hay in blossom.
280 " best meadow hay.
250 " best clover hay, before blossom.
118 " oat grain.
100 " barley "
100 " rye "
89 " yellow peas.
80 " wheat grain.

Consequently, 2 lbs. of grain straw is worth as much as 1 lb. of usual meadow hay, or 1 lb. of clover hay, mowed in the blossom, &c.

We find the following table of equivalents, in some English papers, which is inserted by way of comparison:—

100 lbs. of good hay = 90 clover-hay, made when fully blossomed.
" " " 88 " " before it blossoms.
" " " 98 clover, 2d crop.
" " " 98 luzerne hay.
" " " 89 sainfoin "
" " " 91 tare "
" " " 146 clover.
" " " 410 green clover.
" " " 467 vetches or tares, green.

100 lbs.	of	good hay	= 275	green Indian corn.
"		"	" 541	cow-cabbage leaves.
"		"	" 374	shelter-wheat straw.
"		"	" 442	rye straw.
"		"	" 164	oat straw.
"		"	" 153	pea stalk.
"		"	" 159	vetch "
"		"	" 201	raw potatoes.
"		"	" 175	boiled "
"		"	" 339	mangel wurtzel.
"		"	" 504	turnips.
"		"	" 276	carrots.
"		"	" 308	swedish turnips.
"		"	" 305	do. do. leaves on.
"		"	" 54	rye.
"		"	" 46	wheat.
"		"	" 59	oats.
"		"	" 50	vetches.
"		"	" 45	peas.
"		"	" 45	beans.
"		"	" 64	buckwheat.
"		"	" 57	Indian corn.
"		"	" 68	acorns.
"		"	" 50	horse chestnuts.
"		"	" 62	sunflower seed.
"		"	" 69	linseed cake,
"		"	" 105	wheat bran.
"		"	" 109	rye bran.
"		"	" 167	wheat, pea and oat chaff.
"		"	" 179	rye and barley "

16 lbs. of raw, or 14 lbs. of boiled potatoes, will allow a diminution of 8 lbs. of hay.

An ox requires 2 per cent. of his live-weight, in hay, per day: if he works, $2\frac{1}{2}$ per cent. A milch cow, 3 per cent. A fattening ox, 5 per cent., at first; 4 per cent. when half fat; and 4 when fat. or $4\frac{1}{2}$ average. Sheep, when grown, $3\frac{1}{2}$ per cent. of their weight in hay, per day.

Much is said in the German works of *artichokes*, as a food for cows. SCHWERTZ gives the result of several experiments on this subject, which it may be useful to quote here. He says, Vol. II., p. 620: "100 lbs. of stalks in a green state are equal to $31\frac{5}{4}$ of hay; in a dry state chopped up fine and mixed with other fodder 16 lbs. of stalks are equal in value to 10 lbs. of hay." THAER also says of the stalks in a green state, "This stalk appears to us to be for sheep more valuable than for cows. They are to be laid before sheep in September when they come home from the pasture. Their desire for it was so great, that they ran up to the stable in expectation of it." The knobs or roots are also most valuable for milch-cows; 24 lbs. of them with 10 lbs. of clover-hay and 3 lbs. of ground rape-seed caused a cow to give as much milk as with 24 lbs. of potatoes. The yield both in leaves, stalks and roots, is very large.

VEIT, Vol. II. pp. 386, 423, gives us the following estimates of the consumption of fodder for a cow and for an ox:

For a cow:
- in summer-stall-foddering for 120 days:
  - green fodder at 18 lbs. worth of hay daily (=23 lbs. English)
- for winter-fodder for 245 days:
  - 10 lbs. worth of hay, 6 lbs. of straw, 10 lbs. of potatoes daily
- if pastured: summer pasture 150 days—equivalent to
  - 18 lbs. of hay daily.
  - winter fodder daily, for 215 days, as before.

For an ox:
- in summer-foddering, 120 days:
  - green clover-fodder = to 18 lbs. of hay,
  - long meadow-hay, 5 lbs. "
  - ground or bruised grain, 1 lb. "

} daily.

in winter-fodder, for 245 days.

hay, 14 lbs. } daily.
straw-fodder, 8 lbs. }
potatoes, 14 lbs. }

The extent of pasture required for different animals during a summer is given by THAER as follows:

"For 1 cow, 1¼ yoke, = to nearly 2 acres. For 1 horse, 2 yoke, = 2½ acres. For 1 draught or laboring-ox, 1 yoke = 2½ acre, nearly. For a sheep or swine, $\frac{2}{15}$ of a yoke, $\frac{1}{3}$ acre."

PETRI says: "In general, we may allow any amount of pasture to be proportioned as follows; the same space, for

12 cows, or
8 horses.
9 team oxen.
10 colts.
21 young cattle.
96 large and small swine who get their whole food from it.
120 head of sheep so as not to suffer want of food."

The extent of stall-room for different animals according to VEIT, is:

				Square feet.
For a horse weighing live-wt.	1000 to 1200	lbs.,	- -	140 to 160
" working ox,	" 990 to 1200	"	- - -	85 to 95
" fatting "	" 1000 to 1400	"	- - -	90 to 100
" cow,	" 700 to 800	"	- - -	70 to 85
" a bullock,	" 500 to 600	"	- - -	40 to 50
" ewe,	" 60 to 80	"	- - -	10 to 12
" wether,	" 80 to 110	"	- - - -	8 to 10
" yearling sheep,	" 40 to 60	"	- - -	6 to 8
" sow,	" 140 to 180	"	- - - -	40 to 50
" a young boar,	" 50 to 80	"	- - -	15 to 20."

THAER, Vol. I. p. 77, says: "The fodder of oxen is very differently ordered in its quality and quantity. In common farms, where one uses oxen only part of the year, and where there is a deficiency usually of winter-fodder, it is extremely scanty. They use in the winter months straw, and only in the spring when labor commences is hay given, which is reckoned at 12, at the highest 16 cwt. per head." "When oxen are kept in a good state, they must have in dry fodder daily on an average 20 lbs. of hay, and consequently 40 cwt. must be reckoned for one ox yearly." "In farms where so much hay cannot be given, it must be supplied by grain, and best ground or broken up. One metzen of oats (1.69 bushel) is as much food as 1½ cwt. of good hay, or 1 lb. of oats is equal to 2 lbs. of hay. If therefore 3 lbs. of oats are given daily, then 6 lbs. less of hay may be given, and the ox remain in equal, probably greater strength. The most profitable fodder for winter without doubt is with potatoes, or other nutritious roots. If an ox has daily 2 mässl, (about 6¾ quarts) with 11 lbs. of hay, he will, according to much experience, keep in full strength. In the summer, oxen must be either kept at pasture, and then one reckons 1¼ usual extent of cow-pasture to an ox; or the ox is foddered in the stall with green clover, (soiling) vetches, or other fodder-plants. A strong laboring-ox requires then daily on an average 5½ square klafters of red clover (= 25 square yards), in two cuttings—consequently for the season $\frac{9}{16}$ of a yoke (= about ¾ of an acre)." "Numerous examples have proved that oxen remain in perfect strength, and abler to work than by going to pasture, if this fodder is properly managed. The cost of an ox therefore, according to the different species of fodder, may be reckoned at:

(a.) 40 cwt. of hay.—Summer pasture.
(b.) 200 days, hay at 15 lbs. = 30 cwt.
" " oats, 7 metzen = 12 bushels.
165 " pasture.
(c.) hay, 18 cwt.
daily, 2 mässl of potatoes, is 21 metzen = 36 bushels.
(d.) Stall foddering.
Hay, 18 cwt.
daily, 2 mässl of potatoes, = 21 metzen = 36 bushels.
green clover.

VEIT divides the fodder of an animal into "*conservation-fodder*, which is the quantity necessary to keep the animal alive in his present state, and *melioration-fodder*,

the quantity necessary to be employed in improving his condition. Thus an ox of 600 lbs. of flesh or dead weight, uses in a month 600 lbs. of hay, or 20 lbs. daily to be retained in his present state, wherefore his dead weight is to his living as 55 to 100, and therefore his live-weight is 1090 lbs., consequently his daily need of nutriment as conservation-fodder is 1.85 to 100 lbs. of live-weight. If now there is proportioned to 100 lbs. of his live weight daily 3 lbs. of hay; then in the whole live-weight there would be 32.7 lbs., so that the surplus 12. 7 lbs. would be employed as melioration-fodder, and assimilated for the formation of fat and flesh, &c. Hence the conservation-fodder bears to 100 lbs. of live-weight, in cattle or kine 1.85 lbs., in sheep 1.85, horses 2 lbs., swine 3 lbs."

Veit, also, in Vol. II. p. 420, thus expresses himself on the subject of fodder for cattle: "The solid, more dry than too watery, juicy, and moist materials of fodder, correspond more to the object of usefulness consisting in the performance of labor, because by strengthening the working-animal in labor, the organs of digestion are put into greater activity, whereby the easily decomposed, and rapidly assimilating materials of food, quickly gather to themselves those that are not lasting, and therefore the duration of the process is shortened. The most suitable principal article of fodder in the winter is hay, partly uncut, partly cut with good straw for chaff (Häcksel). In addition also may be used root and knob-plants, broken grain, &c. If a greater quantity of juicy articles of fodder are used, it should not be omitted after each feeding to give for an after-food for each head 2 lbs. of long hay. Besides, let them drink as they wish, and in sufficient quantity, which, especially in warm weather and with hard labor, is indispensably necessary, and yet is so easily neglected. In the summer, green fodder usually forms the principal article of food. By itself only it is not sufficiently lasting. In such a case, it is to be cut on the Häcksel-board, and mixed with Häcksel from hay and straw, or at each time of feeding 2 to 3 lbs. of long hay, to be given alone. Care must likewise be taken to make an addition of bruised grain at short periods, in the greatest pressure of labor. The working-ox is more susceptible with respect to the weather than the horse, does not bear great heat or cold, drought and wet so easily, and must therefore be employed at work with care: especially is the working-ox injured by too great fatigue in a hot day, as well as by too hard driving and urging forward at a distance, or in returning home from work."

"The yearly expense of the articles of fodder of a working-ox in Bavaria is—

1. In summer fodder from 1st of June, to the end of September, 120 days:

green clover-fodder in the worth of hay daily, at 18 lbs. = 2160 lbs. at 23 kreutzers (= 16¼ cts.) per cwt. =	8 florins	16	kreutzers	= $3,96
long meadow-hay, at 5 lbs. = 600 lbs., at 22 kr. (= 16 cts.)	2	"	12	" = 1,05
bruised grain 1 lb. = 120 lbs. in the worth of hay, 240 lbs. at 40 kr. (= 30 cts.)	1	"	36	" = 0,75

2. For winter-fodder through 245 days:

hay per day, 14 lbs. = 3430 lbs. a 22 kr.	12	"	34	" = 5,49
straw for fodder 8 lbs. daily = 1960 lbs. at 16 kr. (= 12 cts.)	5	"	13	" = 2,50
potatoes 14 lbs. daily = 3430 lbs. in worth of hay = 1715 lbs. at 30 kr. = 22 cts.	8	"	34	" = 4,09
for 91 cwt. of the worth of hay in the whole at 25.25 kreutzers,	38	"	25	" = $18,54

Respecting the feed of oxen, Sir John Sinclair, in his Scottish Husbandry, mentions the case of Mr. Walker, whose bullocks never tasted any other food during winter except turnips and straw, with perhaps a handful of hay while the ploughmen were eating their dinner under the hedge, that they were never spared a day's usual work; and that he had ascertained that thus fed one ox was equal to the work of two on hay alone. There is quite a difference in the nutritive matter of turnips of different varieties. The Swedish turnip appears, from a comparative estimate given in the British Husbandry, to be the most nutritive, as 30 tons yields 216 cwt. of nutritive matter. The quantity of water in turnips and potatoes is said by good authority to vary in different kinds, so that 100 tons of turnips contain sometimes only 9 tons of dry feeding-matter, and sometimes more than 20 tons, and potatoes sometimes only 20, sometimes 30 tons.

In the Annales de l'Agriculture Française, Dec., 1828, mention is made of a kind of sourcrout used in Prussia, and which is prepared by "putting cabbages into large stone receptacles, after chopping them and sprinkling them with salt. The mixture

is then allowed to ferment. The peasants of Swabia, also preserve the leaves of cabbage, beet, and other roots for feeding their cattle. After throwing them into boiling water, they heap them up in deep casks or boxes 5 or 6 feet square, fixed on posts. Every 8th day they add new layers of leaves, which they take care to salt. The whole then becomes sour, and when preserved for winter use it forms excellent food."

I have taken occasion to introduce the above views and calculations in this place, as they seem most appropriate here, and will be found useful to the intelligent farmers of our country, though some of them of course must need modification, as the price of hay and labor is generally so much higher with us than in Germany. The further points of the question respecting the comparative advantages of horses or oxen, will be presented hereafter.—Tr.]

7. Besides the difference of the cost which the support of oxen or horses occasions, we must also take into view, the difference of expense of their purchase, the unlike depreciation in value by use, the different hazards, their value, either wholly or partially lost after death, their harness, &c.

Horses in the first purchase cost almost double what oxen do; their value is diminished in a like ratio; they grow old after six years; defects of beauty have an important influence in the sale of them; their harness and shoeing is more expensive; and if they happen to receive an injury which disqualifies them for work, their whole value is lost, because after they are dead they can be put to no use: whilst oxen, by the same amount of labor do not equally depreciate in value, even if they are old, in 12 years; faults of beauty have less influence in sinking their value; their harness is as simple as it is cheap, and their being shod when used in tillage, is unnecessary; and when killed they answer for food; the working ox too, unfit for labor by being fatted, is made of great value, and even in the event of some misfortune, if killed in a leaner condition, his value is only partially lost.

[On the subject of fattening oxen, our Author, in Vol. II. p. 258, has the following observations: "To fatten oxen simply on hay can only be profitable where there is great natural growth of hay, and the hay has no higher value than it holds in fattening one's own cattle. The greatest experiments concerning the fattening with hay, are related by Count Podewill, in his Wirthsch. Erfahrungen II. Th. 58. (Agricultural Experiments, 2d part, p. 58.) From the year 1784 to 1800, he had 1497 Polish, and 226 country-breed oxen, fatted on hay. Late in Autumn, they pastured on the meadows, after the second-mowed crop was brought home, and were stalled about the 1st of November. They were fed only on hay, and were slaughtered in small divisions, from the end of December till the middle of June; on an average they were foddered 20 weeks. Each ox received weekly, on an average, 187¼ lbs. daily, 26⅔ lbs. of Vienna weight, (1 lb. = to about 1¼ lb. English.) of good sweet hay. For fattening one ox, 3745 lbs. were required. How much they gained in weight in fattening is not given, but only how much they gained in value; and from this the conclusion is drawn, as to the increase of flesh, which is not the correct mode. A Polish ox cost in the purchase, 58 florins 53 kreutzers, Conv. gold, (= $28,25,) and was sold for 75 fl. 45 kr. (= $36,33); there was therefore a gain of 16 fl. 52 kr. (= $8,08); but since for housing and fodder, for interest on purchase capital, implements, &c., there must be deducted on each head, 3 fl. 16 kr. (= $1.56), so 3745 lbs. of hay must be reckoned at 13 fl. 36 kr. (= $6,52), if the straw-litter is made to balance the manure, as Podewill does. One hundred weight of hay here for fattening costs 21¼ kr. (= 16 cts.) According to Table IV. (in his work), the mean of the fatted oxen slaughtered in the house, was in flesh 376 lbs., and 45 lbs. of tallow. But according to Table 38, the Polish oxen weighed in flesh and fat only 397 lbs., the country-breed ones 359 lbs. The pound Vienna of flesh is put at 6.71 kr. (about 4 cts.), a pound of tallow at 15.65 kr. (about 12 cts.), and the hide at 6 florins (= $2.88). The cwt. of flesh, according to Table IV. is reckoned at 15 fl. 54 kr. (= $7,60½ cts.) and since the gain of sale over the purchase, on a head, was 16 fl. 52 kr. (= $8.08), it had in 140 days gained only a little more than 1 cwt., and the gain was very small, if we bring not into the account also the bettering and raising the value of the mass of flesh of the whole stock of cattle. Thaer assumes, but I know not from what experiments, that an ox of 700 to 750 lbs., to which is daily given 40 lbs. of good hay, will daily gain about 2 lbs. If the worth of a pound of fat flesh is 2 groschen (about

4 cts.), then 230 lbs. of hay will be reckoned at 28 groschen (= 56 cts.), or 100 lbs. at 10 groschen (= 20 cts.), which indeed is not too much for many regions, but yet is a sufficiently good reckoning of hay used. The fattening with turnips, cabbage-turnips, but especially with potatoes, spares much hay, and effects the object in a quicker time. Cabbage-turnips, according to many experiments in the fattening of oxen, deserves great regard; since the beasts eat these roots better than potatoes, and with a similar quantity of hay, are soon fatted. Of equal value too are beets, as the experiments of Dombasle prove. THAER maintains, that if a man, in place of 30 lbs. of hay give only 10 lbs., and supply the other 20 lbs. by 60 lbs. of potatoes, the ox will be better fed and sooner fatted, which is very clear; since thus 3 lbs. of potatoes, or indeed 1 lb. of dry, and in a great measure, mealy substance, is given instead of 1 lb. of hay.

"Fattening with grain produces the greatest effect in the shortest time. This should be given either whole or ground to meal, and mixed with Häcksel, or given with their drink in a raw or in a fermented state. Grain broken up, or coarse meal mixed with some salt, strewed over chaff-mixture (Häcksel), is the most common method of feeding. I have found in many of our farms, that for fattening they make a certain quantity of meal, mixed up with salt water, into paste-balls of the size of large apples, of which, after the oxen have eaten hay or Häcksel, they give them by piecemeal twice a-day. Arthur Young found the same practice in Provence, and it seems to me that it is far preferable to giving meal with salt to the beasts without Häcksel. To mix a portion of grain-meal with water, and make it thus agreeable to the beasts, is indeed as suitable as it is profitable; but to employ all the meal in this way is unprofitable, because the dry fodder without meal is less acceptable, and will not be eaten by the beasts in sufficiently large quantities. To mix up a certain quantity of meal with water, and set it into fermentation by leaven, and then give it in a dilute state to oxen as drink, produces a greater effect than when the meal is in an unfermented state. That one may fatten swine with fermented meal-drink is known; but that fatted oxen may be fed in this manner is less known, although it is evident that what will make swine fat must also have the same effect on oxen. In the South of France, Arthur Young found this practice. It is not unknown also in Alsace (see Schwertz Alsace Husbandry, 91); as also in some regions of Upper Steirmark, fermented meal-drink is used as fattening food, and it is maintained by the farmers of these regions, that it produces considerably greater effects than raw meal or common meal drink. I must here mention in passing, the mixture of one part of meal, and two parts of boiled or steamed and broken-up potatoes, which are suffered to go into acid fermentation, and then fed out; of which I have given a more particular notice under the Fattening of Swine. See Vol. II. p. 336."

"A small piece of usual leaven is mixed up with tepid water, in a vessel full of meal, to the thickness of a dough, and this is set in a warm place to ferment; in this one obtains leaven enough to ferment rapidly half a metzen (0.85 bushel) of meal. This meal is placed in a large vat, with tepid, but not hot water, and with that vessel full of leaven made into a thin paste, by which it soon ferments. While this is going on, a metzen (1.69 bushel) of potatoes is steamed or boiled, and broken up, and in a hot state thrown into the fermented dough, and well mixed together. The vat needs only to be ⅔ full, because the mass swells by fermentation. The greater quantity one prepares at once, the more acid it is, so much the more do swine love it, and so much the more useful it is for them. The addition of a handful of salt produces an admirable effect. In feeding it out this thick dough should be thinned with water, or, what is better, with sour milk, and given three times a day to swine."

"How much grain must be given to beasts in fattening them, depends on their size, on the greater or less capacity for nourishment of the grain; also, whether it be given whole, broken up, ground into meal, raw or soaked, or fermented. Of the progress of fattening, we must judge by weight, measure, and handling the beasts. Strachniss's rule is to multiply the square of the diameter of the beast measured behind the shoulders, by the length from the point of the shoulder to the end of the rump, divide this sum by 54, and the quotient will be the slaughter weight of the beast. He mentions also, two computations with swine and a wether, where this formula gave the flesh-weight tolerably correct. My friend Sollner after many experiments, fixed upon 67.5 as a divisor, and with oxen and cows which weigh more than 200 lbs., this formula gives the slaughter-weight very correctly, but not with lesser animals. In proof how correctly the rule answers, I subjoin the following proof; taken at the excellent farms of Karlsberg and Krug.

Year and day of slaughter.	Kind of Beasts.	Measure in Inches.		Flesh weight given.	Wt. at slaughter	
		Circumf.	Length.		Flesh.	Tallow.
		inches.	inches.	lbs.	lbs.	lbs.
1827, Dec. 23,	Cow, 9 years old,	72	54	420	402	50
1828, Jan. 11,	" 7 " "	70	51	375	390	50
" " 30,	Ox, 6 " "	73	57	455	459	
" " "	" " " "	75	53	447	436	
" Dec. 28,	Calf, 3 " "	62	50	288	290	
1829, Sept. 30,	Ox, 5 " "	75	52	438	419	53
1830, Feb. 30,	Calf, 3 " "	66	50	326	326	
1831, Dec. 13,	Cow, age unknown,	64	50	305	323	
1833, Jan. 9,	Bull, 4 years old,	90	61	740	772	40
" Feb. 23,	Cow, age unknown,	68	53	366	381	60
" April 3,	" " "	74	53	434	372	40
" " 16,	Ox, 5 years old,	81	57	575	566	19
1834, Feb. 6,	Cow, 4 years old,	70	55	404	411	50
" Nov. 24,	" 7 " "	67	50	343	316	20
" Dec. 21,	" 6 " "	66	51	328	330	20
1835, April 10,	" age unknown,	76	56	484	460	80
" " "	" " "	71	55	416	381	56
" Dec. 13,	" 11 years old,	67	49	336	321	60
1836, Jan. 30,	Bull, 5 " "	80	57	546	620	40
" March 16,	Ox,	82	56	565	524	75
" " "	"	80	56	1072	1016	150
" " "	"	80	56			
				9657	9583	

From a great variety of experiments, it appears that 100 lbs. of live-weight of a beast, not fattened, yet not lean, gives 52-54 lbs. of flesh-weight, and if the fat is reckoned, 56-59 lbs.; of the half-fattened, 54-60 lbs. of flesh, and with tallow 59-63 lbs.; and entirely fattened, 61-64 lbs., and with tallow 70 lbs. 100 lbs. of flesh give, with lean beasts, 6-8 lbs. of tallow; with half-fattened ones, 9-12 lbs.; but with fattened ones, 13-27 lbs. The fleshy parts of less value, as entrails, head and feet, are to pure flesh in the 4 quarters in a lean beast, as 20-22; in half-fattened, as 15-20; in fattened, as 8-12 to 100 lbs. From this it appears how much more profitable it is for the butcher to buy fat cattle, even if considerably dearer, than lean; because with the absolute weight of the beast he obtains more fatty parts, which, as tallow, is often doubly more dear than flesh; because he obtains a better price for the fattened animal; because the head has a higher proportionate value, and because there is much less weight of such flesh, as frequently has only half the value of better flesh."

In the 2d volume of the British Husbandry, p. 392, it is stated, "The stock-bailiff of the late Mr. CURWEN always calculated from his experience, that the dead-weight was equal to $\frac{5,5,6}{10,10,10}$, that is to say $\frac{11}{20}$ths of the live weight." The following rule is also given: "The girth is taken by passing a cord just behind the shoulder-blade, and under the fore-legs; this gives the circumference; and the length is taken along the back, from the foremost corner of the blade-bone of the shoulder, in a straight line to the hindmost point of the rump, or that bone of the tail which plumbs the line with the hinder part of the buttock. The girth and length are then measured by the foot rule." Tables have been constructed by different persons, calculated on the stone of 14 lbs., "by multiplying the square of the girth by the length, and this product by a decimal, which may be assumed as nearly .238 for the live-weight; the dead-weight is ascertained by multiplying the live-weight by the decimal, .605; thus $\frac{6,0,5}{10,0,0}$ will give the product of the four quarters." Mr. Renton, however, states that for a half-fattened ox, must be deducted 1 stone for 20 from that of a fat ox: for a cow which has had calves, 1 stone must also be deducted, and another if not properly fat." "Mr. McDerment proposes that in case of very fat animals $\frac{1}{16}$ or $\frac{1}{10}$ part should be added to the weight obtained by measurement, and when below the ordinary state of fatness, the same proportion should be deducted. Old milch cows which have had a number of calves should have $\frac{1}{5}$ or $\frac{1}{10}$ of their weight deducted."

The following results are given as thus measured alive, and the weights as having been found nearly accurate when the animals were killed, 14 lbs. being allowed to 1 stone in live weight, and 8 lbs. for dead weight.

GIRTH.	LENGTH.	RENTON'S TABLE.	M'DERMENT'S DO.	CARY'S GAUGE.
ft. in.	ft. in.	st. lbs.	st. lbs.	st.
5 0	3 6	21 0	20 11	21
	4 0	24 0	23 11	27
5 6	3 9	27 1	27 0	27
	4 9	34 4	34 2	34½
6 0	4 6	38 8	38 8	38¾
	5 0	43 1	42 12	43
6 6	4 6	45 9	45 3	45½
	4 9	48 0	47 10	48
7 0	5 6	64 6	64 2	64½
	6 0	70 5	69 13	70¼
8 0	6 6	99 8	99 0	99¾
	7 0	107 5	106 9	109⅜

"Mr. Douglas's mode of calculating is, By decimals square the girth into itself, and multiply the length into the square of the girth; if the beast is fat, multiply by the decimal .24, if only half fat, by .23. The foregoing rule is very accurate, if cattle are divided into classes, and the multiplying decimal proportioned: thus if what is technically termed,

Just killable, multiply by .22,
Fair beef, " " .23,
Fat, " " .24,
Very fat, " " .25,
Extra fat, " " .26."

The average of five different breeds, carcass and offal, are given
Of carcass, to 10 stone of live-weight, nearly 6 stone,
Of offal 3½ to 10 stone of the carcass.

THAER in Vol. IV. p. 240, gives the following formula as one used in England, by Proctor Anderson: "Take half the live-weight; add ⅛ of the same to it, and divide by 2. Thus an ox weighs, live-weight, 700 lbs.,

½ is 350,
⅛ of 700 " 400,

750, divided by 2 gives 375 lbs.

20 lbs. live weight therefore, gives 10 flesh weight." THAER says that "with somewhat fatter oxen 20 lbs. will give 11 lbs., and with fully fattened ones, 12 to 12½ lbs."

On the subject of summer fattening, he says there are two kinds, pasture and stall-feeding; pasture-feeding is on rich pastures, which hence are called fat-pastures. "In the marshes of the lower Elbe, it is customary to pasture the grass-land once, and to mow it once. A fenced lot or one separated by ditches, is appropriated to the fattening cattle in the spring, and a crop of hay is taken from another, then the cattle pass from that to this, and that is now spared and mowed. In these regions they reckon for great marsh oxen, which have a flesh-weight of 900 lbs., a marsh morgen of 450 square rods, containing sixteen feet each, which makes 1⅛ of a yoke, (= ⅔ of an acre)." "Green stall-foddering is not often practised for fattening cattle. I know however many examples where it has resulted well. Oxen can be made very fat with green clover if it is given in suitable quantity. An ox eats 180 to 225 lbs. of green clover in a day, with which he must have good straw, which he may eat at intervals. If one could give part of his food in hay or dried clover, his green fodder would no doubt be more successful. A drink of flax-seed cake has been used with particularly good effect, towards the close of the fattening period." "The winter fattening with hay only in regions rich in hay, is sometimes practised. An ox which will weigh 630 to 675 lbs., and daily uses 36 lbs. of good hay gains daily 1 lbs. or weekly 12½ lbs."—"If an ox, in place of 27 lbs. of hay, has daily 54 lbs. of potatoes and 9 lbs. of hay, or weekly 368 lbs. of potatoes and 63 lbs. of hay, according to numerous experiments among us, he will be in a better state and stronger. If the fattening time lasts 16 weeks an ox gains 204 lbs. of flesh and fat. He consumes, if fed on hay only 4702 lbs., if on potatoes also, 1018 lbs. of hay, and 67 metzen 18 lbs of potatoes (probably the Austrian metzen, which is 1.69 bushel, therefore 67 metzen = 113,$\frac{1}{100}$ bushels). If the fattening time lasts 20 weeks,

the ox must, in hay-fodder consume 5000 lbs. of hay; or with potatoes, 1272 lbs. of hay, and 84 metzen of potatoes (=nearly 146 bushels)."

VEIT is also full on this subject. Yet as his authority is high, I will quote him somewhat at large. He examines the subject with reference to the choice of articles of food, the quantity, and modes of preparation See Vol II. p. 432. On grass-pasture, he says: "This mode of fattening can be used only in rich lowlands, or natural or artificial fat pastures, and on moist, warm, grassy mountainous regions. Such rich pastures produce the cheapest fodder, and hence the highest profit if the grasses and plants on them possess sufficient nourishment to make the beasts fat.

"Green fodder, clover-grass, and mixture of fodder. Cattle readily eat and fatten on these kinds of green fodder; but butchers complain of the want of the firmness and productiveness of the fat; and here it is usual to add at every feeding-time, especially in the last period of fattening, ground-grain or other nutritive articles of food.

"Hay of all sorts. Good meadow and clover hay, is very common as a principal fattening-fodder, at least in the first and second periods of fattening, and with or without juicy fodder; and only in the third period of the commonly diminished activity of the digestive power, is this voluminous fodder lessened, and instead of it, a less voluminous, richly nutritious and easily-digested kind given in a proportionate quantity.

"Knob and root-plants. These are used in very many farms, as the principal article of feeding; because their volume is small, they can be easily mixed with all other kinds of fodder-stuffs; the most suitable proportion between the nutritive power and the volume, between the watery and dry parts can be so easily regulated; and the farinaceous and saccharine principles, as the two most efficacious constituents of a corresponding fattening food, exist in them in a great quantity, and in an easily-dissolved state. Of these the fattening-cattle can take $\frac{3}{5}$ to $\frac{4}{5}$ of the daily need of nutritive substance, in hay-value.

"Grains. These operate the most profitably in the production of flesh and fat in a great quantity, and of the best quality, and are therefore the *most excellent* fattening food. But their volume is too small to fill the belly sufficiently; and hence they must be mixed with more voluminous fodder-stuff.

"Of particular efficacy is the ground grain fermented like bread-dough, and for this purpose mixed with boiled potatoes is made into a thick dough which after 24 hours is stirred up in its fermenting or fermented state in lukewarm water, and is used partly as a drink, and partly mixed with chaff (or Häcksel). But among all the articles of food, the grain-fruits, malted and baked into bread, produced the greatest effect.

"Of the grain-fruits, it is usual to give $\frac{1}{2}$, at the highest $\frac{2}{3}$, of the need of fodder in hay value; the less quantity in the beginning, and the greater towards the end of the fattening. In an economical point of view, the grains belong to the dearest materials of fodder, unless their cultivation especially is so carried on, as to produce them with the least cost. Whoever in fattening will employ the greatest quantity of the grains, must above all give his attention to the cheapest possible production of the same.

"Of the kinds of straw, one should choose only a good, not entirely ripe straw of oats, barley, lentils, vetches and peas, which should be produced by the proportion of his husbandry in large quantities, and for the most part only for the purpose of filling up and extending the paunch in the first period of fattening, and to prepare it for the reception of greater masses of food.

"Oil-cake, of rape-seed, flax-seed, bran; the remains in the starch and beet-sugar manufacture; whey, sour milk; horse-chestnuts, acorns; in short, all articles of food, which possess much nutriment in a small volume, and can be obtained cheaper than grain, are valuable aids in fattening.

"Salt belongs to the most excellent aids to keep the digestive organs in greater activity, to increase the growth of fat, but especially to improve the quality of the flesh and fat. This should be given in greater quantity towards the end of the fattening period. Only with the soured (pickled) fodder, less salt need be given. Among the most efficacious aids to digestion, are reckoned bruised gentian-roots, juniper-berry beer, and horse-chestnuts. They are mixed with salt, bran, and malt-shoots; let this mixture be given $\frac{1}{2}$ hour before the morning feeding, in the first period twice a week; in the second 4 times, and in the last daily. This mixture has a particularly profitable influence in sickly and lean beasts.

A principal question in foddering fattening cattle is, How much fodder can be employed to advantage? All experience agrees in this:—that it is only the rapid fattening which gives the highest results. The more fodder one can give to the fatten-

ing cattle in a definite time; so much the more melioration-fodder will be derived from it; and so much earlier will the fattening be completed. The quantity of fodder, so far as it can be perfectly prepared, and assimilated by the organs of digestion, has its limits. For a surplus on the one hand, occasions a limitation of the powers of digestion, and on the other, a waste of the fodder; whilst with too little fodder, the fattening is protracted too far, and becomes too costly.

"Universal experience shows, that an ox, in his last period of fattening, must have double his conservation-fodder, (1.85 lbs. of hay-value to 100 lbs. of live-weight); therefore daily 3.7 to 4 lbs. of hay-value to 100 lbs. of his live-weight. In the last period of fattening, the digestive activity of the fattening beast is evidently circumscribed. But since exactly in this period, the most nutritious, and most easily-digested articles of fodder may be reached; so they are able to take of them still more than in the earlier period they can of the more voluminous means of nutriment. For the first fattening period then we fix upon about $2\frac{1}{2}$ lbs : for the 2d, 3 to $3\frac{1}{2}$ lbs., and for the 3d, $3\frac{1}{3}$ to 4 lbs. in hay-value to the 100 lbs. of live-weight, as the daily conservation-fodder.

"Usually cattle need to be fed 3 times in the day; when fed 4 times, the beasts have too little time for rest, and to ruminate their food. If fed twice a day, such daily fodder is first laid, in which the voluminous, coarse fodder forms the chief fattening-fodder, and therefore also the slower fattening is chosen as the most suitable. In this case, the beasts enjoy a long, unbroken rest, as the cheapest means of improvement, and thus use up perfectly the nutriment given.

"Among the most essential conditions of success is the order, in which the materials of fodder should be given at each feeding, and the interchange of the different kinds of fodder.

"At first, we give the more voluminous means of nutriment, Häcksel of hay and straw, with juicy fodder, roots and knobs, &c.; in the second period of fattening less of the voluminous, or hardly-digested, and more of the easily-digested and stronger, in greater interchange, and in increased quantity; and in the last period, the most easily-dissolved, nutritive and most efficacious for forming fat, as well as the most palatable. In this last period, great care is required to keep up the already declining digestive activity by tempting anew the sinking appetite, and thus introduce so much food, and sustain the organs of assimilation in such efficiency, that either the increase of weight of the animal or the perfection of the mass of flesh and fat may pay sufficiently for the increased expense."

"The 3 periods of fattening are usually so divided, that the last shall be the shortest, because the most costly; in which there is the least increase of weight, only the mass of flesh and fat is perfected. If at the time of beginning of the fattening, the oxen are in a good condition, not in a lean, but in a sound state, they can fat up ten the lesser ones weighing from $8\frac{1}{2}$ to $9\frac{1}{2}$ cwt., in two months, and others weighing from 10 to 12 cwt. in 3 months. Most commonly we allow 3 months to the former, and 5 months to the latter, and in the longer fattening, where more of voluminous coarse fodder is given, than of the nutritious, the period reaches to 6 or 8 months. In the first and second period, the fattening cattle gain the most flesh; in the third the most fat and grow better, especially as to the flesh. Very fat animals, therefore, towards the end of this period, may show no increase of weight on the scales, but yet with stronger appetite to consume their fodder, stand in a profitable condition, on account of bettering the quality of the flesh and fat. Whether the half (to the middle and end of the second period of fattening,) or the whole fattening, be the most profitable, depends especially on the state of the market, and on the quality and quantity of the materials of fodder provided."

As to the amount of fodder consumed, the following table may be taken as a specimen of many furnished by Veit:—

PERIODS OF FATTENING.

	Fodder-material consumed. I.	II.	III.	Average of the 3 periods.
	Hay value.	Hay value.	Hay value.	Hay value.
Hay,	13.3lbs.	15.3lbs.	18 2lbs.	15.5
Straw,	7.7	5.5	2.4	5.2
Grain,	2	6.14	10 2	6.11
Juicy fodder,	9.1	10.76	12 3	10.7
	32.1	37 7	43.1	37.5

The following are some of the results summed up by VEIT. There were 5 experiments: the first with 28; the second with 16; the third with 4; the fourth with 60; and the last with 13 cattle. The averages were as follows:

"1. Average live-weight at the purchase, ... 1080 lbs.
2. " " " sale, ... 1397
" from the beginning to the end of
3. " fattening, ... 1238.6
4. " increase of weight in the whole time, . . 317
5. " daily " " " 2.9
6. Duration of fattening, 5.4 months, or 23 weeks, or 162 days.
7 Average value of fodder consumed in a day, at hay value, 37.5
8. Of this for conservation-fodder, ... 19.9
9. " " melioration-fodder, ... 17 6
10. Average amount of fodder for one ox, ... 5548
11. " of this as conservation-fodder, ... 3213 4
12. " " " melioration " 2334.6
13. " quota of fodder on 100 lbs. live-weight per day, 3
14. " conservation fodder " " " " 1 85
15. " increase " " hay-value of entire fodder, 5 57
16. " " " " " melioration fodder, 12
17. Average price of oxen, each, at purchase, . 72 florins = $34,56
18. " " " at sale. . . . . 134 fl. = 64 32
19. " surplus to cover cost of keeping the whole time. 62 fl. = 29,76
20. " " for the day, ... 21 kr. = 18
21. " cost of purchase of 1 lb. live-weight, . . 4.04 kr. = 3.03
22. " amount of nett proceeds. " " . . . . 6 kr. = 4.5
23. " entire cost of one ox per day, ... 13.2 kr. = 10
24. Of this for the fodder per day, ... 9 7 kr. = 7.2
25. " " " " " cwt. . . . . 26.24 kr. = 19.7
26. Proportion of cash value of fodder to a cwt. of hay value, 54.6 kr. = 40.8
27. " " " " for the week, 2 fl. 22 kr. =1,12
28. " " " " " day, 20 3 kr. = 16
29. Clear profit in the whole, each, . . . 26 fl. 33 kr.=12,72
30. " " on the 1 cwt. of hay value, . . 28.56 kr. = 22"

On page 455, he says:

"The live-weight is to the dead weight in the following proportions:

	IN 100 POUNDS LIVE WEIGHT—		
	Flesh.	Tallow.	Together.
Of lean animals,	43—46	3—4	46—50
" half fattened,	50—53	5—7	55—60
" fattened,	54—60	7—10	61—70

And 100 lbs. of flesh give, of tallow:

In lean animals,	4—7 lbs.
" half fattened,	9—12
" fattened,	14—20

The fleshy parts, of less worth, as entrails, head and feet, are to the flesh of the 4 quarters:

In lean cattle,	18—22
" half fattened,	15—20
" fattened,	8—12 to 100 lbs.

The weight of the head is to 100 lbs. of flesh 9—18 lbs.; with smaller cattle, the larger, and with greater ones the lesser of these weights; or in small animals of a live weight of 6—8 cwt, 40—50 lbs.; with middle sized of from 9—10 cwt, 55—70 lbs.: and with great ones, of 11—16 cwt., 80—100 lbs. The price of fattened ox-flesh, on an average of many years, is from 8—11 kreutzers, = 6—9 cts.: of the cow 1½ to 2 kr. cheaper."

The following are the results of the increase of weight in the case of a fattening ox weighing, live-weight, 12 cwt.

Daily need of fodder reckoned in hay value.		Of this as		Daily increase of weight.		Increase of weight, proportion to 100 pounds of		Of the value of the increase of weight proportioned to 100 lbs.				Value of Melioration fodder in Federal money.
On 100 lbs. live weight.	On the 12 cwt.	Conservation fodder.	Melioration fodder.	Am't.	Value, at 5 krs. nearly 4 cts. per lb.	Collect'd fodder.	Melioration fodder.	Collected fodder.		Melioration fodder.		
lbs.	lbs.	lbs.	lbs.	lbs.	kreutzers	lbs.	lbs.	fl.	krs.	fl.	krs.	cts.
2½	30	22.2	7.8	0.75	4 2 = 3 1/6 cts	2.3	8.9	—	13 8 =10c.	—	53.4	40
—	—	—	—	1,0	6. = 4½ "	3.3	12.8	—	19 8 =14½	1	16.8	60½
3	36	22.2	13 8	2.0	12.0 = 9 "	5.5	14.4	—	33.0 =25c.	1	26,4	67½
—	—	—	—	2.5	15.0 = 11¼"	6.9	18.0	—	41 4 =31c.	1	48.0	84
3½	42	22.2	19.8	3.2	19 2 = 14 "	7.6	16.1	—	45 6 =34c.	1	36.6	75
—	—	—	—	4.	24. = 18 "	9.5	20.0	—	57 0 =42c.	2	—	96
4	48	22.2	25.8	4.5	27.0 = 20 "	9.3	17.4	—	55 8 =41¾c	1	44.4	81
—	—	—	—	5.	30. = 22½"	10.0	19 3	1	=48c.	1	55.8	90

According to all experience it follows, as to the increase of weight from all the given quantities of fodder:

1. The daily increase of weight for the before-mentioned weight of a fattening ox is 0.75 to 5 lbs.

2. On the 100 lbs. of the entire fodder, (conservation and melioration-fodder) it is 2, 3 to 10 lbs.; and on 100 lbs. of melioration-fodder. on the other hand 9 to 20 lbs.

3. The weight of the beast and the cash-product of the increase rises with the increase of melioration-fodder in so profitable proportions, that even the dearest means of fodder themselves, as melioration-fodder, show themselves so much the more lucrative, as exactly the richest in nourishment, and also animalize themselves, and therefore pass into direct usefulness the sooner, and with an unlike greater part of their natural weight, than the other voluminous materials of fodder.—Tr.]

8. Finally, we must take into consideration the amount of labor which horses and oxen can perform, in a given period, if we would decide respecting the one or the other.

Because horses perform more in the same time than oxen, and are better adapted for many kinds of work; so it not rarely happens that labor is carried on cheaper with horses; a person gains more in the less number of the horse-teams and the men required for them, compared with the greater number of the ox-teams, than the cost of their keeping, and the interest of the out-lying capital.

If the ox-team in a given time performed as much work as the horse-team, it would unquestionably be cheapest to use them for all the work of the farm, and quit the use of horses wholly; but because oxen are much slower in drawing, and a yoke of them, if they are strong and well-trained, will accomplish in favorable circumstances only ¾ or ⅔ of what a good span of farm-horses will; therefore if the keeping of oxen is not unusually cheap, on account of the increased number of teams and of men required to take care of them, there will be greater expense with oxen, than with horses.

[This question has been much discussed by different writers in Germany. Thaer, Vol. I. p. 71, thus states the substance of the arguments for and against.

"*Horses* have an undeniable preference in the following particulars:

"They are suitable for all and every kind of work of land-husbandry, in all ways, and in all weathers. One. therefore when he keeps only horses, is not obliged to choose out work for them, but can use his whole team for any business that occurs, and leave no part of it to stand still.

"They accomplish every kind of work more rapidly, and are more constant. One

can, therefore, not only complete the work in the same time more promptly, but also require a longer day's work of them. Thus the wagon will accomplish more with an equal number of horses than with oxen; although with the usual draught of a load they exert not more power than oxen, yet they overcome by their rapidity of motion and energy, many a short resistance before which oxen stand still.

"In favor of *oxen* are the following:

"They perform the greater part of the works on a farm, as ploughing, and the near carrying of loads, as well as horses do; and one can in a usual day's work, if they are well fed, expect nearly as much from them. They perform the work of ploughing in a certain degree better than horses.

"The cost of them is considerably less. Their purchase, on an average, is not near so high; their harness is much cheaper, their food costs much less, and consists in such things, as on account of its transportation, are not so marketable as the grain, on which horses are kept.

"What is an important particular is: that if they are well taken care of, and not too long kept at work, they lessen not as much in value, but improve for the most part; so that they often sell for more than they at first cost, and thereby soon pay the interest on the standing capital; whereas, on the other hand, the value of the horse soon sinks to nothing, and the capital is wholly exhausted. They are also subject to fewer hazards and casualties.

"They demand less attention, as one ox-herd can take care of 30 oxen, if others work with them by change.

"Finally, they give a greater quantity of excrement, which in general affords a more productive manure than that of horses. Such horses and oxen must be compared, the relation of which in respect to their condition and care, are not unlike, &c.

"There can, therefore, be no doubt, that those labors which can be proportionally well performed by oxen, will be done cheaper with oxen than with horses. If a farm had only such work to be done as is convenient for oxen, and it could be executed with allowing time to rest, &c., then oxen should be used. But if, according to recent experiments, another fodder can be introduced for horses than corn, and thus the expense be lessened, then the question between horses and oxen would probably stand differently."

Vett. has also discussed this question with his usual philosophical accuracy and practical skill; and presents us with the following views in his 2d Vol. pp. 527. &c. After alluding to various experiments by which the cost of a day's work of a horse was found to be from 24.45 kr. to 28.8 kr. (= 18¼ to 21.6 cts.), while that of the ox was 20 kr. (= 15 cts.), he proceeds to compare the two.

In *favor* of *horses* compared with *oxen*, he says:

"1. The horse performs about one-third more labor in a day than the ox; (a horse can, with good treatment, work 10 hours in a day, and in a year 250 to 290 days' work, and his age endure to 16 or 20 years;, and in the pressure of work and unfavorable circumstances of the weather, may more certainly be strained without danger on account of the unusual performance, than can the laboring ox; which is to be reckoned highly, because at the time of sowing the seed in the spring, and in harvesting, a greater part of the results not rarely depend on the despatch of the team at work.

"2. On account of their power and continuance, horses also can be used a greater number of years and of days in the year, for labor, than working oxen.

"3. They can be employed in bad open, stony, uneven ways; in more unfavorable, wet weather; in greater heat; in winter; and for more remote and more rapid carrying of loads, where oxen cannot be used to advantage, because these go more slow, have not so hard a hoof, and show themselves more affected by the influences of the weather.

"4. Horses may be used for many kinds of work in the cultivation of plants, for drawing sowing-machines, shovel and hilling-plough; for treading out grain of different fruits, &c., for which oxen cannot be used.

"5. If one has occasion to avail himself of horses, or provides himself, at the outset, with young strong animals, then they would hold out a long course of years in work, whereby the danger of loss would be avoided, or very greatly diminished; which the frequent change of the team occasions.

"On the other hand, the following are the *disadvantages* of keeping *horses*, or in *favor* of *oxen*:

"1. The outlay of capital is important; greater by one-half than that of working-oxen.

"2. A working-horse uses more, and better fodder, than the working-ox, which increase of the quantity and quality of fodder, other circumstances of the value of fodder being equal, is at least a third part of the food of an ox, which in time of necessity, is satisfied with the smallest quantity and of different quality.

"3. The other costs, of keeping, team-harness, appurtenances of carriage, shoeing, care, repairs of apparatus and buildings, &c., are higher in the same proportion, than for working-oxen.

"4. The horse has, if no more used for labor, no value for use; therefore, the purchase-capital must be recovered from the number of years, whilst the laboring-ox, after his performance of labor, can be fattened with great profit.

"5. On account of their temperament, horses especially, in case of the care of them being neglected, are exposed to many inflammatory complaints. The risk, therefore, is so much the greater, as they are of no value after they are dead. On the contrary, oxen are exposed to fewer illnesses, and for the most part of the asthenic kind, of longer duration, in consequence of which, if danger threatens, they can yet be slaughtered.

"6. The working-horse gives, though he needs more fodder, less manure than the working-ox."

"Hence, from these results the following rules follow:

"1. That in farms where cows are used for the common team-labors of husbandry, none or few oxen should be kept; on the contrary, more horses, and particularly for all those kinds of work which can be performed neither by cows nor oxen with equal profit.

"2. That in countries where horses can be procured to advantage, and many and remote carriages are to be made over the land, and many grounds lie at a distance from the farm-house, the roads and ways are in a bad condition, &c., more horses should be kept than oxen.

"3. That on the contrary, where fattening-fodder is easily produced or obtained, and the fattening of cattle is profitable; or where the proportionate fodder for oxen is easier raised than that for horses, more oxen should be kept than horses; and of these latter, only so many as those labors demand, which cannot be performed by other kinds of working-cattle."

Veit gives also the following as the rate of insurance of the different animals mentioned, which may show how the hazards of exposure to death are viewed by those who have been at pains to ascertain these things:

Oxen	at 1.3 per ct.
Cows	1.2 " "
Three year old kine	1.0 " "
Two year " "	1.1 " "
One " " "	2.0 " "
Cows of different kinds on an average	1.2 " "
Horses	4.9 " "
Sheep	7.7 " "
Swine	2.9 " "

The losses by fatal accidents are different according not only to the different species of cattle, but to different ages: as the following table shows:

LOSS ACCORDING TO PER CENTAGE OF VALUE.

	Horses.	Kine or Cattle.	Sheep.	Swine.
From their birth to their weaning,	5	3	10	12
" weaning to 1 year old,	4	2	8	6
" 1—2 years, - - -	3	2	7	3
" 2—3 " - - - - -	3	1.5	5	3
During the time of being used -	5	2	5	4

Loudon, quoting from the Gentleman Farmer, has the following, among other observations, deserving consideration on this subject, Vol. II. p. 782. "Another objection is, that an ox-team capable of performing the work of two horses, even such kind of work as they can perform, consumes the produce of considerable more land than the horses. If this be the case, it is of no great importance, either to the farmer or the community, whether the land be under oats or under herbage and roots. The only circumstance to be attended to here is, the carcass of the ox; the value of this in stating the consumption of produce must be added to the value of his labor. He consumes from his birth till he goes to the shambles, the produce of a certain number of

acres of land; the return he makes for this is, so much beef, and so many years labor. The consumption of produce must therefore be divided between these two articles. To find the share that should be allotted to each, the first thing is to ascertain how many acres of grass and roots would produce the same weight of beef from an ox, bred and reared for beef alone, and slaughtered at three or four years old. What remains has been consumed in producing labor. The next thing is to compare this consumption with that of the horse, which produces nothing but labor. By this simple test, the question, viewing it upon a broad national ground, must evidently be determined. Every one may easily make such a calculation suited to the circumstances of his farm; none that could be offered would apply to every situation. But it will be found, that even if three oxen were able to do the work of two horses, the advantages in this point of view would still be on the side of the horses; and the first objection (as to being unfit for a variety of labor, exposure to the weather, &c.) applies with undiminished force besides."

Respecting the comparative advantages of horses and oxen, in the British Husbandry, it is given, on high authority, that the work of 107 oxen may be done by 65 horses—and, in some parts of England, it is said, that 5 or 6 oxen are equal to 4 horses. Another person quoted in the work estimates the number of oxen necessary as compared with horses as 3 to 2 on a light soil, or 2 to 1 for heavy soils. BAILEY and CULLEY, in their Comparative Estimate, to which the author of British Husbandry attributes great weight, give it as the result of their conclusions, that 2 horses are equal to 6 oxen in regular work, and to 8 during the first year. In the decision of this question, in respect to the *national value* of either animal, Messrs. BAILEY and CULLEY also say, that a working animal is generally supposed to consume the produce of four acres of good land annually; and as an ox eats ¼ more in weight than the horse, his food is equal to five acres; but as he can be partly fed on straw, he might be maintained on 2½ acres a year, while at work; and 1½ acres will be required to fatten him for the market. Farm horses average for work 12 years; and in that time will wear out four team of oxen used only 3 years each; and supposing 1 horse to be equal to 2 oxen, the land required will be,

1 horse till fit for work - - - - -	6 acres
12 years' work, at 4 acres - - - -	48 "
	54 acres
2 oxen till fit for work, at 5 acres - -	10 acres
3 years' work, at 2½ acres - - - -	15 "
fattening, 1½ acres each - - - -	3 "
This amount 4 times in 12 years,	28 = 112 acres.

The difference then would be 58 acres; but eight fat oxen would, in this time, have been brought to market.

The practice which prevails in this country, as is well known, is different in different sections. In many cases both horses and oxen are used; indeed this is usually the case where the farms are of a moderate size; as persons need horses for their travel from one part of the state or country to another. Horses are more exclusively used in the middle and southern States; oxen more so in the Eastern or New England States.—TR.]

9. Teams of oxen or horses are two or more spanned.

10. The number of animals required for a team, must be determined by the difference of the strength of the animals, and the burden or weight they have to overcome.

11. Most kinds of labor of the household (Hausehalt) demand no greater exertion of strength than 2 stout oxen or horses can supply; and since 2 beasts costs less to keep than 4, and one man only is needed to take care of them; therefore it is self-evident, that the use of the two-spanned team is preferable to that of more.

[By a *span*, the author means a single animal; thus two span is with us a one-yoked team; four spanned, a two yoked one, and so on. Sometimes 3 are used together, 2 nearest the plough or cart, and 1 before them; this is called a three spanned team.—TR.]

12. Hence is clear the necessity of providing a good, strong, and well-fed team, which costs more at the first, and must be better fed; but which also gives a greater profit by its greater labor, and by the saving in the number of beasts and men, than a weak, small, and poorly fed one.

Where the breed of the beasts of labor is small, but the soil heavy and binding, there indeed it is necessary to use 4 or 6 or more span before the plough; we often find 4. 6, and yet more yoked together, even when the beasts are large and strong, or the soil easy and mellow; and then there is a waste of power, and greater means are applied to the attainment of the object, than are necessary. In many countries it belongs to respectability, and is thought to be a mark of being well off, to plough with and drive 4 stout horses, or 4 and 6 great oxen, and it is considered mean to have only 2; so that for the sake of this satisfaction, one is contented to sacrifice a portion of the profits of his farm. There are few kinds of work which cannot be performed with 2 good beasts of draught, either horses or oxen. Such exceptions are, the breaking up of clover, or those lands which have lain fallow for a number of years, in clayey soil, and the driving the plough to an unusual depth. All other kinds of work can be performed with 2 span. When it is thought that 4 beasts paired work as quick as 2, because each one has to overcome less resistance, this is an error. The 4-span goes somewhat quicker, it is true, in the furrow, but does not double so quickly; and since the turning about of a 4-spanned team needs more time than a double span, so the quickness of the former, compared with the latter, is. on the whole, by no means greater; it is often less. Arthur Young laid a wager with Lord Egremont that, with 2 oxen and one man, he would plough more in a day than his competitor could do with 6 oxen and two men; and he won (Begtrup A. a. C. II. Th. 39); though we would not maintain, that in all circumstances, a person with 2 oxen would be in a situation to plough up a greater extent of ground to the same depth. Mr. Young probably had a pair of ten year old, well-trained, and very powerful beasts, an able, trusty man, well acquainted with his oxen, with a suitably constructed, sharp, cutting plough, whilst his competitor had a less skilful ploughman, or a badly made plough. The turning about of a 6-span, on account of the greater circuit that must be made, requires much time; and with 6 beasts, their stopping to urine must be double that in the case of two only.

13. If a man has a pair of good *horses* in ploughing, and the plough is well made, and conveniently arranged, he will plough, in a moderately tight soil, in 9 hours one yoke (= 1.422 acres), if the plough goes no deeper than 4 or 5 inches, and the furrow-slices are not made narrower than 10 or 11 inches, and the beds are 12 to 14-furrowed. If the soil is binding, he can only plough $\frac{3}{4}$ of a yoke.

14. In like circumstances, one may plough in the same time with an equal number of *oxen* $\frac{1}{4}$ to $\frac{1}{3}$ less.

If a person labors with a change of oxen, he might, as may be easily conceived, plough as much in a day, as with horses, indeed probably more; since if he changes the ox-teams once in the day, he could labor more time with the two teams than if the same team were kept yoked up through the whole forenoon and afternoon; and at least there are 10 hours in which one works with two teams. Since the same are more rested they are fresher and stronger.

If the change is three times, then a man labors from 12 to 14 hours, and ploughs somewhat more than with one pair of horses. But that with a given number of oxen, one must plough more in a given time if he works them with changes of teams instead of one team and without change, we need not believe; much more certain is it that a man ploughs more if he makes each team work 9 hours, than if he works them only 4 to 5 hours; though in this time he is somewhat fresher. The advantage of the change of oxen consists in the sparing of men and in the better condition of the working-oxen, on leaving off; since if the team is not changed the man labors at the plough together with the driver only 8 or 9 hours in the day; whereas, with the change of team, the oxen are brought to them and both continue in the field from early dawn till nightfall, during which time the plough is constantly going. It seems to me, therefore, that this saving may be over-balanced by the greater necessity of working-oxen, even if I allow, that the beasts after the time of ploughing may

look better than if they are not so changed The correctness of this position will be shown most admirably by a comparison of the number of cattle for teams required in Brandenburg, where they change with three oxen at the plough three times—with that of Thuringia where they labor with the same team all day. See THAER'S ANNALS, Vol. IV. pp. 660.

15. If the field is already ploughed and has not yet become hard, or if a person makes furrows of only 3 to 4 inches depth, one might easily plough up more land in a day.

The Fröhner in some parts of Austria and Hungary, are obliged to plough up with their poor horses 2000 square cords (klafters); the peasants in Prussia 1800 square cords in a day. How such furrows look may be easily imagined.

[As a square klafter is 1600th part of a yoke, 2000 square klafters are equal to somewhat more than $1\frac{3}{4}$ acres, and 1800 klafters equal to $1\frac{1}{2}$ acres English. On p. 11, a klafter was computed at $4\frac{1}{2}$ sq. yards; it is however nearer 5 sq. yds. English.—TR.]

16. The longer the field is, the more can be ploughed of an equal depth of furrow, because a man loses less time in turning about. The narrower the beds of the field are, the more can one plough up, because a greater space of the field between the furrows of the beginning of the field (Anfangs-furchen) is left unploughed, than if the beds are broad; and a man can work over more land with a Hacken (another kind of plough), than with a common plough, because the furrows made by the Hacken are 12—14 inches broad, and only a part of the land is turned over.

If the field is 100° (klafters) long, then 16° breadth will give a yoke (1.422 acres). If the furrows be made 11 inches broad, and a person plough in a 24-furrowed bed, there will be 4.354 beds. Should a man plough the field wholly even with with a Norisch, or hill-side plough, then 104 furrows would be necessary. But because here for each bed two furrows are to be deducted, which lie as unploughed land in the centre of the bed; so there would be needed to be made only 95.3 furrows. For every turning about on an average one minute at least must be allowed, partly to make the circuit and partly to allow the beasts to urine, to right the plough, &c., by which 95 minutes are lost. The day's work consists of 9 hours; there remains therefore for forming the furrows $7\frac{1}{2}$ hours, and since 95.3 furrows each 100 klafters (= about 600 feet) long, contain 9530 klafters, and $7\frac{1}{2}$ hours contain 25,800 seconds, therefore the beasts must proceed at the rate of a klafter's length (about 6 feet) in 2.7 seconds. If a man plough in 4-furrowed beds, there are then on a breadth of 66 inches, only 4 furrows, i. e. $\frac{1}{3}$ of the plough-land is not ploughed, and from 104 furrows 34 must be deducted; there remains then to be ploughed only $69\frac{1}{3}$ furrows; i. e. 7133 klafters furrow-length, which with equal activity of the beasts a person can plough in $5\frac{1}{2}$ hours. If for the same space, $7\frac{1}{2}$ hours are taken; then the beasts should go about $\frac{1}{3}$ slower and employ $3\frac{1}{4}$ seconds on the length of a klafter (about 6 feet); or should they go as rapidly, they would plough about $\frac{1}{3}$ more, i. e. 2133 square klafters.

[The fields under cultivation by the plough, &c., in Germany, are most generally divided into beds, and as they are successively ploughed up, what one year was the centre of the bed, the next year becomes the edge of one, while the edge of the previous year becomes the centre of the next. It is evident, therefore, that in the centre of each new bed there will be two furrows' width, which will be covered over by the furrows turned on them from opposite sides; for each bed then, as our Author says, there must be deducted 2 furrows' width, and as by his supposition of 24-furrowed beds there were 4 beds and a fraction over in the 104 furrows, he deducts above, the width 8 and a fraction, from the 104 furrows. As the estimates by klafters in the preceding statement is merely proportional, the reduction to our measure did not seem always necessary; the data are furnished in the Translator's Note under 15, and also in the Table of Weights and Measures, subjoined to this work.

On the subjects embraced in the preceding paragraphs numbered 9—16, there are some particulars gathered from VEIT, THAER, and others, which may be introduced here. With reference to the day's work of a span, VEIT says that "according to the rule" of economical management, &c.

"In the summer it should be: in the forenoon, from 6—11; afternoon, from 11—6. in the winter from 7 or 7½ to 11 A. M.; and from 1 to 4½ or 5 P. M."

The exception is in the time of pressing work. He also says that in ploughing in very difficult circumstances a one-horse-span can plough in a day ½ to ⅞ of a morgen (= ⅞ to ⅞ acre), and a one-ox-span ⅘ to ½ (= ½ to ⅝ acre) and in circumstances which lighten or accelerate the labor of ploughing, a one-horse-span can plough in a day 1¼ to 1¾ of a morgen (= 1 ⅛ to about 1½ acres), and an ox-span ¾ to 1¼ of a morgen (= ⅝ to 1 ⅛ acres). "Where the field, as is the case in most parts of Bavaria, is ploughed in 4-furrowed beds other things being equal, the labor of ploughing is more assisted than in broader beds; of this portion, the first two furrow-slices are laid together by the so-called bordering of the furrows upon each other, whereby these furrows are left unploughed. With a one-horse span, therefore, a man can plough 1½ to 2 morgen (= 1½ to 1¾ acre) and by employing the double plough for dividing the ridge, one of the usual 4 furrows will be saved."

THAER says: "Opinions are very different as to how much a plough can perform daily. Some say only ⅓ of a yoke, (⅓ of an acre) others 1 and even 1¼ (1.422 to nearly 2 acres), according to their experience. Each one is grounded on experience, but a man must weigh the circumstances whereby he comes to his conclusion. The breadth of the furrow-slices makes an important difference. If on a bout of 60 klafters (360 feet) broad I cut off 6 inch furrows, I have to make 720 furrows: but if 10 inch furrows, only 432 furrows. I will suppose such a bout of 60 klafters (360 feet) long, then a span in ploughing the same, in the first case, goes over 10½ geographical miles, but in the second case only 6¾ miles without the turnings. The labor which a plough can perform in a day, then must stand in an inverse ratio with the breadth of the furrows, which a man must closely examine. In the usual mode of ploughing on soil of average kind, 9-inch furrows are used; and the plough in 2¼ yokes (3.2 acres) goes over 23,800 klafters (172.800 feet = 30 miles), or 7½ geographical miles. According to the breadth of the piece compared with the length, the turns are more or less frequent and stronger or weaker; yet they must for the most part be so performed that we must suppose 7½ miles. When therefore a plough with this breadth of furrows, ploughs daily 1⅛ yoke (1.6 acres), the team and the man go 3¾ miles (about 17 English miles); and one could not desire more in labor, enduring the whole day. But if a man make smaller furrows, he must expect less, and can only demand more where the furrows are broader."

In forming the estimate, he mentions as necessary to be regarded, also, the quality of the soil, the depth of the furrow, the situation on a level or on hilly ground, the kind of plough, the time of the year on account of the length of the days, &c. The result of many experiments shows that a plough with a share of 5 inches broad, is a half-hundred weight harder for draught than 7 inches broad. LOUDON says: "With respect to ploughing relatively to time, in the strongest lands, a pair of good horses ought to plough ¾ of an acre in 9 hours; but upon the same land, after the first ploughing, on friable soils, one acre, or an acre and a quarter is a common day's work. Throughout the year an acre a day may be considered as a full average on soils of a medium consistency. The whole series of furrows on an English statute acre, supposing each to be 9 inches broad, would extend to 19,360 yards, and adding 12 yards to every 220 for the ground travelled over in turning, the whole work of an acre, may be estimated at 20,416 yards, or 11 miles and nearly 5 furlongs."

In the Supplement to the Encyclopedia Britannica, it is stated that a two-horse plough may on an average work an English acre a day throughout the year, and in general according to the nature of the soil and the labor previously bestowed upon it, a pair of horses in ploughing may travel daily 10 to 15 miles, overcoming a degree of resistance equal to from 4 to 600 weight.

Sir JOHN SINCLAIR, in his Code of Agriculture, also furnishes some interesting statements on this subject. He says: "A gentleman who has paid much successful attention to several branches of husbandry, calculates that the number of yards travelled in ploughing an acre and a half

with a furrow-slice of	9	inches, is	29,040 yards
"	8	"	32,640 "

The following Tables are given from the same authority, founded on the above principle of calculation.

Tables showing the Quantity of ground ploughed according to the different breadths of the furrow slices and the rates of the horses' walking.

Breadth of the Furrow Slice.	Rate per hour.		Length of the way travelled in ploughing.	Quantity of the ground ploughed.	
Inch	Mls.	Fur.	Yards	R'ds.	Poles.
8	1	—	14,144	2	24
9	—	—	14,157	2	37
10	—	—	14 148	3	11
11	—	—	14,157	3	22
The rate of walking being one mile and half a furlong.					
8	1	½	14,960	2	36
9	—	—	15 004	3	4
10	—	—	15,012	3	19
11	—	—	15,048	3	32
The rate of walking being one mile four furlongs.					
8	1	4	21,216	3	36
9	—	—	21,120	4	14
10	—	—	21,168	4	35
11	—	—	21,186	5	14

Breadth of the Furrow Slice.	Rate per hour.		Length of the way travelled in ploughing.	Quantity of the ground ploughed.	
Inch	Mls.	Fur.	Yards.	R'ds.	Poles.
8	2	—	28.168	5	7
9	—	—	28,193	5	33
10	—	—	28,188	6	21
11	—	—	28,215	7	5
The rate of walking being three miles.					
8	3	—	42,296	7	31
9	—	—	42 350	1	30
10	—	—	52,336	9	32
11	—	—	42,273	10	27
The rate of walking being four miles.					
8	4	—	56.336	10	14
9	—	—	56,386	11	26
10	—	—	56,376	13	2
11	—	—	56,430	14	10

It is supposed that in England, in general, the common breadth of the furrow-slice is about 9 inches; but the generality of the farmers in Norfolk, for various reasons, prefer having their furrow-slices full 11 inches broad, so that the quantity of the ground stirred in the same number of hours worked by them, must be considerably more than farmers in other districts can do, where the nature of the soil requires to have the furrow-slice of a narrower breadth. The effect of short ridges, and consequently of frequent turnings, is most strikingly exemplified in the following table, drawn up by the same gentleman from actual experiment.

Names of the Fields.	Length of Ridges.	Breadth to give an acre.	Breadth of the Furrow Slice.	Number of the furrows in the acre.	Time taken in turning.	Time taken up in stirring the soil.	Number of hours in the day's work.
	Yards.	Feet.	Inches		H. M.	H. M.	H. M.
7. South Gubbet	78	186	8	279	4.39	3.21	8.0
3. East Loch	149	98	—	147	2.27	5.33	8.0
11. Harperhill	200	73	—	109	1.49	6.11	8.0
2. South Muir	212	69	—	103	1.43	6.17	8.0
17. Long Bog Croft	274	53	—	79	1.19	6.41	8.0

Thus it appears, when ridges are 78 yards in length, that no less a space of time than 4 hours and 39 minutes is spent in turnings, in a journey of 8 hours; whereas, when ridges are 274 yards long, 1 hour 19 minutes is sufficient in the same length of time."

The following estimates as to amount of land which can be ploughed, &c., are taken from the British Husbandry. The author of that work says, that according to the common calculation for the year round, 1 acre of average soil may be ploughed in a day; 1½ acres is the utmost with a common furrow on any soil, and an average of 1 acre to 1¼ in summer, and ¾ of an acre in winter is a fair day's work with a team; elsewhere also he gives ¾ of an acre as a fair average daily. As to the ground gone over in ploughing an acre, he asserts that with a broad furrow-slice it equals about 11 miles, or with one of 8 inches 12 miles and 3 furlongs, exclusive of

turnings; and a team walking at different rates of $1\frac{1}{2}$ to 2 miles per hour will plough to the depth of 5 inches the following quantity in 9 hours:

	acre.	rood.	poles.
Rreadth of furrow 8 inches at $1\frac{1}{2}$ mile per hour	1	—	—
" " 9 " " " "	1	—	20
" " 8 " 2 "	1	1	10
" " 9 " " "	1	2	0

The distance at a slow pace is only 12, while at a quicker rate it is 16 miles.

In relation to ploughs, BURGER in Vol. I. p. 216, quotes from Arthur Young's Annals of Agriculture, a series of experiments to determine the necessary power which needs to be employed with different ploughs. The experiments were made under direction of a Committee of Agriculture of the London Society of the Arts.

"1. With the Rotherham plough which weighed 96.6 lbs. with a share of 7.71 inches, on a clover-field in a heavy clay soil at the depth of 5.78 inches and 9.63 inches breadth, good work, the power requisite was 498,3 lbs.

"2. With the same plough at the depth of 3.85 inches, with equal breadth, good work, 385 lbs.

"3. With the same, with a share of only 4.81 inches, at 9.63 inches breadth and 5.78 inches depth, very bad work, because the share was so small, 498.3 lbs.

"The experiments 1 and 3 differ only in the breadth of the share, and prove the advantage of the larger breadth.

"4. Brand's iron plough, full weight $129\frac{1}{2}$ lbs. The furrows were 5.78 inches deep and 9.63 inches breadth, good work, 546 lbs.

"5. Arbuthnot's red plough, weighing 118 lbs. needed in similar circumstances 475 lbs.

"6. The same plough loaded with 10.8 lbs. in order to render it like No. 4, in the same circumstances, 430 lbs.

"A proof that the share of the plough does not always hinder its advance. But how the same plough loaded with 10.8 lbs., with like depth should require less power, I cannot conceive, and suppose that here must have been an error of the observation.

7. The usual Surreyer plough weighing 125 lbs. The share is forwards 6.26 inches, behind 12 inches broad. The breadth and depth of the furrows as No. 1, 3, 4, 5, 6. The furrows were not cut up on the ground; power, 611 lbs.

8. The same loaded with $4\frac{1}{2}$ lbs. in like circumstances 566 lbs.

9. Arbuthnot's blue plough weighing 108.7 lbs. Necessary power in like circumstances, 430 lbs.

10. The same plough loaded with 25.3 lbs., in like circumstances, needs 475 lbs.

11. Ducket's cutting plough weighing, with appurtenance, 240.9 lbs.; the furrows were 7.71 inches broad, and 5.71 inches deep: power, 588 lbs.

12. Arbuthnot's blue plough (No. 9), loaded with 132.2 lbs. to make it equal to Ducket's, in 9.63 inches breadth, and 5.78 inches depth of furrows, needed 453 lbs.

From these experiments it is clear how much cultivation depends on the plough, that one in like circumstances demands more power than another. With Arbuthnot's plough No. 9, not loaded, with a breadth of furrow, of 9.63 inches, only 430 lbs. power were required; the same loaded with 132.2 lbs. required 453 lbs. for equal breadth and depth, whilst Ducket's plough, with a less breadth of furrow of 0.92 inches, required 588 lbs., therefore, about 158 lbs. more than the first. If we reckon 200 lbs. to a horse, this is a waste of power of 158 lbs. = to 0.79 of a horse. That the same, if loaded, demanded more power, is shown by this experiment.

I take this opportunity to mention the experiments of DOMBASLE, concerning the influence of the weight of the plough on the necessary power required for its progress, which he found wholly insignificant, since the Dynamometer showed no difference when the same plough weighing 107–114 lbs. was gradually loaded with 89 to 133 lbs. if the weight was always laid on the point of weight of the plough.

The greatest part of the resistance which the plough opposes to the animals is occasioned by the pressing in of the share and the coulter into the earth, that is, the cutting off the furrow-slice of earth; since the resistance would only be slightly diminished, were the mould-board in the same plough wholly thrown away. The remainder of the power is used if the plough is joined to the mould-board, to heave up the loosened clods of earth, to shove them aside and to turn them, and here will take place a friction between the clods of earth and the different parts of the mould-board, which takes off part of the moving power. But since this motion advances from

below upward, hence it is impossible to conceive how the weight of the plough can serve for this purpose to increase the resistance which proceeds from it. Of experiments of my own:

1. In an easy, sandy soil, in turning over a stubble field of rye, the breadth of the furrows uniformly 11 inches:

With the Norisch (a hill-side plough), depth	$4\frac{1}{2}$	inches,	required	290	to	309 lbs.
" " "	$5\frac{1}{2}$	"	"	328	"	340 "
Plough in common use . . "	6	"	"	430		"

In the comparison, was then taken the Hacken (another kind of plough), since it would answer to show the difference of power and effect between these two instruments.

The Hacken required on . .	$4\frac{1}{4}$	inches depth	340		lbs.
" " "	$4\frac{3}{4}$	"	"	362	"
" " "	$5\frac{3}{4}$	"	"	445—485	"

2. In a moist, sandy marl soil, similar experiments were also tried:

The plough required in . . .	$5\frac{3}{4}$	inches depth,	435	lbs.	
" " "	8	"	"	645	"
" " "	10	"	"	790	"
The Hacken "	$5\frac{3}{4}$	"	"	518	"
" " "	7	"	"	545	"

The ploughs here mentioned were rather imperfect and therefore needed more power than was required in the first English experiments on a fallow field."

The ploughs in Germany are poor compared to those of England and in this country: various experiments have been tried in this country in different places to determine the merits of many of the ploughs which lay claim to public favor; the results of which have been published in the Agricultural Journals. I have quoted the above on account of the deductions our Author makes from them. The Hacken above alluded to, he describes to be a plough which forms a complete wedge, its share being an isosocles triangle, or with two equal sides, which must always turn furrow slices one over the other, in the same direction, and hence its share cuts on both sides, and it has two strickles or strike-boards, which work alternately. The Norisch plough has a small-mould board that hangs on the sole, and seems to be a hill-side plough as it derives its name from the old Noricum, a mountainous region where it is in use.

In WILKINSON's Agricultural Mechanics, p. 161, it is stated, that the strain of the draught upon a plough is calculated according to the square of whatever portion is under ground; thus where only 3 inches are buried, the pressure will be only 9; but if the furrow be carried to the depth of 6 inches, it will be 36.

The following result of the trial of several ploughs, given in the Agricultural Transactions of the ESSEX CO. SOCIETY, MASS. for 1842, is confined to ploughs by two manufacturers:

No	Description of Plough.	Power applied.	Depth of furrow.	Width of furrow.	Earth turned	Result.	Earth turned by 100 lbs. of horse power.
1.	Prouty & Co. A.	35	$6\frac{1}{4}$	$12\frac{3}{4}$	80	2 28	$18\frac{1}{3}$
2.	" " B.	33	6	12	72	2.19	$17\frac{1}{3}$
3.	" " C.	31	6	10	60	1.94	$15\frac{1}{2}$
4.	" " C.	36	$5\frac{3}{4}$	10	58	1.61	13
5.	" " A.	34	6	13	78	2.30	$18\frac{1}{3}$
6.	" " A.	37	6	$13\frac{1}{4}$	80	2.16	15
"	" " "	44	$7\frac{1}{4}$	13	94	2.14	17
	Ruggles & Co.'s						
7.	Sward C.	33	6	12	72	2.19	$17\frac{1}{2}$
8.	" "	40	$7\frac{1}{4}$	13	94	2.35	$18\frac{4}{5}$
"	" Eagle	33	6	11	66	2.00	16
9.	" Sward D.	$33\frac{1}{2}$	6	$11\frac{1}{2}$	69	2.06	$16\frac{1}{2}$
10.	" Eagle	33	6	$10\frac{3}{4}$	65	1.99	$15\frac{3}{4}$

The ploughing was by oxen; the numbers in the column of power applied, indicate the 8ths of 100 lbs. The number of square inches of earth turned, is ascertained by multiplying the width and depth of the furrow together, and the proportionate result is ascertained by dividing the quantity of earth turned by the power applied."—TR.]

17. If for ploughing, oxen are more adapted on account of their steady, uniform draught, than spirited and impatient horses; yet the latter, on account of their more rapid movement, are much better fitted for *harrowing*, because not only the pressure, but also the jog of the instrument must here operate.

If the harrow is slowly drawn over the field, the clods of earth lying on the surface will be pushed one side by the teeth of the harrow, and only the deeper earth, or the larger masses be broken up. But let the harrow be drawn quickly, its jog will effect more than its pressure for reducing the clods and masses.

18. According to the difference of the compactness of the soil, and the depth to which one wishes to loosen the surface, sometimes more, sometimes less time and power will be requisite in harrowing.

It is usual to harrow with one horse, or two or more horses or oxen, according as the soil is mellow or binding; according to the time that has elapsed since it was ploughed; and whether the field is to be loosed deeply or not.

19. When the harrow only goes once in the same line, one can, with horses, in a not very binding soil, or not filled with weeds, harrow up $4\frac{1}{2}$ yokes (6.39 acres) in 9 hours.

The above given (See 16) yoke of land was 16 klafters broad; and since the one-spanned harrow is 3 schuh (not quite 3 feet) broad, we need only make 32 streaks to harrow over the field once. If we reckon 32 turns to one minute, and the line of draught of 3200 klafters' length at the rate of $1\frac{1}{2}$ seconds for a klafter (6 feet), because the harrow can be drawn twice as swift as the plough, we shall need for harrowing one yoke of land (not quite $1\frac{1}{2}$ acres), taking in also the turns 1 hour and 52 minutes, in round numbers, 2 hours time. If we use a double or more spanned harrow in a similar field, according to the proportion of the breadth of the instrument and less resistance which is taken away from the animals, we could probably go over 6 yokes ($8\frac{1}{2}$ acres) once in 9 hours.

One-spanned harrows can only serve in heavy soil for covering over the seed, but in loose soil in the same time for harrowing up the ploughed field. More than two beasts are needed only with the great harrow, which has the slope of the teeth pointing forwards.

[Thaer, speaking of harrowing, says: "The difference is greater in this than in ploughing. This arises from the degree of carefulness and the character of the instrument with which this important work is done. The round harrowing is the most difficult kind, and of this a 4-span can perform at the highest 7 yokes (nearly 10 acres). On binding and grassy soils, one must content himself with 6 yokes ($8\frac{1}{2}$ acres). If we refer to even harrowing and not the breaking up of the clods, one might accomplish 9 yokes (12.8 acres). If the harrow is merely drawn along once, with 4 horses in a day a man might go over 11 to $12\frac{1}{2}$ yokes (15.6 to 17.8 acres)."

Veit reckons for harrowing about 4 morgen on an average ($3\frac{1}{3}$ acres) per day. As Veit's estimate is for one beast, it does not differ much from Burger's. Elsewhere he says: "With the usual harrow, a man will go over in a day 5 to 6 morgen ($4\frac{1}{6}$ to 5 acres)."

Sir John Sinclair says: "In Norfolk it is the custom to walk the horses against the rise if any, and trot them back again in the same place. The quantity done in this way is about 7 acres per day. In Scotland, a man and a pair of horses will do a single *tine*, as it is called, to the extent of 10 acres, and if a double *tine* only 5 acres per day."—Tr.]

20. With the three-shared extirpator, or the hilling plough, two men will hoe with 1 horse a yoke (nearly $1\frac{1}{2}$ acres) in 3 hours. With the straight eleven-shared extirpator in easy soil 2, and in heavy soil 4 beasts and two men will loosen up a yoke in 2 hours, but with the oblique seven-shared extirpator for 2 horses, 3 hours are required for a yoke.

[Veit says, that with a nine-shared extirpator with 4 oxen and two men, on a soil not very binding or weedy, in a day they may hoe 5 morgen ($4\frac{1}{6}$ acres) per day.

On a close weedy soil, it will take them the same time to do 3 to 4 morgen ($2\frac{1}{2}$ to $3\frac{1}{3}$ acres).—TR.]

21. The labors of carrying out manure, of the harvest, of going for wood and to market, cannot be estimated in general, but are very easily so for a given case; because the distance of the fields, meadows, and woods as well as the market from the farm-houses, the condition of the roads, the even or mountainous locality, &c., determine the length of time which must be employed for this purpose.

[The labor of a horse in a day according to Professor LESLIE is commonly reckoned equal to that of five men, but he works only 8 hours, while a man easily continues his exertions for 10 hours. The power of traction of horses seldom exceeds 144 lbs., but they can carry more than 6 times as much weight. The pack-horses in Yorkshire transport loads of 420 lbs. over a hilly country; but in many parts of England the mill-horses will carry to a short distance 910 lbs. This is about the same that the porters of Constantinople are said sometimes to carry. According to experienced carters, in a load of 20 cwt., 5 cwt. but not more, may be made to rest on the back of the horse by means of the traces, chain and saddle. In the SUPPLEMENT to the ENCYCLOPEDIA BRITANNICA, it is said, "On a well made road, two horses will draw about a ton in a two-wheeled-cart for 20 or 25 miles every day."

VEIT'S estimates respecting labor in carrying manure, the harvest, &c., have already been given, to which the reader is referred on pp. 15—18. For carrying wood, and other fuel, THAER says: "We usually reckon at from 1 to $1\frac{1}{2}$ miles ($4\frac{1}{2}$ to $6\frac{3}{4}$ English miles) distance, 1 klafter of wood for a 4-spanned load; at a greater distance only $\frac{3}{4}$ klafter; at the distance of half a mile 2 loads daily." A klafter of wood is 6 feet long, 6 feet broad and 3 feet high, consequently 108 cubic feet. A German mile is $4\frac{1}{2}$ miles English.—TR.]

22. The number of beasts of labor necessary for conducting the household (Hausehalt), therefore depends in every farm on the kind and nature of the same; on the mode of husbandry; on the nature of the soil; on the various parts of husbandry taken collectively; and on the climate.

23. One needs more oxen than horses; more small or weak than great and strong cattle; more teams are required where one cultivates a great variety of fruits, especially of fruits that must be tilled by the Hacken; less on the three-field (Dreifeld) system, still less on the natural grass-growth (Egarten) husbandry; more in clayey soils, less in the sandy; more, too, when the fields and meadows are wide apart from each other, than when near together; and where the climate limits the sowing of the winter-grain to 6 weeks, a man must use one half more teams than where there are 12 weeks for the same purpose.

If any one will examine the actual state of the beasts of labor in different countries and in different circumstances, he will find these propositions to be true.

In a farm of mellow soil which has no fallow, and where they devote the 6th or 8th part of their fields to fruit to be cultivated by the Hacken, in which moreover is raised on stubble ground of winter-wheat, buckwheat, turnips and mixed fodder, we usually reckon with us 8 moderate sized horses for 100 yokes of plough-land (= 142.2 acres), but if the climate is colder and no stubble-crops are cultivated, 10 or 12 horses or the same proportion of oxen, must be kept.

The Hungerborn estate in Carinthia on 60 yokes ($85\frac{1}{3}$ acres) of plough-land, and 30 yokes ($42\frac{2}{3}$ acres) of meadow, had 2 horses, 6 oxen, and 2 three-year old oxen.

Krug had on 54 yokes of plough-land (76 acres) and 30 yokes ($42\frac{2}{3}$ acres) of meadow, 8 oxen, and 2 three-year olds. A moderately mountainous, cool, moist situation and a mellow soil.

Karlsberg, on 90 yokes of plough-land (nearly 128 acres), and 40 yokes of meadow-land ($56\frac{8}{10}\frac{5}{0}$ acres), had 4 horses and 8 oxen. Marly soil, warm exposure.

Wiesenau, on 75 yokes ($106\frac{6}{10}\frac{5}{0}$ acres) of plough-land, and 45 yokes of meadow (64 acres), kept 2 horses and 10 oxen. Soil mellow, situation cold.

Rogeis, in Steirmark, on 100 yokes (142.2 acres) of plough-land and 12 of meadow (17 acres), had 4 horses, 6 oxen. Mellow soil, warm exposure.

In the Netherlands, says BALSAMO, quoted by SCHWERTZ, they allow for conducting agriculture, on an average 5 Bunder, equal to $11\frac{1}{4}$ yokes (from 15 to 16 acres) for a horse. In Tournay, a farm of $112\frac{1}{2}$ yokes ($159\frac{3}{4}$ acres) had 10 working horses. In Ath, on 135 yokes 192 acres), there were 12 horses; another farmer held 6 horses necessary for 30 Bunder, equal to $67\frac{1}{2}$ yokes (96 acres). The farm of Von Lille, at Voorde, had 8 horses for 40 Bunder, equal to 90 yokes (128 acres). In the region of Contigh, they allow for 10 Bunder of plough-land, equal to $22\frac{1}{2}$ yokes (32 acres) 2 horses.

The peasantry farms in South Germany, in Alsace, and also in the Netherlands, where they have no fallows, keep a proportionally greater number of cattle for teams than the larger estates. In Alsace (Alsace Husbandry, p. 47), SCHWERTZ reckons one horse to $5\frac{1}{4}$ yokes ($7\frac{3}{4}$ acres). In Carinthia, in the warmer parts of the country, for 10 yokes (14.22 acres) of plough land, there are 2 oxen and 1 horse; and in the cold regions, and with natural grass growth (Egarten) husbandry, and numerous pastures, they reckon 4 oxen. But where fallowing is practised, few cattle are found. In Marchfield, in Austria, on an average there are 2 horses to 24 to 30 yokes (34 to $42\frac{2}{3}$ acres). So, too, in Bohemia, on 30 to 35 yokes ($42\frac{2}{3}$ to nearly 50 acres) of plough land, there are only 2 horses, although the peasants when they hold the whole fief must give up two days in Austria, and in Bohemia 3 days of the week as Frohner, or to soccage service.

In England they have, in the similar circumstances, more team-cattle than in Germany, because the climate allows of the cultivation of the soil nearly the whole year, and a greater part of their fields are temporarily used for meadow and pasture.

Mr. Bloomfield, in Norfolk, had, on $563\frac{1}{2}$ yokes of plough-land (793 acres) only 16 farm horses; but Mr. Hunter of Tynnefield, in Scotland, had 16 on 405.9 yokes (434 acres); he could plough through the whole winter, and sow winter wheat in the clover stubble field, from the middle of January to the 12th of March. In the vicinity of London they allow on 70 yokes (100 acres) of plough-land, and a proportional quantity of meadow, as with us, 6 horses.—(Begtrup II. p. 161.)

Dickson quotes many estimates as to how many team-cattle one requires in different descriptions of farming. With 2 horses and 4 oxen, often 70, often 140, and more yokes (100 or 200 acres) of plough land are cultivated.

THAER, in his estimates of labor on an assumed extent of 444 yokes ($621\frac{1}{2}$ acres) of plough-land, and $62\frac{1}{2}$ yokes (85 acres) of meadow, and 133 yokes ($189\frac{1}{10}$ acres) of pasture, cultivated on the threefield (Dreifield) system, allows 15 horses; on 100 yokes (142 2 acres) $3\frac{3}{5}$ horses. In the 8-division-Koppel system, he reckons for $552\frac{1}{3}$ yokes of plough-land ($787\frac{1}{2}$ acres), $66\frac{2}{3}$ yokes of meadow (85 acres) and 44.4 yokes of pasture (62 acres), 12 horses to be sufficient, or on 100 yokes of plough-land (142.2 acres), $2\frac{1}{4}$ horses, and for the same extent, on the system of the rotation of crops in 7 to 11 divisions which is connected with stall-feeding, he considers 17 horses to be sufficient, which is for 100 yokes (142.2 acres) $3\frac{1}{5}$ horses, and thus less in number than on the threefield (Dreifield) system.

It appears to me impossible, with so little team, to manage plough-land in Germany.

I regret that I cannot give from my own experience a closer estimate of the number of team-cattle, on a cultivated extent, because my particular circumstances make a greater number of horses necessary than the conduct of a farm requires. But I am entirely convinced I could succeed now with 7 horses on 100 yokes (142.2 acres) of plough-land, with 30 yokes ($42\frac{2}{3}$ acres) of meadow, although I should cultivate the 5th part of the field that required to be tilled, with a Hacken: as maize (Indian corn), potatoes, Swedish turnips, and on the stubble of winter rye, buckwheat, turnips, maize, and mixed fodder. But the soil is very easy, loamy sand, and the fields and meadows are near the house.

[It may be well here to introduce, for the sake of comparison, a few estimates respecting the subjects above mentioned, from the BRITISH HUSBANDRY: they include, also, the number of men, &c.:—

On 150 acres were 4 plough-horses, 1 hack-horse, two ploughmen, one common or jobbing laborer. two laborers, one boy, two women.

On another of 200 acres, 6 draught-horses, 2 young ones, 2 draught-oxen, 2 steers, four men constantly employed, two boys, and two women, and extra laborers in time of harvest.

On 500 acres, in Scotland, as appears from the Quarterly Journal of Agriculture,

14 draught-horses, 1 saddle-horse, nine men regularly employed, nine women 150 days, two domestic servants, and extra laborers in the harvest.

On 650 acres of arable land, 7 pairs of horses, and a pair of mares in foal, and 1 pair of young horses.

Again it is said, that one team is usually sufficient for from 40 to 50 acres of heavy soil, or 50 to 60 acres of lighter soil. Elsewhere on 150 to 200 acres of plough-land, there were 12 to 16 oxen; and on a farm of 150 to 200 acres, 4 horses, and of from 50 to 60 acres, about 3 horses.

It is also said, p. 122 of Vol. I. of the same work: "Each plough-team must have a ploughman, if 4 horses, or a proportionate number of oxen, be used together; and they must have a driver; if in pairs, two ploughmen; but in the former case, one man and boy are sufficient; and in the latter, two men are required, a carter and ploughman, and his mate. These, with a constant day-laborer, and a boy to every 100 acres of arable land, will be generally sufficient for the regular work on that, and a due proportion of the meadow; but on large holdings, where grazing and dairy forms part of the system, flocks and herds require separate attendants."—Tr.

24. The cash value of a day's work of a beast, for a team, may be calculated, if we add together the value of the fodder and straw which the beast needs during the whole year, the interest of the purchase-capital, the deterioration of the beast, of the harness, and farming utensils used by him; then deduct from this sum the value of the manure obtained from him, (B. 3.3), and then divide the remainder by the number of days' work.

The value of fodder which has no market price, consists in the proportion of the nutriment it contains to grain. Those materials for litter which are not produced on the fields, should be reckoned to the animals according to the cost of obtaining each of them.

[According to Dr. Playfair, the principles of food necessary for the two great processes of life, Nutrition and Respiration, are these:

Elements of Nutrition:		Elements of Respiration:
Vegetable	Fibrine,	Fat,
"	Albumen,	Starch,
"	Casein,	Gum,
Animal	Flesh,	Sugar,
"	Blood.	Wine,
		Spirits,
		Beer.

The following table gives the analysis of various kinds of food of cattle in their fresh state:

lbs.		Water.	Organic matters.	Ashes.
100	Peas,	16	80½	3½
"	Beans,	14	82½	3½
"	Lentils,	16	81	3
"	Oats,	18	79	3
"	Oatmeal,	9	89	2
"	Barley meal,	15½	82½	2
"	Hay,	16	76½	7½
"	Wheat straw,	1.	79	3
"	Turnips,	89	10	1
"	Swedish turnips,	85	14	1
"	Mangel wurtzel,	89	10	1
"	White carrot,	87	12	1
"	Potatoes,	72	27	1
"	Red beet	89	10	1
"	Linseed cake,	17	75	7½
"	Bran,	14½	80½	5

The following is also a table of the equivalent value of several kinds of food, with reference to the formation of muscle and fat; the albumen indicating the *muscle*-forming principle; the unazotised matters indicating the *fat*-forming principle:

100 lbs.	Albumen.	Unazotised matter.
Flesh,	25	0
Blood,	29	0
Peas,	29	51½
Beans,	31	52
Lentils,	33	48
Potatoes,	2	24½
Oats,	10½	68
Barley meal,	14	68
Hay,	8	68½
Turnips,	1	9
Carrots,	2	0
Red beet,	1½	8½—Tr.]

B.—of manures.

1. Since manures are the nourishing material of plants, and, other things being equal, the higher profit of the fields depends only and alone on the greater easily-extracted quantity of the same found in the soil; therefore, the more accurate knowledge of this substance, its preparation, proportional use, and how it may be procured on a farm in sufficient quantity, and with the least cost, is of the greatest importance to the husbandman.

2. The knowledge, preparation, employment, and proportionate value of the substances used as manure, has already been shown in Chemical Agriculture; only how much of it is necessary in a farm, and how it may be procured at the least expense, will now be attempted to be shown.

[The present Treatise, it will be recollected, forms only a concluding portion of a much larger work, embracing the whole range of topics connected with Farming. Of course the Author finds it unnecessary to repeat what he has already said, and therefore merely refers to his previous discussions; but separated as it now is from the whole work, it may be useful to incorporate as much of these portions with it as the space will allow. Yet it will be impossible to enter very largely on so extended a subject, important as it is. There are many admirable things in the Authors I have already quoted, which were I to subjoin, would no doubt be of great practical utility, and add much to the value of this work; but this would be to swell it beyond all reasonable bounds for the object prescribed. I must therefore reserve these valuable materials, for the most part, for the whole work to be published hereafter, if the success of the present essay shall seem to justify so much more difficult an undertaking. Without, therefore, embracing every topic, I shall now simply cull out such remarks as may seem most appropriate to the points just suggested by the Author, on the knowledge, preparation, and proportionate value of the manuring substances. Burger's remarks on this subject are embodied in a series of propositions, followed by illustrations of the principles advanced, similar to the mode of the present Treatise. Some of these I shall quote in full, and in the words of the Author; of others I may give only the substance, interweaving also such things as may seem proper, from Thaer, Veit, Schwertz, and others.—His remarks may be found on pp. 90, &c. of Vol. I.

"By *manure*, we understand in general those bodies which directly conduce to the nourishment of plants."

"Plants are nourished only by sucking in the nutritious substance, in a fluid or gaseous form, out of the earth or air, by means of their roots or leaves. Nourishing substances must therefore be soluble in water; and if a substance is thus insoluble, it must first be dissolved by the agency of some other substance, and in its new combination become soluble in water before it is to be considered as nourishment or manure.

"Such materials only can be considered as the nutriment of plants, the elements of which we find in them on their decomposition.

"The dead organic matter contains all the constituents out of which the living of the same kind is combined. It is therefore the most excellent nourishment of beasts and plants.

"The organic substances contain not all the elementary materials, and their proportion of combination is very different. In this consists their more rapid or slower decomposition, and their greater or less facility of affording nutriment.

"Those organic substances are most rapidly decomposed which are combined from the greatest quantity of elementary substances, and give a perfect, satisfactory and rich nutriment, because all the constituents of the material exist in them, out of which the living bodies are renewed and fashioned.

"Organic substances, which are combined of only 3 or 4 elementary substances, are harder to decompose, especially if their connexion is firm. Hence it is that flesh and animal substances generally are so nutritious for beasts and plants, as they are combined from hydrogen, carbon, oxygen, sulphur, nitrogen, phosphorus, lime, potash; and hence also the less capacity of nutriment in wood, which is combined only of hydrogen, carbon and oxygen, of alkaline bodies and earths, and besides, is of strong cohesion.

"As we find silex, alumine and magnesia, iron, manganese, sulphur, phosphorus, lime, alkaline salts, and many other salts in the analysis of the organic substances, we must therefore justly conclude, that these bodies also, since they are essential constituents of the organic substance, are to be considered as directly nutritive. Experience, too, shows that all these bodies do aid the growth of plants.

"Their efficacy as manures must be much less than of the organic substances, since they contain only one or two materials in themselves which go to the nutriment of plants. They are also less because, too, these substances only aid plants in a small mass.

"The *organic* bodies are divided into two great classes—*animals* and *plants*. As animals are consumed in so great a degree by other animals, only a small portion of them goes directly to the benefit of plants as nutriment. Plants afford not only a large portion of the nourishment of animals but of other plants, since the following stock lives on the remains of the preceding one. The nutritious material found in the humus of the soil, or which is brought to the field, consists in a great part of vegetable and only a small portion of animal substances."

Humus, which, according to LIEBIG, is the decayed fibre of wood, is characterized by THAER as "a mould, not properly an earth, but a powdery substance, in a greater or less degree found in the soil. The fruitfulness of the soil depends on its proportions, as likewise it is the only thing in the soil that gives nutriment to plants: it is the remains of vegetable and animal putrefaction—if dry, black and powdery; if moist, it has a smooth, fatty feeling; it is different according to the bodies out of which it is formed, but it has certain general peculiarities or properties in which it is essentially alike. Humus is a form of organic power, a combination of carbon, hydrogen, nitrogen and oxygen, and also in lesser quantities of sulphur, phosphorus, and various salts—gives nourishment to organism; the more life there is, the more humus; and the more humus, the more life.

"Humus has less oxygen but more carbon and nitrogen than the plants of which it is composed; it differs also as there is more or less water or air: as it is in a free or confined state, it is liable to changes, and forms a substance indissoluble in water called *extract* or *extractive matter:* if it has not access to air, carbonic acid and extract is produced. Salts exist in a mass in humus—humic acid by itself is unfruitful and injurious to vegetation. Humus differs as it is formed from animal or vegetable bodies. The animal has more nitrogen, sulphur and phosphorus, as is perceivable by the smell it emits when burning."

SCHWERTZ also, says that "the nourishing substance of plants, to which we give the name of *humus*, has the appearance of a powdery and usually a brown or dark gray loose substance, in which can no more be discerned its original condition. It burns in the fire, and is soluble in water, especially after an addition of alkali. It is not every decayed substance that is humus, and not every species of humus is in a condition for the fertility of plants. It forms itself from the soil more or less rapidly, according to the organic substances from which it is derived, the firmer or the less firm its texture is, the less or more earthly parts it contains; and as the circumstances of temperature and soil exert a stronger or weaker influence on the humus." He mentions both the acid and the astringent humus.

Our Author himself, in Vol. I., under the head of AGRINOMIE, p. 40, after giving similar characteristics of the appearance, &c., of humus, observes: "It will hold nearly double its weight in water without losing a drop," and says that "SCHUBLER found that 100 parts of humus would retain 190 parts of water. KORTE also, of a humus formed from the wild chesnut wood, found it would hold 239 per cent. of water while a loamy clay only held 45 per cent. It loses the water also very slowly.

According to SCHUBLER, of 10,000 parts of water, 108 evaporated from humus in the same time that 245 escaped from 313 of garden earth. He fixes the power of humus to retain warmth at 0 49, while CROME sets it down at 0.72. It has little cohesive power; if set out in the open air, of all the integral parts of the soil it absorbs the most moisture. According to SCHUBLER, 1000 grains of humus in 48 hours absorbed 110 grains of water. According to KORTE, in 4 weeks it absorbed 6 times as much moisture. Of all the constituents of the soil it is most easily decomposed in the air, and absorbs a great portion of its acids. According to SCHUBLER, in a moist state, of 0.21 of oxygen existing in air, it absorbed $\frac{1}{5}$ in 30 days.

"Humus, combined with oxygen, is soluble in water; and a portion of the carbon of humus unites itself, with the oxygen, to carbonic acid gas. It becomes warm, when set out in the sun, very rapidly and strongly; but it also very rapidly loses its acquired warmth: it is especially found in the upper strata of the earth."

The combinations of humus with different soils, clayey, sandy, &c., deserve the attention of the agriculturist, but the subject is too extensive to be entered on in these brief notes.

LIEBIG, speaking with reference to the action of humus on plants, says: "The opinion that the substance called humus is extracted from the soil by the roots of plants, and that the carbon entering into its composition serves in some form or other to nourish its tissues, is so general and firmly established, that hitherto any new argument in its favor has been considered unnecessary; the obvious difference in the growth of plants, according to the known abundance or scarcity of humus in the soil, seemed to afford incontestable proof of its correctness. Yet this position, when submitted to a strict examination, is found to be untenable, and it becomes evident, from most conclusive proofs, that humus, in the form in which it exists in the soil, does not yield the smallest nourishment to plants." He enters into such an examination, and proves that the carbon of plants must be derived exclusively from the atmosphere, where it only exists as carbonic acid, and of course in combination with oxygen. He also shows that the carbon of the atmosphere is more than adequate to all these purposes. The influence of humus upon vegetation, he states to be, that "humus does not nourish plants by being taken up and assimilated in its unaltered state, but by presenting a slow and lasting source of carbonic acid, which is absorbed by the roots, and is the principal nutriment of young plants at a time when, being destitute of leaves, they are unable to extract food from the atmosphere."

In reference to humus and to soils, SPRENGEL remarks in his most able work on soils (Die Bodenkunde), p. 133, "To the growth of plants 18 or 19 elementary substances belong, and as whilst frequently one plant needs more of this or that substance for its success than another, so a soil may be *poor* for this plant while it is *rich* for another, according to the rule that a soil is the richest or most fruitful for our cultivated plants which contains the most humus, and much easily dissolved humic acid; whilst that is the poorest or most unfruitful which contains little humus, and from which few or scarcely any other bodies than silicious earth allow themselves to be withdrawn by water."

A distinction has been supposed to exist between a *rich* and a *fruitful* soil. "By a rich soil is understood such a one as contains a great quantity of humus or organic remains, whether already prepared or not for the nutriment of plants. By a fruitful soil we understand, on the contrary, that in which the humus is already fully prepared, or in a soluble state for the nutriment of plants." This view SPRENGEL pronounces not wholly correct, since it is derived from an incorrect representation which is generally made of humus and the nutriment of plants generally. The peat soil, for instance, he says, contains much humus soluble in water, and is for the most part very unfruitful. Among his analyses of soils we find two of portions of very fruitful soil from near the Ohio river. These may be interesting to some of our readers.

1. "From the low alluvial soil on the Ohio river, distinguished for extraordinary fertility

100,000 parts by weight of the earth consist of	Parts by weight.
Silicious earth and very fine quartz sand,	79,538
Alumine,	7,306
Oxyde of iron and oxydulated iron (oxydul)—much magnetic iron sand,—	5,824
Oxyde of manganese,	1,320
Calcareous earth,	0,619
Magnesia,	1,024
Potash—a great part of it in union with silicious earth—	0.200

	Parts by weight.
Natron or soda,	0,024
Phosphoric acid united with iron and calcareous earth, i. e., phosphates of iron and lime,	1,776
Sulphate of iron,	0,122
Chlorine,	0,036
Humic acid,	1,950
Organic bodies containing nitrogen,	0,236
Wax and resin,	0.025
	100,000

2. From uplands, near the Ohio, also distinguished for extraordinary fertility.

100,000 parts by weight of the earth contain

Silicious earth and fine quartz sand,	87,143
Alumine,	5,666
Oxyde of iron and oxydulated iron,	2,220
Oxyde of manganese,	0,360
Calcareous earth,	0,564
Magnesia,	0,324
Potash united with silicious earth,	0,120
Natron or soda,	0,025
Phosphoric acid,	0,060
Sulphuric acid,	0,027
Chlorine,	0,036
Humic acid,	1,304
Humus,	1,072
Carbonate of lime,	0,080
Organic bodies containing nitrogen,	1,011
	100,000

3. The sub-soil of this soil consists, in 100,000 parts by weight, of

Silicious earth and quartz sand,	94,261
Alumine,	1,376
Oxyde of iron,	2,336
Oxyde of manganese,	1,200
Calcareous earth,	0,243
Magnesia,	0,310
Potash and soda united with silicious earth (silicate of potash),	0,240
Phosphoric acid,	slight traces
Sulphuric acid	0,034
Muriate of soda,	slight traces
	100,000

The conclusion at which he arrives, after 170 analyses of soils is, that "according to close inspection of all these chemical analyses, we must conclude that a soil which is very fruitful, besides clay, calcareous earth and humus—which have heretofore been considered necessary—must contain also a considerable quantity of iron, manganese, magnesia, potash, soda, chlorine, phosphoric acid, sulphuric acid, and bodies containing nitrogen."

SPRENGEL also mentions, as points to be regarded in deciding the value of soils for the purposes of culture; their position as inclined or horizontal, high or low, exposed more to the north, south, east or west, and near the sea or lakes and rivers, &c.; their climate, warm or cold, moist or dry, &c.; their relations or circumstances near woods or islands, &c.; mountains, marshes, cities or towns, manufactories of various kinds, which may afford materials for manure, market, &c. The worth of soils also may be judged of by certain visible marks, as the wild plants which are found on them. Of these he gives a list which he classes as (the bodenstete) those *set* in the soil, natural to it; (the bodenholde) those friendly to it; and (the bodenvage) those which, though not natural to it, are sometimes found. By the two first, the former of them especially, the character of the soil is determined. The color too, taste, mixture, the stones great or small, looseness or firmness, friability, insects, worms, moles, birds, and many things of this kind, should be taken into account in forming the judgment.

THAER, Vol. II., 109, 110, gives the following table of the value of soils, which may be introduced here:

No.	Systematic Name.	Usual Name.	Clay pr. ct.	Sand pr. ct.	Hum. pr. ct	Lime pr. ct.	Val.
1	Humose clay soil	Strong wheat soil,	74	10	4½	11½	100
2	Strong humose "	" " "	81	6	4	8⅖	98
3	" " "	" " "	79	10	4	6½	96
4	Rich marly "	" " "	40	22	36	4	90
5	Humose, loose "	Mead, or green pasturage soil,	14	49	10	27	?
6	" sandy "	Strong barley soil,	20	67	3	10	78
7	Rich clay "	Strong wheat "	58	36	2	4	77
8	Marly "	Wheat "	56	30	12	2	75
9	Clay "	" "	60	38	a very small quantity of lime.	2	70
10	Loamy "	" "	48	50		2	65
11	" "	" "	68	30		2	60
12	" "	1st class barley "	38	60		2	60
13	" "	2d " " "	33	65		2	50
14	Sandy loam "	" " " "	28	70		2	40
15	" " "	Oat "	23½	75		1½	30
16	Loamy sand "	" "	18½	80		1½	20
17	" " "	Rye "	14	85		1	15
18	Sandy "	" "	9	90		1	10
19	" "	Six years' rye "	4	95		¾	5
20	" "	Nine years' " "	2	97½		½	2

BURGER divides the manuring bodies into the *organic* and *mineral*; and says that "all that is of organic origin, and is soluble in water, or gradually by contact with the same and the air, must be considered as a means of manure:" and of the substances, "those, which as compound bodies contain the constituent parts of organic matter, and under the operation of the water, heat and air are rendered capable of entering into combination with the constituent parts of the soil, or dissolved in water, are taken up by plants." The organic materials are animal and vegetable. Under the animal are mentioned, besides excrements, particularly bones. These contain of gelatine, an important principle of nutriment: of oxen, 0.50–0.55; of horses, 0.36—0.40; of swine, 0.48—0.50. An important consideration in reference to animal excrement is, that it has no other value practically except as manure. According to THAER's and EINHOFF's analysis, it appears that the excrements of cattle are specifically heavier than water 104.5, and consist of 71⅞ water and 28½ of solid substance. 3840 grains of fresh dung contained of

Probably accidental sand,	45 grains,	=	0.011
Juices of plants,	600 "	=	0.156
Animal matter soluble in water,	90 "	=	0.023
Insoluble, probably vegetable matter,	360 "	=	0.093
Water,	2745 "	=	0.714
	3840	=	1.000

According to Dr. DANA, 100 lbs. of cow-dung contain:

ORGANIC MATTER.

Water,	83.60
Hay,	14.60
Bile and resinous and biliary matter,	1.275
Albumen,	.175

SALTS.

Silica,	.14
Sulphate of potash,	.05
Geate of potash,	.07
Muriate of soda,	.08
Phosphate of lime,	.23
Sulphate of lime,	.12
Carbonate of lime,	.12
	99 86
Loss,	0.14
	100.00

By MORIN's analysis 100 parts contain:

Water,	70.
Vegetable fibre,	24.08
Green resin and fat acids,	1.52
Undecomposed biliary matter,	0.60
Peculiar extractive matter,	1.60
Albumen,	0.40
Biliary resin,	1.80
	100.00

Dr. DANA observes also that in 100 parts of cow-dung there are of

Nitrogen,	.506
Carbon,	.201
Hydrogen,	.824
Oxygen,	4.818

So that 100 parts of fresh cow-dung will afford 0.614 or $\frac{5}{8}$ of a pound of pure ammonia, or about 2 lbs. 2 oz. of carbonate of ammonia of the shops.

The urine of the cow, according to BRAND, contains:

Acid, salts, potash, and ammonia,	= 0.015
Sulphate of potash	= 0.006
Carbonic acid,	= 0.004
Uric acid,	= 0.004
Phosphate of lime,	= 0.003
	0.032

The urine of the horse, according to FOURCROY and VAUQUELIN, contain:

Benzoic acid with natron or soda.	0.024
Carbonic acid,	0 009
Acetate of potash,	0.009
Uric acid,	0.007
Carbonate of lime,	0.011
	0.060

According to VEIT, also, the analysis of the dung of some of the domestic animals furnishes us with the following result:

	Of 100 parts. Cattle.	Horse.	Sheep.
a. The constituents of excrements, in a dry state.			
1. Juices of plants, with remains of food,	56.5	65.0	44.0
2. A mud-like green powder, with coagulated albumen, and bowel-slime,	33.5	20.5	40.0
3. Gall stuff, with extractive matter,	4.35	5.6	6.1
4. Gall sugar with soluble salts,	4.46	6.5	7.5
b. The ashes of the excrements, amount to	6.0	6.0	9.6
And contain, of silicious earth, phosphate and carbonate of lime,	1.2	0 9	2.0
Carbonic acid, phosphoric acid, and acetate of natron	0.2	0.5	1.6
c. The absorption of the acids of the atmosphere, and the formation of carbonic acid gas corresponds to the proportions,	17.8	15.8	23.0
d. Excrements in a moist state, contain of water,	75.0	69.0	68.0

Of vegetable manures, there are a great variety in leaves, straw, weeds, ferns, pond-mud, &c. &c., green plants, &c. So of mineral manures: sulphur, lime, potash, &c.

The proportion of ashes and of potash in a variety of substances are thus given by BURGER:

		Of Ashes.	Potash.
100 lbs. of	Elm or Maple gave	2.4 lb.	0.39 lb.
" "	Oak,	1.35 "	0.155 "
" "	Poplar,	1.23 "	0.075 "
" "	Box,	0.584 "	0.145 "
" "	Fir,	0.341 "	
" "	Vine,	3.379 "	0.55 "
" "	Fern,	5—— "	0.626 "
" "	Maize stalks,	8.3 "	3.6 "
" "	Wheat straw,	4.3 "	0.39 "
" "	Oat straw,	5.6 "	0.87 "

In THAER and SCHWERTZ are also many valuable remarks, most of which must be omitted for want of room; and they are less necessary since the publication and more extensive circulation of the works of LIEBIG, JOHNSTON, DANA and others, on this subject. THAER defines the object of all manures to be twofold: to nourish plants, and to help decompose other nutriment for them.—TR.]

3. Because the fertility of fields in most farms depends on the manure from the stalls, and other substances used as manures, must be considered as extraordinary; therefore, the present remarks will relate more particularly to manure of the stalls; and in case other kinds of manure are used, they must be reduced to their value according to the same.

4. As stall-manure consists of the dung of animals and different vegetable substances mixed therewith, so it is the product of beasts kept on the farm for labor and other uses, of the fodder furnished them, and of the litter laid for them to lie upon.

5. The nourishment of beasts and men depends on the culture of plants, and the culture of plants on the labor of beasts, and the quantity and quality of manure they produce. The production of beasts and plants is therefore reciprocal.

6. To bring the cultivation of land into a convenient proportion with the rearing of cattle, in any given case, the husbandman must know:

1.) How much manure he needs, in order to retain a given amount of field in a fruitful state, and in what proportions the manure is taken from the fields by the production of plants?

2.) What beasts will produce manure in any given case at the cheapest rate?

3.) How great must be the number of these beasts?

4.) What is the proportion of the weight of fodder consumed, together with the litter employed, to the weight of the manure?

5.) In what proportions the production of plants for fodder, and materials for litter, must stand to the grains and plants for the purposes of trade?

6.) How the different plants cultivated on the fields must follow one another, so that the necessary supply of fodder and litter may be produced, and be coupled with the greatest possible production of plants for grain, or for trade, without the fields being thereby over-worked, or run to waste, or any extraordinary improvement being required?

7. In the solution of these questions consists the greatest and most essential part of the doctrine of the organization of Land Husbandry; and a correct system of farming adapted to the nature of the soil, the climate and other local respects, can then first be established, if one knows what

beasts and plants are adapted to a given case, what powers and means their support requires, what the procuring them will cost, and what result one may promise himself from the profits of the beasts and plants.

[THAER, Vol. I. p. 186, remarks: "It is a desirable object to be gained by the farmer, to obtain for himself animal manure in sufficient quantity for the highest production of vegetable substances in the cheapest manner possible, and with the least possible sacrifice of marketable crops in the production. This may be effected:

1. When he produces the greatest possible quantity of nutritious fodder on the least extent of his land.

2. When he does this with the least outlay of work and money.

3. When he obtains fodder on that portion of his land where there is the least interruption in the cultivation of other fruits.

4. When he so arranges the cultivation, and his choice of the means of fodder, that by cultivation itself he puts in a fit state the field for the production of other fruits; i. e. that the labor expended may be for the advantage of the successive fruits.

5. When by the fodder itself he produces the greatest quantity or value of animal products.

6. When he so keeps his cattle that the collected dung produced by them will be the most suitable manure for his fields and fruits, and in the end be applied in the best mixture, locality, and fermentation.

7. When he uses the manure obtained as quick as possible for the raising of marketable products, or such as will furnish manure again, and as much as possible hasten the progress on his farm from the earth into vegetables, from vegetables into the bodies of animals, and from these again back to the earth.

These objects may be obtained in the most perfect manner by a system of cultivation regarding, and as much as possible corresponding, to the situation of the farm." —Tr.]

1. HOW MUCH MANURE IS NEEDED, IN ORDER TO RETAIN A GIVEN AMOUNT OF FIELDS IN A FRUITFUL STATE?

1. The greatness of the growth of plants, other things being equal, stands in exact proportion to the amount of soluble substance found in the soil, adapted to be the nutriment of plants.

2. When the quantity of this substance which is taken away from the soil by the harvest, is restored in like measure by manure, then the power of the same remains as before; and in an average of many years, though the influence of extraordinary weather may alter it, we can obtain the same harvest. If more is given back to it than is taken away from it, the richness of the soil, and its productive power will be increased; but if more is taken away than is given back, then the amount of its product is lessened in the same proportion.

3. It is therefore of great importance to ascertain the proportion of the consumption of manure by different plants, according to the difference of the soil and climate, in order always to carry out, at a suitable time, a quantity of manure adapted to the field, that its capacity of production may be kept in that degree which we consider best suited to its circumstances.

4. A field requires more manure to yield the same product, if it is loose, and too little strengthened by clay; because it then not only needs the humus for the nourishment of plants, but also for absorbing vaporous atmospheric particles, and for a greater retentiveness of the moisture of rain; and the humus decomposes sooner in a loose soil, and is earlier evaporated, before the roots of the plants can suck it in.

[The theory of our Author, here, is evidently the old one; and consequently, his language needs some modification to make it conform to the more recent view of LIEBIG,

before mentioned, that the great effect of the humus is to furnish a supply of carbonic acid to the plants, though LIEBIG's theory is disputed by some—TR.]

5. The same quantity of manure produces, therefore, in the course of the time of its decomposition, a greater product of plants in a clayey than in a sandy soil, provided the warmth of the climate is in a suitable proportion to the tightness of the soil.

Herein consists the essential cause that the product of the sandy soil is everywhere so small, and that a clayey soil, with an equal cost of manure, yields a greater product. If a person would raise grain on a sandy soil continuously with profit, he needs extraordinary aids; either such a rotation of crops in which a certain extent is devoted to the culture of plants for fodder, or if the field is only sown with grain, then are large pastures, foreign materials for litter, and much meadow requisite. If a man has not these, the product of the field will diminish from year to year, and finally, it will be necessary to let a part of the field lie fallow, in order to hold at his command the requisite aid to keep the other under cultivation, or he must lay out artificial pastures, and try the Koppel-system of husbandry.—(See 6: 7, 9, 27, below.)

6. In a cold climate we generally use for the production of the same crop more manure than in a warmer, and more in a heavy than in a mellow soil; because the dissolution of the humus is less favored in the former of these cases, and the cold soil must be warmed by the greater quantity of manure.

The manure does not itself directly warm the soil, for the decomposition goes on in the field so slowly that the warmth which is thereby occasioned is imperceptible: it only takes place indirectly, because, not reflecting back the sun's rays, it absorbs their warmth and imparts it to the surrounding earth. Hence the reason that one notices no extraordinary accumulation of humus in the oft-manured fields of high and coldly-situated countries, must be ascribed to their inclined position on the mountains, in which a greater part of the dissolved manuring substances is carried away by the rain. On the plains, we always observe an accumulation of black mould.

7. By how much the more the humus is rendered easy of decomposition by the repeated ploughing and loosening of the earth, by so much the more easily it gives itself out of the soil.

When a more excellent grain grows after an unmanured fallow than one obtains with such fallow preparation, the reason of this is partly from the green manure which exists there, often, indeed, in a small quantity, and in a great measure from the dissolution of the old humus, which, by the repeated upturning of the soil in all parts of the strata of the earth, is brought into connexion with the air, and heat and light. But we always observe that those farms which lie fallow three years, and the fallow field is wholly manured, as well as those which lie fallow twice in six years, and are only once manured, produce less in proportion to the manure expended on them than those which, with like amount of manure, are not suffered to lie idle; from which we may undoubtedly conclude, that a great part of the humus evaporates uselessly by the labor on the fallow. If the plants are hoed and hilled, they give, unquestionably, a greater product than if these labors of culture are neglected, since thus the dissolution of the humus is aided, and it is brought by the hilling into the nearest vicinity of the plants. But because at the hilling the plants are in their greatest growth, therefore all the dissolved nutriment is for their benefit, which cannot be in the case of a fallow, since in the same years when the field is often tilled with the greatest care, and is manured already in the summer, the seed first comes into it in the autumn, and all the manuring substances which were dissolved in the first years, can only in a small part be sucked in by the tender plants, and must therefore evaporate uselessly. Fruit that is hoed gives a greater product, but in a larger proportion draws nourishment from the soil, than that which is not hoed; because by this loosening a great part of the humus is evaporated before it is sucked in by the roots of the plants. The proportionally greater need of manure there is in those farms which cultivate much hoed fruit, is therefore not only to be ascribed to the larger

crops which are there obtained, but in part also to the earlier and more rapid evaporation of the humus.

[On the subject embraced in the preceding paragraphs, VEIT observes: "By the working over of the soil, the operation of atmospheric influences is aided, and thus its activity is increased. The more the soil is cultivated, and the more the nourishment of plants is found in a dissolved state in the pulverized soil, so much the greater quantity of the same evaporates." "The greatest evaporation of material for nourishing plants is when, long before the sowing, the already-dissolved stall-manure is carried out and ploughed under, and the so-manured soil is worked over, by repeated ploughing and harrowing, till the time of sowing. Then, indeed, the manure mixes itself intimately and proportionately with the pulverized soil, and is dissolved in a great part up to the putting in the seed, and the seed following after comes to the full enjoyment of the given nutriment. But the greatest part of the manure, therefore, falls to the account of the harvest, whilst, for the succeeding crop, there usually remains only a small portion of the manure in the soil.

"This method those observe who cultivate on the three-field, or three-shift (Dreifeld) system, with pure fallows; who, in the course of the months of May and June, in the period after the spring seed-time to the harvest, bring the manure produced in the winter on the field in a well-dissolved state for the next winter fruit, plough it under and work over the field many times, with plough and harrow, till the time of sowing. So, exactly at that time when the atmospheric powers exert the most activity in the decomposition of the organic matter in the soil, will the greater part of the manure be uselessly evaporated, until the seed-time and its nourishment begins. Even of the old power of the soil will the greater part be consumed during the warm period of the year, by the strong working over of the open and unshadowed soil: then the mutual effects of the substances of the atmosphere and the soil, are carried on especially at the expense of the organic matter of the soil, the dissolution of which, by the loosening and pulverizing of the same, will be yet more favored."

"The more the climate and soil favors the putrefaction, so much the earlier will the organic matter be decomposed, and in so much a shorter time will the power of the soil be exhausted. In a warm climate in a warm season—in a soil, the prevailing constituents of which attract and retain much warmth, or, decomposing the same, operate on the organic matter—in an iron-charged ochrey soil (called a manure-exhauster)—in loose kinds of soil, the particles of which are easily penetrated by the atmospheric influences, or which is dry, with a gravelly base, letting the water through it, &c., the nutriment of plants will be decomposed far more quickly, and partly brought to the roots of the plants, partly carried off by evaporation, or downwards by the water, and hence earlier withdrawn from the soil, than in a cold or moist climate, or in a wet or cold summer, in tight, moist kinds of soil, with a deeper upper layer, or with a base which lets the water through."

"Might the amount of power which is earlier dissolved in an active than a less active soil, come independently to the benefit of the plants cultivated, then the result of the same would be greater on the active soil, while it secures the same interest of manure-capital in a shorter time than the less active. But, on the one hand, the plants cannot take up the great quantity of manuring substances which offer themselves to them during the period of vegetation; and on the other, the rapid decomposition of the manure goes on in the period from the harvest of the last fruit to the sowing of the next. Of an equal quantity of manure, consequently, a far greater part will be lost on an active soil than on a less active one. We then give the necessity of manure a shorter period.

"Besides, it is an evil that the active, dry, heated kinds of soil usually possess less capacity for the materials of the principal components of manures; therefore, on the one hand they consume more manure, and on the other, yield less material for its production.

"In less active kinds of soils, if indeed the manure is to be longer retained, it must be employed in an undissolved state, in order to favor the operation of atmospheric influences by loosening them. Partly from this and partly from the proportionate working over of the tough, cold soil, will the result of the manuring be more certain than on the over-active kinds of soil, and especially the success of the usual fodder-plants be more assured."

SPRENGEL, in his valuable work on soils before quoted, pp. 134, 135, thus characterizes them in respect to their affinity to manures: "We name a soil, in reference to its relation to manure, *consuming*, *hungry*, or *needy*.

"A soil is *consuming* when the manure is soon consumed by the plants, rapidly

changed into humus, and the humic acid so existing, not connected with a base, but by water, is sucked in or evaporates, suffering a more extended decomposition. But it is also consuming, in that all the salts already found or first existing in the manure, are soon carried deeper by water. To those soils which are consuming, belong the dry, gravel, and sand soils, and in a lesser degree, also, the chalk and lime-stone soils. The sand, and yet more the gravel soil, loses easiest of all soils the bodies existing by the rotting of the manure, and which serve as nutriment for plants, and therefore requires an often-repeated, but only weak manuring.

"A soil is *hungry*, when it requires much manure to make it fruitful. To this class belong all kinds of clay soil containing much iron, especially if they are moist. Similar kinds of soil particularly require much manure, in that the humic-acid arising from the decomposition of the manure is chemically connected with much alumine and oxyde of iron, and that on account of the difficulty of decomposition of the existing humic acid salts (humate of alumine and oxy-humate of iron), the humic acid is drawn from the plants."

On p. 288 he says: "The soil of the earth contains water in two different forms, viz., in a chemical combination, as water of crystallization, (as hydratic water) and in a free state, or as capillary water (hygroscopic water)."

"The quantity of water chemically combined, depends principally on the quantity of humic acid, humates, free alumine, and oxyde of iron, as these bodies contain much water in chemical union. Besides, also, there is some hydratic water in silicious earth, in gypsum and many other salts. It is in the highest degree probable that plants need no water in chemical union, since their roots have no power to draw out the hydrates.

"The power of the earth to take up and hold back more or less water mechanically in its pores, is of the greatest importance for vegetation, not only because the water in and of itself contains the life of the plants, but especially, also, because it carries to them means of nutriment from the soil. In the *want* or *excess* of moisture, we frequently must seek the cause of the unfruitfulness of the soil. The ease of the soil to hold moisture, but especially the decompositions and combinations which take place, are of importance, since the decomposition of the organic remains may be presented either from the excess or the want of moisture.

Professor SCHUBLER, who tried many experiments as to the power of the earth with reference to the taking up water in its pores, found the following results:

Kinds of Earth.	Power according to weight.	A cubic foot Paris of moist earth contains of water,	
	per cent.	lbs.	
Quartz sand	25	27.3	A Paris foot is 9 lines shorter than an English one.
Lime " (aggregated lime and sand)	29	37.8	
Gypsum, of an earthy form	27	27.4	
Carbonate of lime, in powdery form	85	47.5	
" " magnesia " "	256	62.6	
Stratified clay	40	38.8	
Loamy "	50	41.4	
Pure gray "	70	48 3	
Humic acid	181	50.1	
Loam soil	52	40.8	

"The humic acid has therefore the greatest power after magnesia; still greater is this power in the peaty soil, since 100 parts by weight will take up 300 to 360 parts by weight of water in its pores, if it has been first artificially dried out."

"By many experiments it has been ascertained, that most soils serving for the cultivation of grain possess a power of taking water into their pores of 40 to 70 per cent. If this power is much less or greater than these, the soil is more suitable for pines and such like trees, and for grass cultivation.

"To judge of the value of a soil in this respect, we must regard the climate, the mean quantity of rain fallen, and the temperature; as the same soil in one region may be fruitful, while in yet another, under different circumstances, it is not so. A *clay* soil, with great power of taking water into its pores (very porous), is desirable in a hot,

dry climate, while it is worth little in a cold, moist climate. A *loose, sand*-soil, is worth little in a dry, hot climate, while it is more valuable in a moist one," &c.

As to the power of the soil to retain moisture, he says, p. 291: "Next to the power of a soil for taking up water into its pores, the greatest importance for vegetation is, how long it will hold the moisture so taken up. Many soils soon lose the water by evaporation; others, on the contrary, very slowly. Sand, lime-stone, gravel, and slaty kinds of soils, dry up the quickest, and on that account form the so-called hot soils, while clay, which holds water long, is named a cold soil."

Professor SCHUBLER found, by many experiments on the power of soils to retain water, the following results:

KINDS OF EARTH	EASE OF DRYING UP.		
	Of 100.0 parts of water absorbed, was evaporated at 15° Reaumur = 67° Far. in 4 hours,	Of 100.0 parts of water absorbed, 99.0 parts evaporated at 15° Reaumur = 67° Far. in	
		Hours.	Min.
Quartz sand	88.4 parts.	4	4
Lime "	75.9 "	4	44
Gypsum in earthy form	71.7 "	5	1
Stratified clay	52.0 "	6	55
Loamy "	45.7 "	7	52
Pure gray "	31.9 "	11	17
Carbonate of lime in a fine state	28.0 "	12	51
" " magnesia " "	10.8 "	33	20
Humic acid	20.5 "	17	33
Loamy soil	32.0 "	11	15

"On the drying up of the deep layers of the soil in a longer or shorter time, the different looseness or consistency of the upper soil, has also an important influence; the *fine clay*, for example, at 2 inches thickness strata, has a moist surface long after the surface of the peaty soil at the same depth is dried up.

The power of the soil to retain water in all depends on: 1, The quality of the subsoil; 2, The quality of the upper soil; 3. The degree of warmth by the sun; 4, The atmospheric pressure, and the degree of the change of the atmosphere. The atmospheric pressure has great influence on the evaporation; and on this account a soil dries up so much the more rapidly, by how much higher it lies, and the more it is struck by the wind, especially the east wind.

"If a soil contains many salts which attract moisture from the air, this has great influence also on the evaporation, as these by night absorb again the water evaporated."

Respecting the property of the earth to attract moisture from the atmosphere, he also observes, p. 294:

"Besides quartz-sand, all the earths which constitute the soil have the property, so far as they are dried to a certain degree, more or less to attract moisture from the air, which is naturally of high importance for the growth of plants. In the strongest degree, generally, this affinity for moisture in the atmosphere shows itself in the clay soil, especially if it contains much humus; since these bodies, of all the constituent parts of the soil, attract the most moisture from the air; the kinds of humus indeed are somewhat differently proportioned; the heath-humus, for example, because it contains so much carbonized humus (or humic carbon) and resinous wax, attracts not so much moisture from the air as the mellow humus, which in a great measure consists of humates or salts of humic acid.

"All earths attract more moisture by night than by day; they also give back, through evaporation in the sun-light, the moisture absorbed by night.

"From the capacity of the soil to attract more or less moisture from the air, we might likewise form a conclusion as to the degree of its fertility, yet we can thereby come to no certain result, as a leaner clay soil absorbs more moisture than a richer loam soil.

"In order to ascertain how much moisture one kind of soil will absorb from the air, we laid a certain quantity of finely pulverized and fully dried earth on a plate, which was put under a glass bell made water-tight and left it to lie there 12, 24, to 48 hours, in a moderate temperature (12° to 15° Reaumur, = 59° to about 67° Far.) and then weighed it. The addition of weight exhibits the quantity absorbed in watery vapor."

Here also we are reminded of Professor SCHUBLER's numerous experiments of this kind. He found the following results:

Kinds of earth.	100 parts in weight of dry earth spread on a pane beneath a glass bell, water-tight, absorbed in 12 hours,	24 hours,	48 hours,	72 hours,
Quartz-sand,	0 parts.	0 parts.	0 parts.	0 parts.
Lime-sand,	2	3	3	3
Gypsum of earthy form,	1	1	1	1
Carbonate of lime, in the form of powder,	26	31	35	35
Carbonate of magnesia, in powder,	69	76	80	82
Potters' clay,	21	26	28	28
Loamy clay,	25	30	34	35
Pure gray clay,	37	42	48	49
Humic acid,	80	97	110	120
Plough-land, loam soil,	16	22	23	23

"As to gypsum, we see that it attracts scarcely no water from the air. But it is usually believed that gypsum, employed as a manure, especially promotes vegetation, in that it attracts moisture from the air, which it transmits to plants. Thus, theories which are written down, often fall to nothing when tested by experiment."

Speaking of the absorption of oxygen from the air, to which acid he attributes an important part in vegetation, he remarks, p. 296, that "the working over of the soil has this benefit, that thereby new strata of the earth always come in connexion with the air, and thus absorb much oxygen, by which they are more and more fertilized. Other gases also, as carbonic acid, nitrogen, hydrogen, are absorbed." The decrease of the volume of different earths, by being dried, PROFESSOR SCHUBLER found to be the following:

Kinds of Earth.	1000 cubic lines diminution of volume in	1000 parts by weight diminished therefore in its volume
Quartz sand,	0—C. L.	0—
Potters' clay,	940 "	60
Loamy clay,	911 "	89
Pure gray clay,	817 "	183
Humic acid,	800 "	200
Carbonate of lime, as powder,	950 "	50
Plough-land loam soil,	880 "	120

From this table it is evident that the degree of the decrease of the volume of the earth stood in no direct proportion with its power of retaining water."

"The property of some kinds of the soil, especially marl, by moisture and then by being dried again, to fall into small pieces and become crumbly, is sufficiently explained by the great difference of the decrease of their volumes, which the constituents of the soil undergo, as clay, lime, humus, &c.; since, be the soil or marl ever so intimately mingled, yet their constituent parts always only lie near together. But the particular parts change by the shrinking together, in different proportions, of their volumes, which naturally produces their separation, and soon their decomposition."

"According to SCHUBLER's experiments (see SPRENGEL, p. 301) the following are the results as to the capacity of different earths to retain for a longer or shorter time the warmth they have received:

Kinds of Earth.	Power of retaining warmth, that of limestone-sand being fixed at 100.0.	Length of the time which 30 cubic inches of earth need, at a temperature of 13° R. = 62 Far. to cool from 59° = 145 F to 17° R. = 70 Far.
Limestone sand,	100.0	in 3 hours, 30 min.
Quartz sand,	95.6	3 " 20 "
Gypsum earth,	73.8	2 " 34 "
Potters' clay,	76.9	2 " 41 "
Loamy clay,	71.8	2 " 30 "
Pure gray clay,	66.7	2 " 19 "
Carbonate of magnesia finely powdered,	38.0	1 " 20 "
Carbonate of lime " "	61.0	2 " 10 "
Humic acid,	49.0	1 " 43 "
Plough-land loam soil,	70.1	2 " 27 "

"Hence it appears that the sandy kinds possess the greatest power of retaining warmth, if the earths are compared in equal quantities. Have the sandy soils reached

a certain temperature, they retain it considerably longer than most other kinds of soil. The less amount of moisture which they retain is the ground wherefore they grow cold so little.

"Humus, next to carbonate of magnesia, has the least power of retaining warmth. A moist soil, rich in humus, gradually warms itself in the sun, because the evaporating water is chemically combined with much warmth. Dry soils, very rich in humus, warm themselves on this account gradually; because, on account of their great porosity, they hold shut up much air, and are the poorest conductors of heat. From SCHUBLER's experiments we obtain the following conclusion: the more mass the earth possesses in the same volume, or the greater is its absolute weight, so much the greater generally is its retentive power for heat; so that from the absolute weight of an earth we can judge with tolerable accuracy as to its greater or less power of retaining heat."—TR.]

8. All plants draw humus from the soil in proportion to the length of time they remain in the same.

Winter-wheat, therefore, for an equal quantity of product, requires more humus than barley, and oats more than buckwheat: vetches or tares suck in more humus when they are left to ripen than when they are mowed while green. That the perennial increase of the soil be not weakened, the dying portions of the plants must be left to be incorporated in the soil; otherwise, the increase is arrested. If one, therefore, takes away the fallen leaves, together with the fruit, from young groves, and applies it in the stalls as litter, the trees sicken, remain crippled, and grow but poorly.

[VEIT, in treating of the exhaustion of the power of the soil according to the properties of plants, considers the subject in reference to the nourishing mass of their products; the thicker or thinner state of the fruit; the quality of the leaves and stalks; the quality of their roots; the amount of the organic mass remaining in the soil after the harvest; the duration of vegetation, and the degree of the ripeness of the fruits.

He remarks; "the greater the nourishing mass of a plant, so much the greater, other things being equal, is its need of nourishment. 'The exhausting power of different grains, according to their volume,' THAER says, 'are in the following proportion: wheat 13, rye 10, barley 7, oats 5.' The longer a plant takes from the soil, from the time of the sowing the seed till the time of its ripening, so much the more nourishment will it draw to itself, other things being equal. Thus the winter-fruits consume more power of the soil than the summer-fruits of the same species. On the other hand, the exhaustion of powers is so much the smaller, the shorter the period of the vegetation of a plant is, unless other properties produce an exception. The period of the vegetation of different plants cultivated on the farm vary:

"For buckwheat, summer rape, small maize, flax and white turnips, 12 to 15 weeks.

"For summer-rye, early-ripe oats, spring barley, millet and hemp, from 16 to 17 weeks.

"For summer-wheat, late-ripe oats, larger barley, lentils, transplanted beets, maize, early-ripe turnips, about 18 weeks.

"For potatoes, artichokes, late-ripe turnips, beets, &c., 22 to 24 weeks.

"Winter rape-seed vegetables in the autumn of the seed-year, at least 10 weeks, and in the following year of its fruit about 18 weeks; together, therefore, 28 weeks.

"Winter barley, winter speltz, winter wheat and winter rye, ripen indeed 3 weeks later than winter rape, but they are also sowed as much later, and have, therefore, with themselves an equally long period of vegetation."—TR.]

9. The greater the organic product which plants produce is, the greater also is the weight of the humus which they employ for this purpose.

Rich harvests require rich manure. If a person wishes always to raise on the same soil, hemp, maize, or head-cabbage, in equal quantity, it must every year be richly manured. If he omits to do this, the product of the second year is very considerably less; a proof that the great production of the first year has appropriated the greatest part of the humus, and that the small quantity of the same soluble in the second year, is no longer sufficient for as great production.

10. Plants that are taken from the fields earlier than their grain or fruit is developed, as well in an absolute as in a relative respect, need less humus than those which not only produce leaves and stalks, but also flowers and fruit.

If some suppose that plants for the production of leaves and stalks need only air and water, they may convince themselves of the contrary in gardens and fields if they will observe salad, cabbage and other leguminous plants, that are planted partly in manured and partly in exhausted beds. The consumption of manure of green plants and those ripe for gathering is very different, as we observe by the different power which the fields exert in case half of the field—when the whole is sown with vetches, rye, or any other plants—is mowed green and the other half suffered to ripen. The cause of this appearance lies in part in the longer time which the plants of the last half remain in the field, of which we have already spoken (8); in part it must be ascribed to the different necessity of organic nutriment which the plants need for the formation of their different parts; and if they require less humus for the formation of leaves and stalks, yet more is necessary for the formation of the grain; therefore, if we see in poor, yet not wholly exhausted fields, in favorable weather, that the crops are often as large as in stronger fields, this shows the dependence on the humus for the formation of the grains, which under such circumstances are less numerous and smaller in size. Peas in poor fields grow in moister and warmer weather, always showy enough indeed, as to stalks and leaves, but the pods remain mostly empty. Finally, the greater exhaustion of the soil by the production of grain, especially of the grass kind of plants, must be sought herein that the leaves begin to dry up as soon as the blossoming is over, and are unfitted for the absorption of air and vaporous nutriment when the grain is formed, which in a great degree must be produced by the nourishment mounting from the roots through the stalk.

11. Plants do not require for that which they have produced from the field, and which has been taken away from thence, an equal addition of manure; because they possess the power to appropriate organic matter in unequal degree, and the quantity of organic remains which they leave in the fields, as decaying leaves and roots, is very different.

12. The pod-bearing vegetables need generally less manure than the plants of a grass kind; for, in a given soil, and in a given time, they produce more organic matter than do the latter; because they absorb a greater quantity of atmospheric and mineral substances.

We have already proved the correctness of this opinion in the Special Culture of Plants (§ III. B. p. 76), and refer to those remarks.

[The observations to which our Author here refers are the following: "Plants can take so much the more moisture from the air as the surface of their leaves collectively is greater, or as they have more absorbing vessels, or hair upon their surface. They dry less easily the thicker their leaves are, and the moisture shut up between them is more slimy or viscous; and if the plants are connected with many thick or strongly-haired leaves and roots pressing deep into the soil, they all of them must mostly draw a great part of their nourishment from the air, and also resist dryness.

"The pod-bearing plants have these properties in a higher degree in themselves than the grasses. Those with a small root, vetches, peas lentils and beans, form themselves very perfectly, therefore, in a moist climate and an easy soil, with little manure; but in a dry climate their roots must be protected by a close soil before drying up, or by a greater quantity of nutriment in the soil, obtain more physical power. Those with deep, penetrating roots, clover, sainfoin, luzerne, endure in the same circumstances a warmer climate, and greater dryness than if the soil is more clayey and the plants older and the roots penetrate deeper into the soil. The extraordinary great organic production of this last plant cannot possibly be ascribed only to the humus existing in the soil; since, were it possible that the same field, if it were sown with grain, should produce in a course of 4 years some 150 cwt. of grain and straw, if it bears luzerne, it produces more than double, often three times this weight in dry leaves and stalks: and how can we explain the luxuriant growth of the white horse-bean, *lupinus albus*, in a poor and light soil, unless we suppose that these plants, by means of their many large, thick and heavy leaves, suck a great part of their nourishment from the air, and that their long tapering (pfahlförmig) roots, running into the soil, with small horizontal sucker roots, appear to be designed more to suck in water in the depth of the soil, and to protect the plants before drying up, than to supply them with nourishment?

"The culture of the pod-bearing plants, therefore, exhausts the soil less; and because

they leave behind in the soil much organic matter—in their leaves falling off at the season of fruit—and frequently quite large roots; and further, their thick condition sets the field fully in the shade, and hinders the coming up of weeds and the useless evaporation of the humus—therefore the following fruit of that time succeeds better than after grass-kind of grain or knob and root-plants."—TR.]

13. A field, then, requires for the production of all kinds of fruits in a course of years, so much the less manure, according to the frequency with which pod-bearing plants, with thick roots, are cultivated with culmiferous fruits.

The culture of clover, luzerne and sainfoin, is therefore of the greatest consequence, because they not only produce a very great proportionate quantity of fodder, but also abstract but little humus from the soil, and by their remaining roots and leaves decaying, they leave in the soil a great amount of organic matter which must likewise be reckoned as entire manure with stall-manure.

14. Because the herbaceous plants generally yield a larger organic product than the weight of the humus which they absorb from the soil during their growth: hence it is possible to keep the field in the same state of fruitfulness if we do not bring back again a part of the product on the same.

If plants lived only on organic matter, then must we, for that which we produce from the fields and have not returned in manure, add vegetables grown elsewhere to the same matter, whereby a gradual disappearance of vegetation would be effected.

15. The products of our fields are taken away from the same, either in whole or part.

16. Those products are *wholly* taken away which yield no manure on the farm; those in *part* from those fields to which is restored more or less again in manure on the same.

The grain-kernels, plants for commerce, &c., which we sell from the farm, are wholly taken from the field. But the grain that we consume on the farm itself, and the plants for fodder, with which we support our beasts, are only so far taken from the fields as a part of it is changed into animal substance, during the processes of digestion, or is dissipated by means of the putrid fermentation.

17. To keep the fields in the same state of fertility, there must be so much manure restored that the mass of the humus may remain the same in a course of years.

18. But in order to return to the fields a quantity of manure proportioned to their needs, it is necessary to know in what proportion the plants need humus; or much more how the quantity of the product is proportioned to the consumption of the manuring substance in the soil; and how much they lose in substance consumed out of the field as fodder, and by putrefaction.

19. What we take away from the fields in any vegetable products, must be restored again with other organic products, in the same degree as we have taken away more than the increase which the plants have appropriated to themselves in inorganic matter.

20. But because plants are of different natures, and the power to convert inorganic matter into organic is not the same with all; and because the same plants in different periods of their growth herein vary, therefore the amount which must be restored for that which is taken, is not always alike.

21. Meadows which are artificially watered, or are frequently overflowed, need for their product no additional manure, because they are kept up by the slime which is contained in the water. But if they are neither watered nor overflowed, then must a part of their product be restored to them if their productiveness is to be kept uniform.

If on dry meadows which from no quarter possess a remarkable supply of manuring substances, one obtains a yearly crop, though often a small one; yet we need not hence believe that the growing plants live only on air and water, and from these two sources only can produce organic production; they derive nourishment from overflows, to which many years they have been exposed, from the droppings of beasts, which in the autumn, and frequently in the spring, pasture on them; and from the bodies of insects and worms which die and are decomposed within reach of their roots. Were it possible to shut off from the meadows these sources of nourishment, then could they yield such an amount of organic products only when it was not taken from them, and the leaves falling off rotted on the soil. To make hay on such meadows, and take it away, would be to destroy the proportion between the quantity of the organic product obtained from air and water, and that which is not returned again to the same soil, and is elsewhere employed as hay; the consequence of which would be, that in a few years all the plants would pine away, and the meadow would become scarcely better than a lean pasture.

Whoever manures not his dry meadows, must content himself with their inconstant but always small product; but whoever wishes to obtain a more steady, and always a greater product, must take back to them. from time to time, manuring substances; and the greater and more efficacious the quantity of the same is, the richer also will the product be which they will yield, as the manured mountain-meadows show.

22. The pod-bearing plants, perennials, derive only half of their dry products from the humus; the other they owe to the inorganic matter, and since the mass of the roots of clover, of luzerne, and sainfoin, increase yearly about one fourth part of the product of their leaves; hence is clear, the great importance which these plants hold in agriculture, as they yield so great products, and reduce the soil so little.

This opinion is by no means arbitrary, since a well-sown field of luzerne, in a warm climate, yields in a course of five years, twice as much in dry fodder, as has been introduced of earlier dried substance by means of manure. Suppose there has been carried on to it in the time of sowing, 300 cwt. of stall-manure which consists of 150 cwt. of hay and straw, for 1 yoke (1.422 acres), and later twice, each time, 5 cwt. of gypsum has been used; that the harvest has been in 5 years 294 cwt. of hay; in the first year 34; in the four following, always 65 cwt. If now we plough up such a field of luzerne, and all the seeds cast in grow as luxuriantly from the decaying great roots as if they were freshly manured, there could be no doubt as to the correctness of this conclusion. Because the clover usually remains in the soil only two years, its roots are not as important as those of luzerne, but they are always sufficient to affect one quarter of the usual manuring substances from the stall. If the field of clover is thick set, and the growth of the plants has been favored by the weather, then the fresh roots of clover on an average of many experiments bear 140 cwt., and their effect cannot be less than half as great a weight of manure would be. Where the clover is thinner and low, the crop which follows it is then so much the worse.

The causes why fruits following clover so distinguish themselves with respect to their growth and product. must in a slight degree be ascribed to the leaves which have fallen off but in a great measure to the roots remaining in the soil. The experiments which Prof. KÖRTE tried on this subject in 1835, show, that on an extent of a Vienna yoke (1.422 acres), in a part of a clover field where gypsum was used, 366, and on a part where it was not used. 270 cwt. of fresh roots were contained; in the experiments which I tried in August 1837, one yoke of moderately stocked clover gave only 117 cwt. of roots, and a friend of mine found in the same month, per yoke, 87, 124, and 296 cwt., according as the clover was more or less thickly set.

How KÖRTE could obtain from clover which was sowed in the year 1834 with barley, in June of the following year so great a mass of roots, I must leave to be determined; but even in the case where only 140 cwt. of roots per yoke continue in

the earth. yet this would be equal to the third part of manuring it with stall-manure; and probably yet higher, since the wheat, after a thick grown crop of clover, bears a greater product than if a similar field, but badly stocked with clover, was manured with 100 cwt. of stall-manure. That all the clover roots may benefit the following crop, the field must be ploughed up deep with a well-set cutting-plough, because otherwise the harrow tears up or merely exposes too many roots.

23. The annual pod-bearing plants with small roots, if they are mowed before the formation of the kernels, must be considered equal to the perennials in respect to their need of humus; but the roots which they leave in the soil are too insignificant to be regarded.

I see no sufficient reason why vetches and peas, if they should be mowed for fodder, and only occupy the soil for a short time, should draw away to themselves more humus than clover and luzerne. That vetches only slightly take away from the soil, and that grain, which follows after vetches that have been manured and mowed while green, is only a little inferior to that which is fresh manured, is universal experience. But the roots of peas and vetches are so small that they scarcely deserve mention in the estimate of manure; the roots of lentils and beans must be more regarded.

24. If the pod-bearing plants produce ripe grains, they need for the formation of the same more manure; and we must bring the whole product of the kernels into the estimate of manure.

Every one knows that those fields which have borne ripe vetches, compared with others where they were mowed in a green state, show themselves more enfeebled in proportion.

25. Should the grain plants of the grass-kind be cut before the kernelling, then we must ascribe the formation of $\frac{3}{5}$ of the whole product to the humus, and only $\frac{2}{5}$ to the unorganized matter.

I allow that these statements of particular proportions appear arbitrary, because they are grounded on no definite experience, but are only drawn from the estimate of the quantity of manure for the production of the bodies of the plants. But if we take for granted that plants usually appropriate inorganic matter, and that the grass-kind of plants can do this in a less degree than the pod-bearing ones, so only can the relative amount of the necessity of organic and inorganic matter in these two classes of plants be a matter of doubt. We have reckoned of the pod-bearing plants, should they be cut green, only one half of their product to the humus; and if we here bring $\frac{3}{5}$ of the same into the account, yet we hold them not to be too much lessened and the more so since these suppositions are placed in correct proportions in the following paragraphs.

26. If the grass-kind of grain-plants are cut in a ripe state, their whole product in kernels and straw, must likewise be set down for the diminution of the humus in the soil.

The leaves drying up in a great degree are the special cause that the whole plant is henceforth nourished only by the roots. The greater absorption of humus by the roots, and its large evaporation from the soil which is less shadowed, than with the husk-bearing plants or vegetables, are the principal causes why the soil is so much exhausted by the culture of the grass-kind of plants. So, that there is always a surplus of product to be taken into the account compared with the quantity of humus employed, which at a close estimate probably exceeds 10 per cent., cannot be doubted; but I have purposely overlooked it, because on the other side I have not brought into the estimate the loss which the manuring substances undergo, partly in the bodies of beasts which are fed upon them, partly during the processes of fermentation.

[Veit observes: "The grain fruits with their roots run through the whole upper strata, and appropriate to themselves all the store of dissolved humus there existing. After the time of kernelling, the leaves dry up; therefore the atmosphere operates on the uncovered soil, draws out its moisture, forms a crust, enlivens the weeds, and ripens them."

On the exhausting power of the different grains, Thaer remarks, that "according

to the analysis of EINHOFF, they rank in the possession of nutritious matter, as follows: Wheat 78 per cent.; rye, 70; barley 65 to 70 per cent; oats, 58 per cent.: and consequently the exhausting powers of these grains are, wheat, 13; rye, 10; barley, 7; oats, 5."

In the British Husbandry, Vol. II., p. 92 it is said, in view of the above analysis, that a bushel of wheat, weighing 59 lbs., would absorb about 46 lbs. of nutritive matter.

"	"	rye	"	55	"	"	"	"	$38\frac{1}{2}$	"	"	"
"	"	barley	"	46	"	"	"	"	$30\frac{1}{2}$	"	"	"
"	"	oats	"	34	"	"	"	"	20	"	"	"

27. The root-vegetables draw from the soil, in proportion to the time which they remain in it, $\frac{1}{4}$ to $\frac{1}{3}$ of their weight in humus.

Turnips on stubble ground which remain in the soil only three months, require surely not more humus than the half of the dry product which they have produced in this time; whilst to carrots, cabbage-turnips, beets, we must allow at least $\frac{2}{3}$, since they grow hard longer in the soil. The difference of the product of the succeeding crops will determine for us this question.

28. Potatoes weaken the soil most of all the root-vegetables, because they must be hoed and hilled; because they ripen in the soil; and because their leaves lose the power of absorption before the knobs are formed out.

It seems to me that we must allow $\frac{3}{4}$ of their dry weight to the estimate of manure, if we would not enfeeble the fields by them. If the summer grains, especially barley, always agree so well after potatoes, as every one sees this is no proof against us; since, by the culture of potatoes, the old humus, as well as the newly introduced manure, are brought into a very decomposed state; and the stock remaining in the soil after potatoes, is always large enough to produce a rich harvest of barley. If 250 cwt. of potatoes are gathered for a yoke (1.422 acres), this gives 62 cwt. of dry substance with the stalk; $\frac{3}{4}$ of this is 46.50 cwt.; and if for 10 cwt. of dry stalk, $\frac{2}{3}$ be ascribed to the humus, = 6.66, this makes the whole consumption of organic matter to be 53.16 cwt. But since we have brought to this fruit, with 300 cwt. of manure, 150 cwt. of organic matter in the soil, there remains of it in the field $\frac{2}{3}$, unless we suppose that by means of hoeing and hilling, a greater escape of the humus takes place than what is allowed in the above estimate, which is not perceptible in the first, but especially in the second and third fruits following the potatoes.

29. The oil-plants, and the plants which are to be spun, if they are suffered to ripen, must be computed like the ripened culmiferous grains. If they are taken away from the field in a green state, we need only reckon $\frac{2}{3}$ of their product in dry materials.

There is no sufficient ground for the conclusion that the oil-plants, and those used for spinning, are as absorbing as the culmiferous grains; much more is it true, that the latter appropriates to itself more humus than the former plants. The small, low rape and flax plants, which remain in the soil a shorter time, need not proportionally more for their production, than wheat and rye; and if the flax and hemp are not left to ripen, certainly less. The notion of some that these plants especially exhaust the soil, rests on the observation that many farms which can yield no sufficient addition for that which is wholly taken away from the soil by the oil-plants, and such as are used for spinning, must for a while have their fields withdrawn, as wholly enfeebled, from this culture. But it is clear that here the indirect effect is confounded with the immediate one.

[By the oil-plants, are meant the winter and summer rape-seed, the poppy and dotter. By the spinning-plants, flax and hemp.

Some particulars relating to the plants mentioned in some of the preceding paragraphs may be suitably introduced in this place.

The following estimates from BURGER and SCHWERTZ and from the British Husbandry, show the average amount of seed needed, and the average product of the different plants. The averages are of many experiments, made in different countries, with various soils, climates, and modes of culture. Schwertz uses the French measures. It has been necessary to abbreviate in some cases.

Names of the Fruits.	ACCORDING TO BURGER AND SCHWERTZ.					BRITISH HUSBANDRY.	
	Average proportion of straw to grain.	Seed required.		Product.		Seed required for an acre.	Produce of an acre.
		For a hectare.	For an acre.	For a hectare.	For an acre.		
		Hectolitres.	Bushels.	Hectolitres.	Bushels	Bushels.	Bushels.
Wheat,	100 : 40.6	2.25	2½	22 str. 3977 kilogrs. = 3506 lbs.	25	b'd cast 2½—3½ drilled 2—2½ dibbl'd 5—7 p'ks	28
Rye,	100 : 41.5	1.80	2	22¼ str. 3118 kilog. = 3023 lbs.	25	early sown 2—2½ later 3	25
Barley, winter,	100 : 50.7	2.5	2.71	38 str. 2327 kilog. = 2046 lbs.	34	rich soil 10 p'ks adhesive 12 " light 14—16 "	32—40
" summer,		3	2.8	28½	31½		
Oats,	100 : 61.5	4	4.5	37 str. 4218 kilog. = 3702 lbs.	40	4—7	32
Millet,	—	31 litres	7 qts.	26 str. 3997 kilog. = 3520 lbs.	28	—	—
Beans,	—	1.8 hect.	1.16	—	—	small 3½—4	34
Horse beans in rows		—	bushels.	24	28	drilled 3	
Broad cast,		3.5	3.8	str. 2766 kilog. = 2433 lbs.		dibbled 2	
Peas,	—	2—3	2.2—3.3	24 str. 3000 kilog. = 2640 lbs.	26	broad cast 3 drilled depends on distance	30—40
Buckwheat,	—	1	1.1	25 as 2d crop	27	soiling 2 for corn 5—6 [pecks	26
Vetches,	—	1½—2	1.6—2.2	12½ 15	13½ 16	2½	20 hay 6 tons
Lentils,	—	2	2.2	16	17	broad cast 1½	—
Turnips,	—	2½ kilog.	2¼ lbs.	—	—	drilled 1—2 p ts. broad cast 1½—2	swedish 30 tons, white glob 35 do.
Rape	—	10 or 12 lbs. per yoke.	7—9 lbs.	24—30 metzen per yoke.	16—20	4 lbs.	—
Beets,	—	—	—	300—400 wt. per y'k st'lk 100cwt = 80cwt	250—300	—	—
Cabbages,	—	—	—	—	—	¼ lb. for plants for an acre.	—
Carrots,	—	6 lbs. per yoke.	5 lbs.	300 metz. per yoke = 360		4—4½ or 5 lbs.	400 bushels.
Clover grass,	—	16 kilograms.	14 lbs.	—	—	10—14 lbs. on light soils 12.16 —18 with wheat or oats on clay	—
Sainfoin,	—	4—6metzen per yoke.	ab. 4½—7 bushels.	—	—	broad cast 4 and a little trefoil.	—
Luzerne,	—	34 kilog. per hect.	28 lbs.	—	—	b'd cast 25 lbs. drill d, 15 "	—
Flax,	—	2—3 met. per yoke.	2—3 bushels.	8—10met. per yoke.	8—10b'sh. per acre.	2—3 bushels	10 bush. seed
Hemp,	—	2½—3 per yoke.	2½—3	600—900 per yoke.	500—660 [lbs.	3	500—600 lbs. pulled before seed, if after, ¼ less.
Teasel,	—	—	—	60-100,000 per yoke.	40-75 000 per acre.	1—2 pecks	15—16 packs of 9000.

VEIT, vol II. p. 272 gives us the following table, containing similar results, with some additional items for 1 morgen. ($\frac{5}{8}$ acre): to which a column or two is added to show the equivalents of English measure. The measures used are those of Bavaria, the metzen and scheffel. for the amount of which, in our measure, reference may be made to the Table of Weights and Measures, which accompanies the present Treatise. The quantity is also proportioned to the acre, as more easily understood by the agriculturists of this country. In some instances, the fractions in the reductions may have been omitted.

Names of the Fruits.	Seed requ'd for a morgen.	Seed required for an acre.	Product obtained of grain, roots and knobs.				of hay, str. and stalks		Weight.		Manure.		Proportionate hay value of a scheffel or bushel.
			For a morgen.	For an acre.	For a morgen.	For an acre.	For a morgen.	For an acre.	Weight of a scheffel.	Weight of a bushel.	Manure for a morgen.	Manure on an acre.	
	mtz.	b'sh.	schf.	b'sh.	cwt.	cwt.	cwt.	cwt.	lbs.	lbs.	cwt.	cwt.	
Winter wheat,	1.8	2.6	3	22½			18	21.6	300	50	75	90	1000
" speltz, { corn, speltz,	4.5	5.5	7	52¼	3	3.6	18	21.6	{ 300 / 170	50 / 28	75	90	377
" rye,	2.0	2.9	3	22½			20	24	200	33,1-3	70	84	700
" barley,	1.8	2.6	4	30			18	21.6	260	43	70	84	590
Summer wheat,	2.0	2.9	2	15	4	4.8	15	18	290	48,2-5	50	60	878
" speltz, { corn, speltz,	4.7	5.7	6	45	4	4.8	16	19.2	{ 290 / 160	48,2-5 / 26,2-3	50	60	333
" rye,	2.2	3.1	2	15	4	4.8	17	20 6	270	44,3-5	40	48	642
" barley	2.0	2.9	3	22	2	2.4	12	14.4	250	41,2-5	40	48	565
" oats	3 0	4.3	4	30			14	16.8	180	30	35	42	360
Maize,	0.5	0.72	6	45			30	36	260	43	88	110	722
Millet,	0.3	0.43	2	15	4	4.8	20	24	270	44,3-5	70	84	750
Peas,	1.7	2.4	2	15	4	4.8	18	21.6	300	50	30	36	909
Vetches,	1.7	2.4	2	15	3	3.6	16	19.2	310	51,3-5	30	36	857
Lentils, { table, soiling,	1.7	2.4	2	15			10	12	310	51,3-5	30	36	939
	2.0	2.9	3	22			14	16.8	290	48.2-5			725
Horse beans,	1.5	2.17	4	30			20	24	290	48.2-5	75	90	725
Sow beans,	1.5	2.17	4	30			20	24	280	46,2-3	75	90	600
Faseole,	1.2	1.75	2	15	4	4.8	6	7.2	300	50	30	36	909
Buckwheat,	1.7	2.4	2	15	4	4.8	12	14.4	230	38,1-3	30	36	460
Mixture of oats, vetches and beans,	2.0	2.9	4	30			18	21.6	240	40	35	42	
Sainfoin, for 5 years,	0.6	0.75					33	39.6					
" 7 "	0.6	0.75					30	36					
Potatoes,	3.0	4.3	40	300			8-10	9-12	300	50	80	96	150
Artichokes,	3.0	4.3	32	240			35	42	300	50	80	96	130
Flax,	2.5	3 62			250	300	10	12	270	44,3-5	80	96	
Hemp,	3.0	4.3			350	120	15	18	200	33,1-3	80	96	
Safflower,	0.4	0.5									80	96	
Red clover, to use the year it is sown,	lbs. 10	lbs. 12	lbs.				20	24					
Do. for 3 cuttings,	10	12					50	60					
Do. for 2 yrs. successive,	5	6					35	42					
Luzerne, for 5 years,	3	3.6					50	60					
" 8 "	2	2.4					45	54					
Beets,	1	1.2			180	216	45	54			80	96	91
Cabbage turnips,	0.2	0.24			180	216	35	42			80	96	93
White turnips, fallow,	1.5	1.8			200	240	45	54			80	96	90
" as stubble,	1.5	1.8			80	96	20	24			30	36	60
Carrots,	2.0	2.4			175	210	35	42			80	96	103
Leaf cabbage,	0.2	0.4					350	420			80	96	
Winter rape,	8	9 6	3	22			20	24	260	43	80	96	
Summer cabbage rape,	8	9.6	2⅔	19.6			16	19.2	250	41,2-5	80	96	
" turnip "	8	9.6	2⅓	17.3			14	16.8	245	40.5-6	80	96	
Poppy,	4	4.8	2½	18.5			18	21.6	230	38,1-3	80	96	
Mustard,	8	9.6	2⅔	19.6			16	19.2	260	43	80	96	
Gold of pleasure,	5	6.0	2½	18.5			14	16.8	250	41,2-5	70	84	
Sunflower,	6	7.2	2	15			30	36	225	44	80	96	
Madder,					10	12					100	120	
Teasel,	0.2	0 24									90	108	

Veit, also, Vol. II, p. 70, gives the quantity of clover-seed for a morgen, ($\frac{5}{8}$ acre,) as follows:

	On first rate clover soil.		On good clover soil.		On soil poorer for clover.	
	per morg.	per acre.	per morg.	per acre.	per morg.	per acre.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Broadcast,	9	10.8	10	12	12	14.4
With the clover-seed roller,	6½	7.8	8	9.6	9	10.8
With a turnip-sowing machine,	5	6	6	7.2		

The increase of the power of the soil of the clover above the consumption of this power, he gives in Vol. II. p. 81, as the following:

	On first rate clover soil.		On good clover soil.		On poorer clover soil.	
	per morg.	per acre.	per morg.	er acre.	per morg.	per acre.
	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
After seed, or the first year of vegetation,	20	24	15	18	10	12
After the 2 1 year "	50	60	40	48	30	36
After the 3d and 4th years "	70	84	60	72		

For luzerne, standing from 4 to 6 years, for the whole time, the proportion of increase on the same conditions, stands thus: See Vol. II. p. 90.

cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
120	144	100	120	80	96

For sainfoin, during the same time, and on like conditions: See Vol. II. p. 96.

cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
100	120	80	96	60	72

Of artichokes, he gives, Vol. II. p. 142, as the result of experiments at Schleisheim, from 1824 to 1827, on a morgen, the following product:

	In knobs.		In st'lks and leaves	
	per morg.	per acre.	per morg.	per acre.
	schaffel.	bushels.	cwt.	cwt.
a.) On a strongly manured field,	38	240	42	50.2
b.) For second manuring,	28	165.6	31	37.2
c.) " third "	21	138.6	22	26.4
d.) The 3d y'r on a broken-up pasture, after 2d, without manure	13	80.9	18	21.6

"Considering the weight of a schäffel at 3 cwt, and the proportion of knobs to hay as 2.5 : 1, the product of materials of manure is, according to,

a.) $\frac{38 \times 3}{2.5} = 45 + 42 = 87$, and so the manure, for a morgen, 174 cwt.

b.) $\frac{28 \times 3}{2.5} = 33 + 31 = 64$, " " " 128 "

c.) $\frac{21 \times 3}{2.5} = 25 + 22 = 47$, " " " 94 "

d.) $\frac{13 \times 3}{2.5} = 15 + 18 = 33$, " " " 66 "

Hence artichokes, for fodder and manure, equal lasting clovers, which stand highest, and on a good clover soil surpass them. For where is there a plant which, on an exhausted, dry, light, and chalky soil, will give 15 cwt. of hay value, and 18 cwt. of straw, and thus 66 cwt. of manure on a morgen. Even if 90 cwt. per morgen be charged to the strongly manured artichoke, there is yet 84 cwt. per morgen, not much less than of the durable kinds of clover."

Rows distant from each other.		Turnips in rows—from each other.		No. of turnips.	No. of turnips.	Weight of turnips at an average of 1 lb. each.		2 lbs. each.		3 lbs. each	
						p'r m'r.	p'r acr.	p'r m'r.	p'r acr.	p'r m'r.	p'r acr.
feet.	inches.	feet.	inches.	p r morg.	per acre	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
2		2		10,000	12,000	100	120	200	240	300	360
1	9	1	9	13,000	15,600	130	156	260	212	390	468
2		1		20,000	24,000	200	240	400	480	600	720

Of the product of the oil-plants, in oil, &c., VEIT gives, Vol. II. p. 184, the following comparative estimate :

	1 schaffel of seed gives in		1 bushel of seed gives in		In 100 lbs. of seed is, of		AVERAGE PRODUCT IN— Seed by measure.		Seed by weight.		Straw.		Oil.		Oil cake.		Hay value of the oil cake.	
	Oil.	Oil cake.	Oil.	Oil cake.	Oil.	Oil cake.	per mor.	per acre	per mor.	per acre.	per mor.	per acre	per mor.	per acre.	per mor.	per acre.	per mor.	per acre.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	schf.	bsh'l	lbs.	lbs.	cwt.	cwt.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1. Poppy, ...	85	134	14⅓	21½	37	58	2½	18.5	575	690	18	12.6	212	254.4	335	402	558	669.6
2. Winter cabbage rape, . .	96	150	15.9	24	36	57	3	22	780	936	20	24	288	345.6	450	540	750	900
3. " turnip "	94	148	15.5	23.6	36	57	3	22	768	921.6	20	24	192	230.4	444	532.8	740	888
4. Summer cabbage " . .	84	153	13.4	24.4	33	60	2½	18.5	625	750	16	19.2	210	242	382	458.4	636	763.2
5. " turnip "	78	154	12.5	24.7	31	62	2½	18.5	612	746.4	14	16.8	195	234	385	462	641	769.2
6. Gold of pleasure " . .	70	166	11.2	26⅔	28	66	2½	18.5	625	750	14	16.8	175	210	415	498	691	829.2
7. Sunflower seed, ...	90	124	15	20	40	55	2	15	450	540	30	36	180	216	248	297.6	413	495.6
8. Oil radish, ...	80	161	12.9	26	31	63	2	15	510	612	18	21.6	160	192	322	384.4	536	643.2
9. Mustard, ...	78	160	12.5	25.8	30	61	2½	18.5	625	750	18	21.6	195	234	400	480	666	799.2
10. a. Spring flax, ...	72	190	11.4	30½	26	70	1	7	275	330	10	12	72	86.4	190	228	316	319.2
b. Threshed do., ...	54	193	8.2	31	20	74	⅔	4.6	173	219.6	10	12	36	43 2	128	153.6	213	255.6
11. a. Hemp, good heavy, . .	40	145	6.5	23.3	20	72	1½	10.5	300	360	15	18	60	72	217	260.4	361	433.2
b. " poorer, ...	24	117	3.8	19	16	78	1	7	150	180	15	18	24	28.8	117	140.4	195	234

In this connexion, it may be well to add the result of experiments on the different kinds of oil here mentioned, and some others, which VEIT gives, Vol. I., p. 231. The trial in each case, was with 4 loths (or 2 oz.).

The	oil	of	poppy	burnt	14 hours.
"	"	"	sunflower	"	13 "
"	"	"	rape	"	11½ "
"	"	"	mustard	"	11 "
"	"	"	flaxseed	"	10 "
"	"	"	gold of pleasure (Leindotter)	"	9½ "
"	"	"	olives	"	9½ "
"	"	"	walnuts	"	9 "
"	"	"	beech-nuts	"	9 "
"	"	"	hemp-seed	"	8 "
"	"	"	tallow	"	10½ "

Various experiments have been tried to determine the proper depth at which seeds should be planted. The following result is given by BURGER, Vol. I., p. 296, with respect to maize or Indian corn:

That which was planted at the depth of

No.	1.	1	inch, came up in	8½ days.
	2.	1½	" "	9½
	3.	2	" "	10
	4.	2½	" "	11½
	5.	3	" "	12
	6.	3½	" "	13
	7.	4	" "	13½
	8.	4½	" "	—
	9.	5	" "	—
	10.	5½	" "	17½
	11.	6	" "	—

"The Nos. 8, 9, 11, were dug up after 22 days, and it was found that No. 8 had an inch more to grow to reach the surface of the earth. Nos. 9 and 11 had just sprouted, but were short, and were three inches below the surface. No. 10 came up in 17½ days, but the tender leaf remained only 6 days green, and then withered. There is no experiment which shows more clearly the advantage of a shallow planting in a soil not too loose, and trodden down, than this. The more shallow the seed was covered by the earth, the more rapidly the sprout made its appearance, and the stronger afterwards was the stalk. The deeper the seed lay, the longer it remained before it came to the surface. Four inches was too deep for the maize, and must therefore be for yet smaller grain kernels. It, indeed, came up at that depth, but in the experiment made in the hot time of the year, in June, on the 15th day after it was planted; in the colder season of Spring it would have been 18 or 20 days. If the germ-leaves of the seed lie too long under ground, they begin to get twisted, and will be bleached and die, as in No. 10, or form weak plants, as in Nos. 7 and 11.

"PETRI gives an experiment, made with respect to rye in Oct. 1817, with the following results:

Depth of Seed.	Appeared above ground in	No. of Plants that came up.
½ inch,	11 days,	⅞
1 "	12 "	all
2 inches,	13 "	⅞
3 "	20 "	⅝
4 "	21 "	⅜
5 "	22 "	⅜
6 "	23 "	⅛

"The root-stalk forms itself always next below the surface of the ground, and if we place the grain deep it must first put out its sprouts to the surface, and form its side-branches in a nearer connexion with the air. We never find that the sucker-roots are ranged from below to above, but the contrary.

"As a proof the correctness of this opinion, I will here give the interesting experiment of UGAZY in ANDRE, Okon. Neuigkeiten (Economical Novelties), July, 1817. He tried 76, between the 5th and 15th of June, 1817, on good soil, where the seed was well ploughed in, with different grains, to ascertain how deep the root-stalk stood in the earth, and what influence the different depths would have on the formation of the stalk. The results are exhibited in the following table:

Name of the kinds of Fruit.	Number of root-stalks which remained in the earth.					No. which on average produced stalks.			
	At 1 inch.	At 1 to 1 1-2 inches.	At 2 inches.	At 2 to 2 1-2 inch.	Total.	Of the 1st depth.	Of the 2d depth.	Of the 3d depth.	Of 4th depth.
Winter rye,	742	221	32	5	1000	$2\frac{1}{5}$	$2\frac{2}{7}$	1	1
" wheat,	765	215	17	—	—	$3\frac{1}{7}$	$2\frac{1}{4}$	1	—
Summer "	645	304	42	9	—	$4\frac{1}{5}$	$2\frac{1}{3}$	$1\frac{1}{12}$	1
" barley,	631	317	41	11	—	$3\frac{2}{5}$	$1\frac{3}{4}$	1	1
" oats,	672	241	64	23	—	$1\frac{1}{2}$	1	1	1

"We see here, that $\frac{3}{4}$ to $\frac{3}{4}$ of all these grain-plants had their root-stalk only one inch under ground, and that exactly these produced the most stalks; $\frac{1}{4}$ of them had their roots only $1\frac{1}{2}$ inches deep and had only half as many stalks as the first; at 2 inches deep there was only 4 in 100, and at $2\frac{1}{2}$ inches deep only 9 of 1000; but one only of them produced stalk, while the first, in rye and wheat, showed only $2\frac{1}{5}$ to $4\frac{1}{5}$ stalks.

"From this it is clear that shallow sowing, if the seed is only so far covered as to sprout, and the germ is protected from immediate contact with the air, is preferable to laying the seed deep, because it springs up quicker, and acquires a stronger growth, and has hardier plants."—Tr]

30. The increase in humus which the field acquires by the three-division Egarten husbandry, depends on the fertility which the soil had when it ceased to be sowed; on the climate which more or less favors the growth of grass; on the number of years the field is suffered to lie, and on the plants which grow on the field.

A three years' Dreschfeld-Egarten may in favorable circumstances be considered equal to a two-year proportionally stocked clover field.

31. That any farm may be retained in the same capacity of production, as much manure is required as it would receive, if all the straw of the grass-kind of grain-plants, all the fodder which has grown on the field, and for the products taken away for the production of manure as much in hay and litter, were restored, as the increase of weight is less than that which the plants restored have gained in inorganic matter.

It seems to me necessary to observe here, that, when I maintain that whatever is produced from the field in kernels must be restored to it in equal weight of other vegetables, so that it may continue in the same capacity of production; this should be understood here not merely of straw, leaves, rushes, wood-litter; since these vegetable bodies contain not in sufficient quantity those elements which are essential to the formation of grain; but that we must also allow hay, clover, and generally the means of fodder in a proportionate quantity, which, fed out in the stall and mixed with the animal liquids and litter, produce those bodies which contain the materials (Grundstoffe) of wheat, maize and lentils.

To make the foregoing positions clear by an example, the following estimate of the consumption of manure may answer.

ROTATION OF CROPS.

1 potatoes, 2 barley, 3 clover, 4 wheat, 5 beans, 6 rye, 7 vetch-mixture, 8 oats.

		PRODUCT OF ONE YEAR. In grain.	In straw.
Potatoes 250 metzen = 422.5 bushels, give in dry substance		5170 lbs.	800 lbs.
Barley 20 metzen = $33\frac{8}{10}$ bush.	at 66 lbs.	1320 "	2500 "
Clover.		—	6000 "
Wheat 16 metzen = 27 bushels	" 82 lbs.	1312 "	3000 "
Beans 20 " = $38\frac{8}{10}$ "	" 96 "	1920 "	2000 "
Rye 18 " = $30\frac{3}{10}$ "	" 76 "	1368 "	3200 "
Vetch-mixture		—	3000 "
Oats 24 " = $42\frac{1}{2}$ "	" 50 "	1200 "	2500 "
		12,290 "	23,000 "

If any one should suppose that all the product of plants can only be restored again by organic substances, and there must be given back again to the field all that it has yielded in straw and grain, or that it must be replaced by an equal weight of easily-dissolved organic substances; then in the foregoing case, for the grain drawn from the production of manure 12,280 lbs. are requisite, which must be gathered somewhere else in hay from the meadows, and in litter from the woods. But as we know that plants in part draw their nourishment from other sources, the estimate of the need of manure according to our supposition is as follows:

Potatoes need only $\frac{3}{4}$ of their dry weight, consequently the saving is	1294 lbs.
Clover needs only $\frac{1}{2}$, and therefore gives a saving of - - -	3000 "
Beans need for their straw scarcely $\frac{1}{2}$, and give a saving therefore of	1000 "
Vetch-mixture green needs only $\frac{1}{2}$, and gives therefore - - -	1500 "
Total saving	6,794 "
The above mentioned weight in grain and knobs equals - - -	12 280
Consequently there are needed - - - - - - - - -	5,486 lbs.
But because the mass of manure will be increased by 140 cwt. of green vegetable substance, which reduced to dry weight, equals - -	3,500 lbs.
Therefore the real deficiency in vegetables which needs to be supplied for the production of knobs and grain, is only - - - - -	1,986 lbs.

which must be made up by hay or litter, unless potatoes are employed in part for feeding out, in which case the cultivation of the field requires no additional supply, but also can spare 1890 lbs. of dry potatoes as not necessary for the production of manure.

Here may be introduced the estimates of the need of manure in order to yield a given quantity of production, in § vii. of Vol. II. p. 180, where we must observe that in respect to clover $\frac{3}{4}$ of its weight of product was assumed instead of $\frac{1}{2}$ as the need of manure, and no account scarcely was made of its roots as manure. For the same object serve also the estimates quoted hereafter § iii. B. 8, seq., what proportions the production of plants for trade must bear to those for fodder and the production of litter.

That the above-mentioned statements must be considered only as probable assumptions, any one may easily convince himself who knows that the growth of plants depends not only on the quantity, but also the quality of the nutriment furnished them, on their culture and the influences of the weather, &c. The quantity of nutriment only can be expressed in numbers, and afterwards verified by experience; therefore I have confined myself thus, in forming an estimate of the proportion between the manure and the product.

[The estimates to which the author refers as found in Vol. II. p. 180, occur in the following connexion: "If we take the straw from the field for fodder, then will a considerable part of its weight be partly assimilated to the flesh of the animal, partly be dissipated, and the remainder only be applied to the benefit of the manure. If further we take from the field much grain-fruit, if we must repay a proportion of it, and are not in a situation to restore it in the same measure by straw, grain, by wood and bog litter, meadow-growth, manure purchased, &c., then will the quantity of the manure produced be always smaller, and the harvest from year to year become worse.

In order to show clearly the value of manure, and the alteration of the power of production of the field, we will quote the product as it really follows under certain given circumstances, and show the aids which are necessary to increase the product. The field will be viewed as tilled according to the rules of the Threefield system, with fallows. Its product per yoke (= 1.422 acres) in grain, the first year, as fallow, was,

2d year,	winter rye,	16 metzen	= 27	bushels.
3d "	oats,	18 "	= $30\frac{3}{10}$	"
4th "	fallow,			
5th "	winter ry,	14 "	= $23\frac{6}{10}$	"
6th "	oats,	16 "	= 27	"
		64 "	= 103	"

In straw, the field gives,

of winter rye, on	2	yokes	= 2.844 acres,	6,200 lbs.
oats,	"	"	" "	2,600 "
				8,800

If the field should henceforth produce this crop, then must it, for the 30 metzen (= 50.7 bushels) of winter rye at 80 lbs. per metzen, = 2,400 lbs., and 34 metzen (= 57½ bushels, nearly) of oats, at 50 lbs. per metzen, together 4,100, yield a sufficient substitute; therefore, at least as much weight in good hay, that is for 6 yokes of plough-land, a yoke of good meadow is necessary; or, if a part of the straw is foddered out, or is taken away for other purposes, then we must have at hand, in proportionate quantity, some foreign materials of litter.

If one changes 88 cwt. of straw, and 41 cwt. of hay, by fodder and litter, into stall-manure, then he has, as we have proved in another place, 278 cwt. of half-rotted manure, = 23 double-spanned cartloads, which must be carried out in the fallow of the first year. As the field is manured only once in 6 years, this comes each year to 46 cwt.

If now we wish to cultivate peas, but without having a less product of rye and oats:

	Metzen.	Bushels.	Wt. of metzen.	Wt. of bushel.	Whole weight.
In the 1st year, Peas,	12 =	20.28	94 lbs. =	56 lbs. nearly.	1128 lbs.
" 2d " Rye,	16 =	27	80 " =	48 "	2280 "
" 3d " Oats,	18 =	30.3	50 " =	30 "	900 "
" 4th " Peas,	10 =	16.9	94 " =	56 " nearly.	940 "
" 5th " Rye,	14 =	23.6	80 " =	48 "	1120 "
" 6th " Oats,	16 =	27	50 " =	30 "	800 "
	86 =	145.28			6168 "
2 yokes of peas give of straw,					6600 "
Straw of rye and oats, as before,					8800 "

The greater production which we may wish to secure gives, in 2 yokes (= 2.844 acres), 22 metzen of peas (= 37.18 bushels), = 2068 lbs., and 66 cwt. of straw, together in weight, 8868 lbs. If with the beginning of the new culture, we buy 21 cwt. of hay, and 66 lbs. of straw, and change it in the yard into manure; or if we buy 174 cwt. of good stall-manure, and carry it on the fallow field, then this product would be possible. If this mode of culture be pursued, there would be needed as much hay as the weight of the grain bears, 6168 lbs., that is, for 6 yokes of plough-land, would be needed 2 yokes of usual meadow, or other kind of substitute, in litter, pasture, &c., in order to be able to employ the straw more for fodder, and to need less hay. Should 6168 lbs. of hay be made into manure, with 15,400 lbs of straw in the stall, then this would give 431 cwt., = 36 double-spanned cartloads. If we divide this quantity of manure among 6 years, then there is for each, 71 cwt. per yoke.

But does this product correspond too little to our needs? Do we wish more grain, and because for this more manure is necessary, do we wish to produce this by employing a part of the field for plants for fodder?

Since we have not sufficient meadow or other opportunity to procure the materials for manure, for this purpose we cultivate our land in the following rotation:

	Metzen.	Bushels.	Weight of a metzen.	Weight of a bushel.	Whole weight.
1st year, Maize,	40 =	67.6	80 lbs.	48 lbs.	3200 lbs.
2d " Barley,	24 =	40.5	66	40 nearly.	1584
3d " Clover,	—	—	—	—	6000
4th " Winter Rye,	18 =	30.3	80	48	1440
5th " Peas,	12 =	20.28	94	56 nearly.	1128
6th " Oats,	18 =	30.3	50	30	900
	112 =	188.98			14,252

We shall have of straw—of Maize, 3500
of Barley, 2000
of Winter Rye, 3200
of Peas, 2000
of Oats, 1400
13,100 lbs.

According to the before-mentioned culture, we produced—

of Grain,	6,168 lbs.
of Straw,	15,400
	21,568
Now we have produced, in Grain and Clover,	14,252 lbs.
Straw,	13,100
	27,352 lbs.

This is 5784 lbs. more than by the former culture, for which we in the beginning, that is, in the first year, buy 20 cwt. of hay, and 40 cwt. of straw, or 120 cwt. of manure, which, together with the already-produced manure, we bring upon the field of maize. The field yields us by this culture, in

Grain,	8,252 lbs.
Straw,	13,100 "
Clover,	6,000 "

We should need to make up for the hay, 8252 lbs. But because the clover, by the falling leaves, and yet more, in a great part, by its many and great roots remaining in the soil, yields a compensation for the humus received; therefore only $\frac{3}{4}$ of the weight of its product need be reckoned as necessary for the production of manure, and we subtract then from the 8252 lbs. of the hay required, 2000 lbs; there remain over only 6252 lbs. of hay, which we need yearly in carrying on this culture, besides the clover.

Should there be	6252 lbs.	of hay,
	6,000 "	" clover,
	13,100 "	" straw,
total,	25,352 lbs.	to be converted into manure, then we have

517 cwt., = 43 double-spanned cartloads. Divided among 6 years, it comes to 86 cwt. per yoke.

In the Threefield system, we have had 41 cwt. of hay necessary to produce 64 metzen of grain; here we need 52½ cwt. of hay, but for it we produce 112 metzen on $\frac{5}{6}$ of the same extent, which we owe in a great measure to the clover.

The estimate is derived from the above proposed positions—that the field remains in like power, if that which it produced be employed again on it; and will produce a compensation for that which is taken from it. If one know, therefore, what he has produced from one manuring to another, and also how much manure he had, he can conclude with tolerable accuracy as to the increase of the latter on the quantity of the increase of production."

Veit has many interesting particulars on these subjects, which in part I shall be obliged to quote in substance only. According to various experiments, the following conclusions are established, Vol. I. p. 333:

"1. That if the soil is fructified before the sowing of the seed, the vegetation is stronger and more rapid than if manured after the sowing of the seed.

"2. In the period from the time of germination to the starting up of the grain stalk, or shooting of ears, a much greater effect follows the manuring than later. But especially was the greatness of the number of the culms of a single root-stalk dependent on the manure which was applied equally after the course of the seed-time, or the coming forth of the germ-leaf, to the putting out of the fourth leaf.

"3. In the period from the beginning of the shooting forth of the ears to their development out of their sheath, the manuring was yet noticeable, but about $\frac{1}{3}$ less than in the former period.

"4. Were the ears already formed and the addition of the grain already visible, then the consequence of manuring would not in all cases be verified, or at most only a slight, scarcely perceptible change of color of the culm.

"5. If manured after the blossom, no trace of the given manuring was noticeable.

"6. The fruits that followed gave, agreeably to the foregoing results, so much the better harvest, by how much the shorter time after the germination of the manured fruit preceding they were taken from the soil or harvested." "The most active working over of the nutritious substance appears, in other words, in the period from the beginning of the putting forth of the culm to the breaking out of the ears from the same. In this period is formed the comparatively vegetable mass, which in the beginning of the time of flowering unites in itself nearly all the nutritious substance,

whilst the hay value of the fruit mown at this time, is not much less than the same fruit in a ripened state. As with the appearance of the blossom, besides moisture plants draw little more nutriment from the soil, so the collective deposit in the roots and stalks gradually conduct the ears to the formation of seeds. Since the longer time before the blossom the plants are cut, so much better is the success of the after-fruit, therefore so much the more nutriment remains in the soil. But the longer period after the flowering the harvest is gathered, so much the more is the power of the soil weakened.

"The progress of the exhaustion of power may be observed in the plants for fodder. The further indeed the meadow grasses or kinds of clover are advanced at the time of being cut in their flower or formation of seed, so much the weaker does the after-increase show itself, compared with those places on which the first cutting was made before the approach of the flower. On this is based the remarkable exhausting power of fully ripe clover.

"But the highest gradation of the exhaustion of power is seen in the so-called yellow-ripe or dead-ripe fruit, in which the plants likewise are dried up and have lost all vegetable life. This state should be avoided as much as possible. The plants of the usual husk-fruit ripen not suddenly but gradually, so that the greater part of the fruit may be ripe, whilst the tips of the plants yet bear flowers, or at least are yet green. The collective production of these plants will therefore rarely be dead-ripe or over-ripe, and on that account the exhaustion of power is less with them in general than with the grain-fruits which are usually cut yellow-ripe."

Again, on p. 341, he says: "As the manure is to be viewed in a progressive decomposition, and the most nutritious animal substances are already consumed for the most part the first year after manuring, or are escaped by evaporation, the less easily decomposed or harder dissolving undergo a decomposition somewhat later; as soon indeed as the condition of the putrid fermentation operates upon them; thus the power of the manure gradually disappears from the soil even without the cultivation of plants. It is estimated that of the nourishing parts of the manure in the 1st year at least 50 per ct., in the 2d, 25 to 33, in the 3d, 15 to 20, and in the 4th, 10 to 15 per ct. are consumed. On soil which possesses no old stock of power, other circumstances being equal, the decrease of production will nearly correspond to the decrease of the manuring power, but not on grounds possessing old power of the soil, upon which, as we have already shown, the diminution of production according to the distance of the plants from the time of manuring, will scarcely be 25 to 30 per ct. But it is ever the rule, that the fruit to which the manure is given will consume most of it, and indeed so much the more as it is according to its nature the more capable of nourishment; demands a stronger working over of the soil; the less it shadows the soil; the more active the soil is; the more dissolved the manure is, and the longer the period of vegetation is." Again, p. 345, "Plants, other things being equal, are very different in respect to the need of manure and compensation for it. They are divided thus:

"1. Into such, the whole product of which employed for the production of manure would scarcely cover half the need, and which, after the withdrawal of the usual parts to be sold with the remaining part for the manufacture of manure, can supply only from a 4th to a 3d part of the need of manure. They are therefore consuming in the proportion of $\frac{6}{4}$ to $\frac{8}{4}$, or their need is to their supply of manure: as 6—8: 4. Here belong flax, poppy, tobacco, hemp, &c.

"2. Those, the collective product of which including the roots and stubble remaining in the soil, equals or wholly covers the need of manure as all the cereals, rape, &c., which therefore are $\frac{4}{4}$, or in the highest $\frac{5}{4}$ consuming.

"3. Those, $\frac{2}{3}$ to $\frac{3}{4}$ of the product of which suffices for the supply of the consumed manure, wherefore they are only consuming at the rate of $\frac{2}{3}$ to $\frac{3}{4}$, as the usual husk-fruits, and root and knob-vegetables.

"4. Those one-year fodder-plants which are cut in their green state, $\frac{2}{4}$ to $\frac{3}{4}$ of the product of which are set off for the need of manure, as a mixture of fodder, peas, buckwheat, rye, &c. These are usually called soil-power saving (bodenkraft-schonend).

"5. Into those perennial plants for fodder, the whole production of the fodder from which goes to the manufacture of manure, and of the mass of the stubble and roots remaining in the soil, half answers to supply the consumed manure, and half remains for surplus to increase the power of the soil. The quantity of manure going

to the soil through the collected mass of roots and stubble, is on one morgen (= $\frac{5}{6}$ of an acre).

Of Luzerne, after 4 to 5 or more years' standing -	200 cwt.
Sainfoin, " " " " " " - -	160 "
Two years' red clover - - - - -	120 "
Many years' natural meadow and pasture - -	120 "
One year's red and white clover - - - -	80 "

one half of which is to be counted for the consumption of manure, and half as to enrich the power of the soil.

"6. Into manuring plants for the so-called green-manuring which give to the soil after the deduction of its own consumption, an increase of from 30 to 40 cwt."

The following tabular view, in which examples are taken from the actual cultivation of many farms, shows the different proportions of the supply of manure to the need of the same. See VEIT, Vol. I. p. 347:

A.—ON A GOOD CLOVER SOIL.

	Manure employed.	Supply of the power of manure by manure of plants.	Total.	Harvest.			Gain, manure.		Manure.		Of manure employed on a morgen.	
				In grain.	In straw, hay, and hay value.	Total.	From the whole product.	Without grain sold.	Deficiency.	Surplus.	Without clover, and fallow.	With clover, and fallow.
I.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
Pure fallow,	140		140									
Winter wheat,				9	18	27	54	36				
Barley,				8.7	14	22 7	45.4	28				
	140		140	17.7	32	49.7	99.4	64	76		70	46
II.												
Clover,		40	40		30	30	60	60				
Winter wheat,	100		100	9	18	27	54	36				
Barley,				8.7	14	22.7	45.4	28				
	100	40	140	17.7	62	79.7	159.4	124		24	50	33
III.												
Mixture,	160		160		20	20	40	40				
Winter wheat,				9	18	27	54	36				
Barley,				8.7	14	22.7	45.4	28				
	160		160	17.7	52	69.7	139.4	104	56		53	53
IV.												
Beans,	200		200	12	20	32	64	64				
Winter wheat,				9	18	27	54	36				
Barley,				8.7	14	22.7	45.4	28				
	200		200	29.7	52	81.7	163.4	72				
V.												
Potatoes.	210		210	45 }	53	106	106					
Potato stalks,				8 }								
Winter wheat,				9	18	27	54	36				
Barley,				8.7	14	22.7	45.4	28				
	210		210	17.7	85	102.7	205.4	170	40		70	50
VI.												
Potatoes,	180		180	45 }	53	106	106					
				8 }								
Barley,				8.7	14	22.7	45.4	28				
Clover,		40	40		30	30	60	60				
Winter wheat,				9	18	27	54	36				
	180	40	220	17.7	115	132.7	265.4	230		50	60	45

A.—ON A GOOD CLOVER SOIL.

	Manure employed.	Supply of the power of manure by manure of plants.	Total	Harvest. In grain.	Harvest. In straw, hay, and hay value.	Harvest. Total.	Gain, manure. From the whole product.	Gain, manure. Without grain sold.	Manure. Deficiency.	Manure. Surplus.	Of manure employed on a morgen. Without clover, and fallow.	Of manure employed on a morgen. With clover, and fallow.
VII.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
Potatoes,	180		180	45 } 8 }	53	106	106					
Barley,				8.7	14	22.7	45.4	28				
Clover,					30	30	60	60				
Clover,		60	60		20	20	40	40				
Winter rape,	120		120	8	20	28	56	40				
" wheat,				9	18	27	54	36				
Oats,				6	16	22	44	32				
	300	60	360	31.7	171	202.7	405.4	342				
VIII.												
Potatoes,	180		180		40 } 8 }	48	96	36				
Potatoes,	170		170		50 } 10 }	60	120	52				
Barley,				8.7	14	22.7	45.4	28				
5 year luzerne,		100	100		225	225	450	450				
Winter rape,	130		130	8.5	22	305	61	44				
" wheat,				9	20	29	58	40				
Peas,				9	16	25	50	32				
Winter rye,				8	18	26	52	36				
	480	100	380	42.7	423	466.2	1022.4	718		238	68	40
IX.												
Flax,	220		220	4	14	18	36	22				
Winter wheat				9	18	27	54	36				
Barley,				8.7	14	22.7	45.4	28				
	220		220	21.7	46	67.7	86	134			73	73

B.—ON GOOD SAINFOIN SOIL.

I.												
White Clover,		40	40		25	25	50	50				
Winter rye,	140		110	8	20	28	56	40				
Oats,				7	15	22	44	30				
	140	40	150	15	60	75	150	120		10	55	36
II.												
Potatoes,	210		210		48	48	96	96				
Winter rye,				8	18	26	52	36				
Oats,				6.3	15	21.5	43	30				
	210		210	14.5	81	95.5	191	162	48		70	
III.												
Beets,	190		190		60	60	120	120				
Summer rye,				8	16	24	48	32				
5 years' sainfoin,		80	80		125	125	50	250				
Winter rye	155		155	9	22	31	62	44				
Peas,				8	15	23	46	30				
Oats,				7	16	23	46	32				
	345	80	425	32	254	286	572	508		163	69	34.5

We have therefore the following results:

1. By employing a pure fallow, the mutual operation of the atmosphere and the constituent parts of the soil, aids the decomposition of the organic matter and hence, prepares the nourishment of the plants for a more rapid consumption. Therefore, the crops in a pure fallow succeed so well. But the power of the soil, will on this

account, be withdrawn in so great measure, that the fruit next following will be found disproportionately small. No increase of the power of the soil, consequently, can be ascribed to the pure fallow.—See Class. A., I.

"2. In the cultivation of the fallow with fodder-plants that consume much nutriment, the supply of manure is, with potatoes 20, with mixed fodder 33, and with beans 36 per cent.; whilst, in the pure fallow, 50 per cent. is required. If the fallow is cultivated with strongly-exhausting plants for trade, which contribute little material for the manufacture of manure, as under A., IX, then the supply of manure mounts up to 61 per cent. From this, the weight of the grain to be sold, and other parts of the material for the fabrication of manure, are to be deducted.

"3. But should the whole product of the plants be employed for the manufacture of manure, then the supply of manure is, with potatoes in the fallow, 2.3, with the mixture 12, with flax 38, and with pure fallow itself 28 per cent.

"4. Of the given manure for A, on a morgen cultivated with exhausting fruits, is used at least 50, in the highest 75, on an average 63 cwt. of manure, and for B. 65 cwt.

"5. Wherever one of the perennial plants for fodder is adopted in a period of manuring, there is a surplus of manure.

"6. But the most striking influence of the property of luzerne to increase the power of the soil, is shown by the course of fruit A., VIII, after which the potatoes, being otherwise employed—which make the best preparation of the soil for luzerne—the least harvest of fodder was obtained, rape is interposed, and yet a surplus of manure gained of 238 cwt.

"7. On a lime, gravelly, sainfoin soil, for an equal production, more manure was required, or of an equal quantity of manure, a less production was obtained. After B., I, II, III, on a morgen cultivated with fruits for sale, were carried on, on an average, 65 cwt. of manure, whilst on the better soil A., with 63 cwt. on a morgen, a greater and better production was gained.

"8. From the amount of the deficiency of manure, may be reckoned the addition to be made in meadow and other lands for fodder.

"9. The proportion of the supply of manure to the need of the manure, is here shown in general. But how much of the employed manure must be counted to each fruit, will be more closely determined in the economy of the culture of plants, when the standard of the cost of manure for reparation of the soil shall be exhibited under the different plants cultivated on a farm."

"Of the full manuring of 200 cwt., therefore, for the winter-fruits, we reckon in the 1st manuring 90 to 100 cwt.; in the 2d, 65 to 75 cwt.

"Of the summer-fruits, the most craving are potatoes, turnips, tobacco, maize, artichokes, flax, &c.; they require in the first period of manuring 80 to 90 cwt. of manure, and in the second, 60 to 70 cwt.

	Period I.	Period II.	Period III.
Beans and millet require manuring,	70—70	50—60	
Summer-wheat, speltz, &c., rye, barley,		35—50	25—30
Oats, ...		30—40	20—25
Peas, vetches, lentils, buckwheat, .		25—35	15—20
Annual vegetables for fodder, as fodder-mixture, rape, &c., . . .	30—40	15—25	10—15

Thaer also has estimates on these subjects. Thus, in Vol. I., p. 175, he says

"We reckon

1 yoke (= 1.422 acre)	of potatoes and other fruit of this kind at	16,500 lbs.	of manure.
"	" clover, in two cuttings, . .	11,380	"
"	" clover, in one cutting, . . .	6,350	"
"	" luzerne, ...	18,970	"
"	" manured vetches, ...	9,490	"
"	" unmanured "	3,690	"

This is exclusive of the increase of weight which the litter-straw produces.

With respect to straw, he observes, that the proportion of the grain to the straw is as follows:

With rye,	between	38 and	42	to 100.
" wheat,	"	48 —	52	"
" barley,	"	62 —	64	"
" oats,	"	60 —	62	"
" peas,	"		35	"

The following Table of THAER's, also shows the quantity of manure applied by different modes of manuring. Of 1850 lbs. cart-loads, there are carried on a yoke (= 1.422 acre) $11\frac{1}{4}$, 18 to $22\frac{1}{3}$. The first is called *weak*, the second *good*, the third *strong* or *rich* manuring.

With $11\frac{1}{4}$	cart-loads or	20,800	lbs.	there will be put on	one square foot	0.403 lb.
13	"	24,000	"	"	"	0.464
15	"	27,700	"	"	"	0.536
18	"	33.300	"	"	"	0.644
20	"	37,000	"	"	"	0.716
$22\frac{1}{2}$	"	41,600	"	"	"	0.805

With the strongest manuring, therefore, there is on a square foot 0.8 lb.

SCHWERTZ too, in Vol. III., p. 141, Anleitung zum Practischen Ackerbau (Guide to Practical Agriculture), has many valuable observations on this subject. He inquires, How much do vegetables gain or lose by their conversion into manure? To answer this question, he says, "that in modern times there has been proposed a multiplier for these materials before use, and variously from 1.3 to 3.7, according as the discussion was of litter or of fodder, of the greater or less nutriment of the latter, or its more or less juicy state. It makes, indeed, the highest conceivable difference, whether the beasts are nourished by watery or dry substance, good or bad; whether they are littered proportionally much or little; whether the weight of fresh manure, or that which has lain some time, be brought into the account, and how long. in this latter case, the manure has lain; whether it has been protected, and how treated; with what kind of beast, finally, the straw and fodder has been employed, since that used by the cow yields more fresh manure than that by the horse, and this more than that by the sheep. But with whatever species of beasts both may be used, therefore the weight of the fresh manure thereby obtained, rests almost simply and alone on the quantity of moisture which is mingled with it, and only in the smallest degree on the kind of the beast, provided that the beasts are sound. and in a condition to be fed for their needs. Therefore the weight is nearly equal, if we take the excrements in their dry state. This dry weight, with a cow is 44, with a horse 40, with the sheep 42. We may hence disregard the difference of the consumer, and in the following estimate confine ourselves to cattle as the most common.

"One of the greatest difficulties in this estimate lies in this, that the beast is not always foddered with dry, but also with juicy substances. Of the first, it is known that though a portion of it, going from the maw to the animal's support, is employed for growth, &c., and therefore is lost for manure, yet the dry fodder yields a greater weight in the excrements than it bore before it was eaten. This increase of weight can rest on nothing else than on the addition of water or other liquids which are introduced into the body of the animal. Wholly contrary is the proportion with green fodder, the texture of which is not only sufficiently filled with its own juices, but of which it makes more than its separated parts could hold after their decomposition. There can, therefore, be no increase of substances foddered out in a still juicy state, but a diminution in its mass must take place, whilst the surplus of moisture then separates itself therefrom, and partly evaporates, and partly unites with the dry-eaten fodder, and partly goes off with the urine and soaks into the litter.

"It follows, therefore, that if we would make an estimate before-hand of the production of manure, it is necessary to bring the substances foddered out, to one common measure of solid parts. and from this to conclude on the increase of weight in manure, on account of the admission of moisture, which is added in the maw or entrails of the beast. It might, indeed, seem, that the dry parts of one absorbing substance would take up more watery parts than those of another, as is the case in different subjects of which they are derived; but the wateriness of organic bodies proceeds not so much from their constituent parts, as from the kind of connexion of those parts and their texture. As this texture is loosened by digestion. so the difference of their water-retaining property passes away, and one pound of dry potatoes will not give more manure than one pound of hay. We have therefore to determine, first, how much dry substance the usual fresh or juicy articles of fodder give after the loss of their moisture, and for this purpose, quote the statements of the excellent A. K. Block." It will be recollected, that we have already quoted a table of Equivalents from this distinguished author, which our readers may find, with other similar and valuable ones, on page 30 of the present work.

"According to BLOCK, there is contained of solid substance,

In 100 lbs. of	hay	21 lbs.
"	potatoes	28 "
"	beets	12 "
"	carrots	13 "
"	cabbage-turnips	21 "
"	turnips	9 "

"We seek to know, therefore, how much dry substance the beast eating can appropriate, and how the rejected parts are increased.

"The solution of the first part of this question is so difficult that we may consider it in general as impossible to answer it satisfactorily. We observe for example that one head of kine, with equal fodder, gives more milk, obtains more flesh and fat, and uses up more of the fodder than another; that one dry substance is more nutritious than another; that therefore foddered in equal quantity the animal bodies retain more or less of it, and in the same proportions more or less is cast out therefrom; that beasts digest that which is eaten better or worse, as well as that the food in and of itself is more or less digestible, &c. Hence, therefore, there remains for us nothing else than to overlook wholly the decrease drawn out by the nourishment—and this may easily be done, since that decrease in fact is not so great that we should represent it to ourselves—and which is replaced again, if not wholly yet in a great degree, by that which the animal organization takes from the air, heat and water, as well as by the slime mixed with the excrements.

"Not much less difficult is it to determine the weight of that thrown out, since its increase rests solely and alone on the moisture mingled with it. But the excrements are, as we know, sometimes thinner, sometimes thicker, and lose weight after being cast out each day, and even each hour, so that they sometimes contain 90, sometimes 80, 70, 60, 50 per cent. of moisture, according as they have lain a longer or shorter time; as they have been carefully or negligently handled, as they have been gathered in the stall or in the yard. Any one can see what a striking difference these circumstances must produce in the weight of the manure. According to the experiments of the Abbate Gazzeri, manure lost after some 4 months, 54.81 per cent.; thus above half its weight. As this learned man, whose experiment was proposed with only a small mass (some 40 lbs.), sought diligently to diminish the fermentation and evaporation of the same, we may suppose that the manure in a considerable mass treated after the usual manner would have lost far more.

We conclude, therefore, that when manure is brought on the field its moisture has lost in proportion to its solid parts $\frac{3}{4}$ of its weight, therefore it yet contains 75 per cent. of moisture, a state in which on an average it will for the most part be brought on the field. Accordingly we may expect of the substances fed out the following quantity of manure.

100 lbs. of fodder.	Contain lbs. of dry parts.	Give in lbs. of manure at 75 per cent. moisture.
Hay	100	175
Straw	100	175
Clover	21	$36\frac{3}{4}$
Potatoes	28	49
Beets	12	21
Carrots	13	$22\frac{3}{4}$
Cabbage-turnips	22	$38\frac{1}{2}$
Turnips	10	$17\frac{1}{2}$
Straw-litter	100	200

"The multiplier of all the substances mentioned in a dry state will therefore be 1.75, with the exception of the litter, which I have taken at double its weight for manure, because it gives nothing for the support of the beasts, and also, on account of its cellular tissue and hollow stalks, it is in a state to take up more moisture than can be the case after bruising and digestion."

SCHWERTZ also gives the following tabular view of a Hectare, 4 of which are equal to 10 English acres (therefore about $2\frac{1}{2}$ acres) of green and dry fodder, and the manure furnished by the same:

Articles.	Weight of Fodder and Straw.		Product in Manure.	
	In a fresh state.	In a dry state.	At 75 per cent. moisture.	
	Kilograms.	Kilograms.	Kilograms.	Cartloads.
Cabbage-turnips,	35 000	7700	13415	14.86
Potatoes, . .	27,000	7560	13230	14.70
Luzerne, . .	26,200	5504	9097	10.10
Turnips, . .	50.000	5000	8750	9.72
Clover, . .	23,800	4998	8270	9.19
Carrots, . .	35,000	4550	7962	8.84
Maize, . .		4500	7875	8.75
Beets, . . .	36,000	4320	7560	8.40
Rye, . .		3500	7000	7.77
Rape, . . .		3000	5250	5.80
Oats, . .		3000	5250	5.80
Meadow-grass, .	13,300	2793	4888	5.43
Beans, . .		2500	4625	5.14
Peas, vetches, .		2500	4625	5.14
Barley, . .		2200	3850	4.27

A Kilogram is nearly $2\frac{1}{4}$ lbs.

"Considerable as is always the production of the straw of a field, yet we see that it is not equal in reference to the mass of manure of the several plants for fodder, since, if we average the articles quoted which yield fodder, it gives material for only $10\frac{1}{2}$ cartloads of manure, whilst the articles producing straw yield only for 9 cartloads per hectare. Hence it is not to be overlooked, that the fluid parts drawn from the juicy plants by digestion are not generally lost, although they are no more found in the excrements derived from those vegetables. But they unite themselves mostly with the dry eaten articles, as well as with the litter. What those, therefore, lose, will be pure gain for these, from which we may conclude how important green fodder generally is. If cattle have no juicy articles, they must drink the more; the quantity of their excrements indeed remains the same, but the quality will not gain much by the strong addition of water, though as to this last the operation cannot all be denied to its improvement."

Burger, Vol. I., p. 121, speaking of plants to be employed as green manure, says: "For a climate in which wheat ripens at the end of June, the lupine—*lupinus albus*—is the most important plant: to this succeed, in colder regions, vetches, gray peas, turnips; for easy soils, spurry and buckwheat."

"The experiments which were made in the experimental fields of the Agricultural Society of Vienna, in the years 1823–4, 1833–4, with such manuring, and which are given Vol. II. 2nd part, and Vol. III. 2nd part, of their Transactions for the year 1834–5, prove especially the great effects of manuring with lupines and gray peas on the ground. In the autumn of 1832, a field was sown with rye. For one yoke (1.422 acres) there was used 1.61 metzen (2.67 bushels) of seed, which was evidently too small. This field was divided into seven parts, and each part had a different preparation, and gave in the next summer of 1833, a product reduced to the yoke as follows:

The above mentioned preparation of the fields.	Product of a yoke, (about $1\frac{1}{4}$ acre.)				
	In grain.			In straw.	str. per acre.
	metzen.	achtel.	bushels.	lbs.	lbs.
1. White lupines, ploughed in,	41		69.3	3912	2600
2. Vetches " "	27	2	46	2232	1500
3. Rye " "	21	6	34	2832	1890
4. Pure fallow, manured,	31	4	52.5	3925	2602
5. Clover stubble, half manur'd	23	3	37.2	2635	2008
6. " unmanured,	23	1	37	2724	2066
7. Barley stubble, half manur'd	27	5	46.6	3480	2411

"The next year, 1833, there was not a sufficient quantity of lupines, and therefore gray peas were taken, which are usually cultivated as fodder-plants. These peas were sowed in the spring, in the half of a field devoted to winter plough-land and ploughed in in their blossom, and once more sowed with peas, which had grown already so far, at the time of sowing rye, that the pods had begun to set. In the other half of the field, peas sowed in the spring were suffered to ripen, and then on this, stall-manure was used at the rate of 380 cwt. a yoke (or 253 cwt. for an acre). Each of the two pieces were divided into two equal parts, and one sowed with winter rye, and the other with wheat. The amount sown, and product, are given in the following table:

The above mentioned preparation of the fields.	Seed sown.		Product in			
			Grain.		Straw.	
Winter Wheat.	Per yoke.	Per acre.	Per yoke.	P'r acre	P'r yoke	P'r acre
After the ripe peas were taken off, manured, 30 loads of 12 cwt. on a yoke, (or 240 cwt. per acre,)	metzen. 2.44	bushels. 4.12	m. 8ths masl. 22 7 $\frac{1}{2}$	bushl's 48.7	lbs. 3,348	lbs. 2,500
Double green manuring, with gray fodder peas,	2.71	4.17	30 3 $2\frac{1}{2}$	65	4,580	3,131
Winter Rye.						
Manured as above, after peas taken off,	3.31	5.09	23 7 $1\frac{3}{4}$	50.5	4,731	3,228
Double green manuring with gray fodder peas,	3.63	5.63	27 6 $1\frac{1}{4}$	47	5,618	3,900

"The results of these two experiments are very decisive, and so far as one may reason from the less to the greater, they show that the marked effects of green manuring cannot be ascribed to circumstances merely."

The following statements and estimates may perhaps be as well introduced here as elsewhere:

From an experiment on the comparative weight of manures, it appears according to the British Farmer's Magazine, that—

	cwt.	qrs.	lbs.
"One cubical yard of garden-mould weighs -	19	3	25
" " " water - - -	15	0	7
" " " of a compost of earth, weeds, lime and dung that had lain 9 months and been turned over	14	0	5
" " " new dung - - -	9	3	18
" " " leaves and sea-weeds -	9	0	7

"Thaer calculates the weight of a cubic foot of any straw farm-yard manure at only about 46 lbs.; while one that has been partly decomposed will weigh from 56 to upwards of 60 lbs. without being compressed." Thaer also remarks respecting the evaporation of manure, not only does theory teach us but during his own experience he has had frequent occasion to observe, "that it is hurtful to remove farm-yard manure while it is in a high degree of fermentation; for according to all appearance, an essential portion of the most active substances of which it is composed are evaporated when exposed to the air while that process is going on. But before the fermentation has arrived at its height, or after it has passed, the dung does not seem to lose any thing by exposure to the air; or at least, nothing but what it regains by some other means." Sir Humphrey Davy says, that "dung which has fermented so as to become a mere soft cohesive mass has generally lost from one-third to one-half of its most useful constituent elements." Prof. Coventry of Edinburgh, has calculated that on an acre of arable land of a medium degree of fertility and management may be produced in round numbers 28 bushels of wheat, 36 of barley, 42 of oats; and that the average quantity of straw yielded by those crops will amount to 21 cwt. He supposes that this, if moistened and rolled, would gain $\frac{2}{3}$, or between $\frac{2}{3}$ and $\frac{3}{4}$ of its own gross weight, thus producing $3\frac{1}{2}$ tons of manure. He has also given an estimate of the average quantity of manure such land might produce, accordingly as used for different crops, thus:

	tons.
"By clover, grass, or herbage, hay, &c., first year - -	6
" " if mowed the second year - - - -	5½
" pulse-crops—as beans—part of the grain being fed by live stock	5½
" " when the grain is sold - - - -	5
" white or corn crops, as wheat, barley, &c., as an average of the whole - -	4

"Meadow-land, which gives 1¾ ton of hay to an acre, has been calculated to give 6⅔ tons of manure to the acre."

As to the quantity of manure voided, we find it mentioned that "36 cows and 4 horses tied up ate 50 tons of hay, and had 20 acres (equal to probably 25 tons) of straw for litter, from which they produced 200 loads of rotten dung." An experiment made with a horse is thus given for one week:

"Oats each day	10 lbs.	= 70 lbs.
Hay " "	12 "	= 84 "
Straw " "	8 "	= 56 "

"He drank within the week 27 gallons of water, and during his time of exercise (1 hour each day), the loss of the dung is supposed to have been 4 lbs. daily, or 28 lbs., in which period therefore,

The total forage consumed amounted to 210 lb.
And the dung and litter produced was 227 "

"Thus—if the lost dung be added—yielding with the addition of the moisture imparted to the litter by urine, an increase of ⅔ beyond the weight of the solid food."

Another experiment was with a cow, "which was fed during four-and-twenty hours with the following provender:

81 lbs. of brewers' grains,
30 " raw potatoes,
15 " meadow-hay.

"The food thus amounted to 126 lbs. She drank 2 pailsful of water, and the urine was allowed to run off; but she had no straw or litter of any kind, and the weight of the solid dung which was carefully swept up amounted to 45 lbs."

A third was on the same cow, which consumed in 24 hours 170 lbs. of potatoes and 38 lbs. of hay, and the solid manure amounted to 73 lbs. It is said, however, that in this last case her milk fell off 2 quarts per day. ARTHUR YOUNG states in the Papers of the Bath and West of England Society. that from a winter stock of 6 horses, 4 cows, and 9 lean hogs, which consumed 16 loads of hay, with 29 loads of straw for litter, besides the usual quantity of oats for working-cattle, the quantity of manure obtained was 118 loads each of 36 bushels, and "45 oxen, littered while fattening with 20 wagon-loads of stubble, are said to have produced 600 tons of rotten dung."

TR.]

32. But because the plants for fodder obtained on the fields and meadows, must be employed for the nourishment of beasts, by which a part of their substance is dissipated by the processes of digestion; and because in the putrefaction of the manure in the stalls and on the dunghills, a part of the substance is wholly lost in the form of air; we must therefore replace, according to the proportion of this loss, a greater part than is furnished in fodder and litter by the restoration of organic and inorganic matter employed for the production of plants, and of that given in addition to make up the quantity by weight taken out for the production of manure.

In the estimate quoted above, as well as in that extracted from p. 180, Vol. I., and in the following one, no regard must be had to the loss of substance, partly in order not to render complex this generally only hypothetical calculation, and partly because it is more than probable that the straw of the culmiferous grains should not be wholly ascribed to the humus, as is the case in this estimate, but also owes an important portion of its weight to the constituent parts of the air, water, and mineral bodies.

33. From the amount of the production in vegetables of different kinds

in a long course of years, we may reckon with tolerable certainty how great the mass of manure would be which one must employ for the purpose.

34. We can therefore compute beforehand how great the production will be if a greater mass of manure has been employed than usual.

How the amount of production on plough-land stands in respect to greater manuring, we have already shown in Vol. I. § VII. d. 14. p. 180, to which reference may be had.

[The remarks and estimates referred to, have already been quoted in the preceding paragraph (31), found on p. 80—92 of this present work.—Tr.]

35. But because stall-manure is a substance which only gradually dissolves in water, and because in the first and second years the greater part of the same reaches to this state; therefore the harvests of the first and second years after manuring must be proportionally greater than of the third and fourth.

It is therefore usual in estimates of husbandry, where the cost of the manure is charged to the fruit benefitted, to assume that every time manure is brought on the field it loses, in the 1st year, $\frac{1}{2}$
" " 2nd " $\frac{1}{4}$
" " 3d " $\frac{1}{8}$
" " 4th " $\frac{1}{10}$

[Veit's estimates corresponding with the above have already been given (31) p. 82. Speaking of the decrease of the power of the soil according to the quality of the manure, he observes, Vol. I. p. 342: "Manure escapes from the soil according to the degree of its being dissolved. As to its quality of solubleness in any case, the farmer will decide who prepares it, according to his object, to obtain a more rapid or tardy effect. In most cases of farming, it is intended to have an effect lasting a number of years, by which one can obtain many harvests on the same field, from one manuring. For this object it is usual to employ stall-manure, if the litter is brittle and divisible by the past fermentation. In this half-rotten state, the manure in the first year of vegetation will exert its greatest activity by the easily-dissolved animal substances; but also a great part of its mass, and indeed the solid vegetable substances of the litter and remains of fodder, will operate in the 2d year, and a considerable remnant, also, even to the 3d year's fruit. If one wishes to make the efficacy of the stall-manure yet more gradual, he may employ it before it begins to ferment, or hold this back till he employs it, in which case indeed in the first year the manuring powers develope themselves in less measure, but yet exert themselves efficaciously in the 3d and 4th years.

But if it is the object to have the full and greatest effect of the manure in the first year of the fruit, he will only employ fermented well decomposed stall-manure, or it may be kinds of manure in the form of powder, or of a liquid, which usually give only a little strength for the 2d year's fruit, and therefore must be repeated in a shorter space."—Tr.]

36. The substance of manure will draw from the soil, through all plants, in an inverse ratio, compounded of the absolute quantity of their similarly-formed product, and their relative power to assimilate inorganic matter.

In manures are contained all the elements of the vegetable material, and thus, as the manure is found in a state to be dissolved in water, the plants suck it in, and the organs existing in the interior of plants, first separate those substances which are needed for the formation of the constituent parts of the plants. The greater, therefore, the quantity of material that can be dissolved which is in the soil, the larger will be the product in plants and parts of plants of all kinds; only in the consumption of manure, a difference is shown, because after a harvest equal in weight of peas and wheat, not an equal amount of humus has been taken from the soil. It seems to me that we explain in this way, much more simply and correctly, the consumption of manure, than if we suppose with Thaer. that the same is proportioned according to the amount of the product of plants, and their capacity for nutrition.

Thus, according to Einhoff, 100 parts of wheat contain, of nourishing matter—starch, gluten, albumen, slime, sugar, and oil, 77.5

100 parts of rye contain 70.
" " " large barley, 62.5
" " " small " 60.3
" " " oats, 58.

Therefore the field would lose so much the more in humus, than the excess it produced of like weight of the first fruits above the last, or would need so much more manure, if one cultivated it in the rotation of wheat and barley, than if with rye and oats. But because the success of the one or the other plants depends not only on the manure, but also on a quantity of moisture, warmth, &c., proportioned to the nature of the plants; therefore it must be ascribed to these circumstances, that the same quantity of manure which is here required for the production of a certain amount of rye and oats, elsewhere produces as great a weight of wheat and barley. I have with the greatest particularity ascertained the quantity of manure used in Upper Austria, in many regions of Lower Stiermark and Carinthia, in Friuli and Istria, with their harvests in wheat, barley, and other fruits, and compared these with the manure and the harvests of other countries, in rye, oats, millet, &c.; and I have not found more manure necessary for the production of a certain amount of wheat and barley, in the former countries than in the latter, to produce an equal weight of rye and oats. I found, moreover, they manured rather less there than here, which seems very probable, if we take into consideration the effect of the light soil of the former regions on the consumption of manure, and on that of the looser soil of the last country. But if any one will cultivate these fruits in a soil unpropitious to wheat and barley, then he needs everywhere more manure, if he would obtain a product proportioned to that of a soil of any particular grade, since the humus must then become not only a nutritious substance, but one which will absorb the water, and retain the same in the soil; and hence must be explained the idea prevailing in all countries with an easy soil, and the correct observation, that wheat needs more manure than rye. Besides this, there are THAER's views concerning the increase of power which the soil obtains by fallows, the threefold division of fields, and the culture of clover—by no means corresponding with my own, yet ingenious, and if we grant the premises, conclusive. I cannot here allow myself a closer opposition to THAER's hypothesis, yet I maintain that mine is capable of proof in all its parts. It is sufficient for the object of this volume, to give a sketch of my own view: whoever wishes to learn THAER's opinion fully will find it in the first volume of his Rational Land Husbandry, § 251, &c.; then in the second volume, p. 14, in his History of Husbandry at Möglin, p. 247; and finally, in the first volume of the Möglin Annals, p. 235.

But it is necessary to read also the views of Wulfen, in the Möglin Annals, Vol. II. p. 258; and a Treatise, very admirable in many respects, of J. G. KOPPE (the Review of the Systems of Agriculture, Berlin 1818), in order to learn what is said for the further explanation of THAER's hypothesis in the first of these papers; and what against it in the second of them.

Finally, I must here mention, also, an Essay, relating to this subject, from an anonymous writer, contained in the Land-and-Forst-wissensch. of SPRENGEL, Brunswick, 1834, p. 396. It bears the title, "Of the Statics of Agriculture," and is extended to the four following questions:

1. In what proportions do the different fruits derive their nourishment from the soil.
2. In what proportions does the product of the fruits stand with nutritious particles existing in the soil, drawn from the crops; and what can one promise himself of a supposed power in the soil, in an average year of any kind of grain?
3. In what proportions can the productive power of the soil, be replaced by manure or in any other way?
4. In what proportion, in fine, is the power of production to a given culture of fruit and weight of manure, for or against, in a certain rotation?

The Author relates when and where THAER proposed these questions; how, hereupon, WULFEN sought to answer them by algebraic formula; how, more recently, Messrs. VON THUNEN and GEISLER have labored on the subject, but without having found any response from the educated agricultural public. Agreeing perfectly with my own view, he goes on to say that in the circumstances, as one cannot leave unnoticed the elementary influences on the culture of the soil, herein lies the ground, wherefore land-husbandry, considered as a science, must not be counted among the positive, but the experimental sciences; and since an infinite number of experiments remain to be made in the same, so the science can take no positive character; whence

it follows that, by a mathematical mode, it cannot be brought to a completeness, and much less to an end; for it is acknowledged on all sides that the solution of the problem depends on the supremacy of the unalterable elements, the effects of which can be known only in the way of experiment, according to quantity, and never according to quality; the operation of the elementary and chemical powers in the culture of the soil, being in a great measure withheld from our verification and observation, and accurate experiments exist in a small number; so that it is extremely difficult, if not impossible, to bring the *free* elements into a union perfectly corresponding in every respect with the *unalterable* ones. The theory at the basis of a formula, according to which the product and exhaustion of the soil can be reckoned—with which especially WULFEN occupied himself—justly appears to the Author superfluous, and is a circuitous mode, if a man hopes by it that the agreement of the formula will prove backwards the correctness of the theory; since this would always be only the old way of experiment, every agreement must be often repeated in order to demonstrate the correctness of the theory, which would not follow from particular cases.

Physics and Mathematics, and especially the practical mathematics, are employed about bodies with varying quantities; but Agriculture knows only one imperishable quantity, the earth which yearly allows new growth to proceed from it. Here, therefore, is an eternal coming and going, and if we could explain that one species of grain used just so much nutritious matter in order to form a certain quantity of kernels, yet it would not thence follow, that by this quantity of kernels produced from the nutritious matter in the soil, which is here named as its power, it must be lessened a certain quantity according to weight, and exactly in proportion to the quantity of kernels; because the production of kernels is in no wise effected by the power of the soil only, by which we here understand the given manure.

The Author justly observes, that we must consider the soil not merely as the bearer of vegetation, but also as an agent, in so far as it acts chemically on the decomposable matter in it, and combines with the constituent parts of the atmosphere; and since moisture and heat cannot be brought into the calculation, because they are too changeable quantities, it follows hence, that we can adopt the Statics of Agriculture for nothing else than a practical natural philosophy of Agriculture with its results; and that the employment of mathematical formula do not answer for the computation of the processes of vegetation; since, though one begins this process well, yet he cannot follow it in the course of its development, and cannot observe and bring into the computation the combinations of earthy, organic and atmospherical matter.

From this cause, I have never been able to explain to myself, so as by it to reckon algebraically the result of the processes of life, and I have believed that I ought therefore previously to confine myself to compute from the quantity of substances affording nutriment to plants brought on the field, the probable profit to be expected in vegetable products for a given rotation; by which, as is easily seen, on account of the difference of the operation of the weather, the product is not brought into the course of a particular year; but the collective amount will agree, so far as one can expect of so imperfect a computation, and which can scarcely be brought to a higher degree of perfection, as we know only the mixture of the soil and the quantity of the substances nourishing plants applied to it; the other two chief factors of the processes of vegetation, heat and moisture, are previously unknown.

That my opinions concerning the proportion of manure to the production; the difference of proportion in grass-kind and husk-kind of fruits, in the root and knob vegetables; then whether these should be cut before or after the blossom, or after the ripening of the seed-corns, contain much that is arbitrary, resting either only on probability, or not demonstrated by sufficient observations and experiments, I will not deny. The object of the question is yet too new, too little diffused, and demands for the solution of the problem, very closely-tried computations of husbandry, which are rarely to be found, and which the farmers can scarcely undertake on account of the continued observation which they require. On this account, I hope that the simple formula which I have proposed, will be acknowledged better than all hitherto set forth, by which to reckon the profit to be expected in products in any given mode of husbandry, and to show afterwards the increasing production which will result from the change of husbandry, so far as this is connected with the production of more manure, or a less consumption of the substance which nourishes the plants.

Though many believe it to be a mere scientific, and as they say, a useless contest, which is here presented, yet every man knows, that the better he manures, the richer harvests he obtains, as well as that he harvests less in the year the further he recedes

from the time of manuring; therefore they may reflect that no practice exists without theory, and that a correct or a false theory always exhibits itself by a correct or defective practice. Is our view—concerning the different capacity of plants to assimilate organic matters; concerning the advantages of clover and luzerne roots; of the necessity of replacing to the grass-kind of grain fruit all that they have produced, &c —correct? this is of the greatest importance for the practice of Agriculture, as we have had occasion to show in the sixth paragraph of this note.

2. WHAT ANIMALS PRODUCE THE NECESSARY MANURE FOR THE MANAGEMENT OF THE FARM AT THE CHEAPEST RATE?

1. Those animals will produce the manure required for agriculture at the cheapest rate, which by the value of their labor or their otherwise usefulness repay wholly or in a great measure, the value of the food given them.

When horses perform so much labor that their food and all that is expended on them is thus repaid; then the manure which they produce in the stables is a clear profit. If they do not perform so much work that the cost is covered, the value of their manure must be reckoned to repair this loss. If through fattening the fodder as well as the trouble is repaid by the increased value of the cattle; then the value of the manure is a clear gain in this undertaking. But if oxen, cows, sheep and swine do not by their use repay the value of their feeding; then we must either reckon their manure to the field far too high to cover these losses, by which we deceive ourselves, or we must enter it as loss sustained on cattle.

According to Arngeville's estimates, 100 lbs. Vienna weight (about 123 lbs. English) of stall-manure stood him at 10.8 kr. (about 7 cts.), as there the value of hay is 51 kr. (= 33 cts. per cwt.), and a cwt. of rich cheese sells for only 20⅔ florins (= nearly $10).

2. Manure has for a given place a definite value. As much greater as is the value in the production of fruits from one manuring on one half of the field manured, compared with another which was not manured, will be the value of the manuring.

According to the cash-value of the plants which one cultivates is the cash-value of the manure. Therefore the gardener can reckon it higher than the farmer. He can reckon it higher who employs it for plants raised for trade, than he can who uses it to raise grain to be consumed on his farm, because the former always sells proportionally higher than the latter. Where maize and wheat are the principal products, the value of the manure is higher than where they are rye and oats. THAER sets down a cart load of stall-manure of 20 Berlin cwt. = 1872 lbs. Vienna weight (about 1 ton English), equal to 1½ Berlin schäffel = 1.32 metzen (= 2¼ bushels), and if we suppose with Hube (der Landwirth, Vol. II. p. 402), that one half of the product in grain in a not-hitherto neglected farm, must be ascribed to the newly-carried on manure, and the other half to the old humus, and that there was harvested in the first half twice as much as in the last half; then this valuation where peas, rye and oats are the field-fruits, agrees pretty correctly. If indeed the product of 86 metzen of grain-kernels in 6 years, mentioned in the first volume, p. 181 of this Manual, is reduced to rye, it amounts to 74.5 metzen (= 126 bushels), for which was employed 46 cwt. of manure. Upon a similar, but not manured extent of the same field, it bore 37.25 metzen (= 63 bushels), consequently the surplus product of 37.25 metzen is equal to 496 cwt. of manure, or 1872 lbs. of manure are equal to 1.49 metzen of rye (= 2½ bushels). But it is more than probable that the unmanured half would not produce so much, and that therefore the manure would have a higher value.

The true value is known by very few farmers; most of them have only obscure and confused ideas on the subject, and so neglect the requisite production and gathering of the same. Nothing therefore would more raise to a proper footing the cultivation of fodder and the rearing of cattle, and by means of this the cultivation of grain and plants for trade, than the ascertaining the proportional value of manure to the staple product of a country, in given circumstances, by a course of experiments for many years; and no subject deserves more to be investigated in experimental farms than this; because it is too costly for others on account of the loss which they suffer in the unmanured half of the field.

How the product of the field increases with the increase of manure, and a propor-

tional rotation of crops, we have shown in Vol. I. p. 180. See pp. 80—82. But as the statements there made are drawn from universal experience and reason, they may be attacked until reference be had to the particular experiments which lie at the ground of them. Every experiment which may be made concerning this neglected subject is therefore of the highest importance and deserves to be carefully collected; and in this point of view, I hold as very deserving of notice what Gasparin says, concerning the relative value of manure in his Memoir on the Culture of the Olive in the South of France (Bibliotheque Universelle, March, April, May, 1822).

"The value of manure is very different according to the country, the vicinity of cities, the usual culture, &c. At Avignon, where madder is cultivated, they reckon 100 lbs. Vienna weight (= 123 lbs. English), for 15⅔ kreutzers (= 11 cts.), and as high at Strasburg, where they cultivate tobacco. In Tarrascon, on an average 9⅛; at Marseilles 13½ kr.; and since we see a man becomes rich in those places where manure is the dearest, we may justly conclude that it is not bought at its true value. I have found by many experiments and comparisons, that 100 lbs. of manure may be considered as equal in value to 0.128 metzen of wheat (nearly a quarter of a bushel). The average product of 7 years of a garden of olives of 1600 young trees which were not manured was 651 lbs. of oil. (One tree gave yearly 0.40 lb.) A similar number of the same trees, which in 3 years had collectively 840 cwt. of manure, gave yearly 1497 lbs. of oil. (For one tree 0.93 lb.) One cwt. of manure, therefore, produced 3 lbs. of oil. The manure was horse-dung.

"The product of the larger trees was raised by manure in the same proportion. Trees thirty years old not manured for a number of years gave 3¼ lbs. of oil, whilst those which had yearly 168 lbs. of manure on a mean average bore 8.14 lbs. of oil. One cwt. of manure increased the product of oil about 2.91. A person yearly manured his olives, and succeeded in obtaining as the mean product of 15 year old trees, 4⅓ lbs. of oil. The trees situated near the house which had yearly 2 cwt. of manure produced 10 lbs. of oil."

3. But since manure is collected from the excrements of animals, and the litter laid under them; therefore, of the mass of manure only, that should be reckoned, which the fodder has contributed to increase, but not the litter for the use of the beasts.

We may assume that the manure consists of ⅕ litter, and ⅘ excrements, since we shall rarely find anywhere in a foddering of 20 lbs. of dry stuffs, more than 4⅔ lbs. of litter employed. If from 20 lbs. of fodder ⅕ be deducted for imperceptible evaporation, there remains 18⅓ lbs. of excrements against 4⅔ lbs. of litter, = 4 : 1. Of 1872 lbs. of manure, 1521 lbs. belong to excrements; and since 1872 lbs. of stall-manure are collected from 936 lbs. of dry vegetables, but of which ⅕ is from litter, = 187 lbs.; therefore the animals must be credited 1521 lbs. of manure, in value 1½ metzen (2 bushels) of rye; and this must also be charged as a debt to the fields; if we reckon 1872 lbs. of stall-manure, which consists of excrements and straw, as equal in value to 1½ metzen of rye. The 351 lbs. of manure falling short of a cartload, may be made up of litter at 0.28 metzen of rye; which must be put down to the account of the field. In the usual Farm-Accounts, the value of the fodder is brought into the Cattle-Account, and the charge is made to manure equal to the value of the litter employed. But it is clear from these statements that thus the product of the field must appear far too high on the cost of the Cattle-Account, and to this circumstance must it be ascribed, that in so many cases the account of cattle kept for manure turns out only loss and not gain.

4. What kind of cattle kept for manure may be the most suitable for a given farm, depends on the nature of the soil and the climate, which agrees more with one kind of beasts and less with others; on the local situation of the fields; on the cash value of the different animal products, &c.

5. It is only after a careful consideration of these different circumstances, that we can know by what kind of animals, and by what use of the same, the fodder necessary for the production of manure can be employed to the highest advantage.

If the value of the fodder is balanced by the value of the use of the cattle, then the

value of the manure is to be considered as clear gain; if the value of the use of the cattle is the greater, yet ought we not to reckon the given manure cheaper to the field on this account, because we should deceive ourselves concerning the pure profit; so that we must reckon to the field the manure in equal value, if the account shows that the use of the cattle has not covered the cost expended on it, although we bring thus into the account the value of the manure. In this case the use of cattle for manure brings a loss, and we must examine to discover and remove the causes.

[The amount of manure produced, its comparative strength and its value as a means of nourishing plants, must have a very important influence in deciding the question as to the kinds of animals kept to the greatest advantage. On some of these topics THAER furnishes us with the following statements:

"NICOLAI, in his Principles for the Administration of Estates, (Grundsatzen zur Verwaltung des Domainenwesens), assumes, probably after Bekendorf, that there will be produced from

1 head of cattle,			10	two-spanned	loads.
" 1 "	young kine,		5	" "	"
" 1 stall-fed horse,			15	" "	"
" 1 grass-fed "			$7\frac{1}{2}$	" "	"
" 100 head of sheep,			100	" "	"

For swine, by careful littering, we may reckon twice as much as the cattle.

Therefore, 1 head of cattle,	will manure	$\frac{2}{3}$	of a yoke	($\frac{3}{10}$ acre).
1 " of young cattle "	"	$\frac{1}{2}$	" "	($\frac{3}{20}$ ").
1 horse, fed in the stall, "	"	$\frac{1}{3}$	" "	($\frac{1}{5}$ ").
100 head of sheep, "	"	3	yokes	($4\frac{1}{2}$ acres).

"FREDERSDORF reckons for one cow, with good fodder, if she has $2\frac{1}{2}$ shock of litter, 6 four-spanned cartloads at 23 cwt; with stall foddering, 10 four-spanned cartloads. Of one, if he has daily $1\frac{1}{2}$ bundle of straw, $7\frac{1}{2}$ loads; 15 sheep, or 4 or 5 full-grown swine, as one cow. According to KARBE, 65 cows in summer on a pasture, being kept over night in the stall, will manure 44 yokes ($62\frac{1}{2}$ acres); horses and small cows are in proportion as 2 : 3; oxen foddered in the stall, as 3 : 2.

"According to VON PFEIFER, 1 cow foddered in the stall gives 184 cwt; a fattened ox, during time of fattening, 73 cwt.

According to LEOPOLD, 4 cows foddered in the stall give 50 loads of manure, of which 6 would answer for an acre.

In a very learned and able treatise found in the Annals of Netherland Agriculture, the proportion of manure of different animals is stated to be,

For 1 head of cattle, ...	180
1 horse, ...	170
1 sheep, ...	10
1 swine, ...	18

On the subjects of the value and cost of manure, the Authors I have heretofore quoted are full of estimates and many valuable remarks. I shall make some extracts from VEIT, as he has treated the subject very practically. It must be obvious indeed to any one, that the estimates must be regarded as comparative, since the price of the articles used, as well as of labor, &c.. varies greatly in this country from those in Europe. Still the computations may be valuable, as furnishing intelligent farmers with rules by which to judge with more accuracy of their losses or gains.

VEIT says, Vol I. p. 365, "The value of stall-manure is determined by the value of the production effected by it. The quantity of production depends on,

"1. The natural capacity of production of the soil.

"2. On the choice preparation and employment of the manure.

"3. On the choice of the plants which are cultivated in one period of manuring.

"4. On the system of culture, especially the rotation of the crops, and the treatment and use of the soil.

"Since so many circumstances co-operate which, with the employment of an equal quantity of manure, may produce a different amount of production; hence is clear the difficulty of ascertaining the part of production which belongs to the account of manure, and the worth of which expresses the *positive* value of the manure.

"Different writers on husbandry have reckoned the value of manure at different amounts, and should all farmers ascertain the value of their employed manure, very probably scarcely one would agree with another. Of the results of a great number of experiments which we have made from 1821 to 1822, concerning the efficacy of different kinds of manure, we take the following extract:

ON A MORGEN, = 0.842 OF AN ENGLISH ACRE

NAME OF THE MANURES.	Amount employed.	On dry meadows.	On bog meadows.	On meadows of clayey soil.	On red clover.	For grain.	For potatoes.	Price of materials for manure.	Cost of manure.
1. Manure of cattle decomposed,	cwt.	cwt.	cwt.	cwt.	cwt.	cwt	cwt.		
	140	29	41			46			
With water,	80			50					
Without "	70						40		
2. Do half decomposed,	200	30	42			48			
	140	20	31			37			
	70						36		
3. Do. not decomposed,	260	37	42			59			
	140	16	19			34			
	70						28		
4. Do. dec. employ'd on surf.	140					48			
5. Mixture of fluids, &c., in a fermented state,	260 eimers	8	19	39	22	19			
	30 "						23		
6. Draining of dung hills,	260 "	6	9	30					
7. Pulverized human excrement,	5 scheffels = 32 bush.	18	23			28	28		
8. Strong manuring in fold, Watered,		26	43	39		35			
				66					
9. Moderate manuring, do.		18	29	28		24			
10. Weak, do, do.		7	18						
11. Fine bone dust,	4 scheffels = 25 bush.								
	or 10 cwt.	12	21	25		24	30	1 fl. 30 kr. = 60 cts.	15 fl. = $7 20
	7	6	10			16			10 fl. 30 kr. = $5 04
12. Urate,	4 scheffels = 25 bush.	4	6						
13. Maltings,	10 scheffels = 62 bush.	7	9					7 kr. per metz.	7 fl. = $3 36
	20 scheffels = 124 bush.	16	17	28	36	38			14 fl. = $6 72
	34schf.	38							23 fl. 48 kr. = $10 40
	41		40						28 fl. 42 kr. = $13 75
	7						26		4 fl. 54 kr. = $2 32
14. Malt dust,	5	10	14	17	19	15		9 kr. per metz.	4 fl. 30 kr. = $2 16
15. Peat dust,	8								
	20 cwt.	4	16		29	22			
16. Fine refuse of the sinks,	20	10	23						
17. Ground manur'g b'kwhe't,						20			
18. Unslacked lime,	6schf.	6	10					20 kr. per metz.	12 fl=$5 76
19. Lime dust and ashes,	6	9	17					6 kr. per metz.	3 fl. 36 kr. = $1 71
20. Street dust,	10	7	10						
21. Gypsum,	4 metzen, = 3.6 bush.				20 7			24 kr. per metz. = 16 cts.	1 fl. 36 kr. = 75 cts.
22. Wood ashes,	5schf.	6	19		19 18			18 kr. per metz. = 13 cts.	9 fl.=$4 32
23. Peat ashes,	6	8	11		11				
	8						21		
24. Leached ashes,	5 cartloads	18	20			26		1 fl. 30 kr. = 72 cts.	7 fl. 30 kr. = $3 60
25. Manure salts,	10 cwt.	6	10			16		1 fl. = 48 cts.	10fl.=$4 80
	8	5	6			9			8 fl.=$3 92
26. Burnt marl,	6schf.	10	21		27				
27. Unburnt do.	30 cartloads					36			
28. Burnt sod,	12schf.	19	26		31		34		
29. Compost from the remains of peat,	15 cartloads	30	37						
	4 "						16		
30. Compost from mud of plants,	15 "	34	38						
	4 "						24		

This table needs to be accompanied by the following observations:

"1. The meadows on which the experiments were made, had not been hitherto manured. Many portions remained, in the progress of it, unmanured, with the natural product of which the production gained by the employment of different kinds of manure must be compared, and the surplus in hay-value be brought in as the pure result of the manuring. In the fields, also, in like manner, a difference must be made between the manured and unmanured parts.

"2. Of the fresh cattle-manure, 260 cwt. lessened, after 8 to 10 weeks to 200 cwt. of half-decomposed manure, which, in 10 or 12 weeks more weighed only 140 cwt., and was fermented and decomposed. The volume was lessened about 8 per cent. more than the weight fell off.

"3. Equal quantities of masses of manure employed in the different states of decomposition, did not raise the production in exactly the same proportion of the addition of their manuring power or quality, otherwise 140 cwt. of decomposed stall-manure must have yielded 48 per cent. greater production than the 140 cwt. of fresh, not-decomposed manure, whilst the increase of production in the dry meadows, was 7.6; in the grain culture, 9.5; in the moor meadows, 14; and with the potatoes 17 per cent.

"4. As in respect to Remark 2, as much nutritious power was contained in 140 cwt. of wholly-decomposed, and in 200 cwt. of half-decomposed manure, as in 260 cwt. of fresh stall-manure, from which it was derived; so should the effect of these different masses of manures be the same. But according to the result of the experiments, the production rises with the increase of the mass; and indeed in comparison of the greatest mass of manure of 260 lbs. with the least of 140 lbs., the rise is in the culture of grain about 13 lbs. of hay-value; in dry meadows, about 8; and in the moor meadows, about 1 lb.

"5. Should the production again be employed in the manufacture of manure, 100 lbs. of the employed manure would give—

		Wholly-decomposed manure.	Half-decomposed manure.	Not decomposed. manure.
a.	On the dry meadow, . .	41 lbs.	29 lbs.	26 lbs.
b	" moor meadow, .	58	42	30
c.	" watered meadow, .	125	—	—
d.	" grain culture, .	65	50	46
e.	" potatoes, . . .	114	102	80

Therefore, only for c. and e. is there a surplus over the consumption, which would be soon evaporated from the decomposed manure when weighed, so that the foregoing supply of manure, by the multiplying the production in hay-value, gives 2 per ct., which increase is found only in the employment of the half-decomposed manure, but agrees not either on the undecomposed, which increases itself more, or on the wholly-decomposed manure, which diminishes 30 per cent. from the half-decomposed state fixed on. Consequently, according to the Table heretofore given (see 31. p. 84), if we should employ the whole product yielded for the forming of manure, on 100 lbs. of employed manure, would be given

In A. VIII.,	215	lbs. of	manure,	In A. V.,	99	lbs. of manure,
B. III.,	165	"	"	B. II.,	90	" "
A. II.,	159	"	"	A. III.,	87	" "
A. VI.,	147	"	"	A. IV.,	80	" "
B. I.,	136	"	"	A. I.,	70	" "
A. VII.,	135	"	"	A. IX.,	61	" "

"6. The effect of the mixture of the fluid and other manure (marked as No. 5) on the clay soil, was five-fold, and on the bog-soil two-fold, compared with the effect on dry kinds of soil.

"7. The pulverized human excrement, as well as all other materials of manure in the form of powder, display a dissimilar greater effect, if they cover the soil, and are shadowed by the plants manured by them, than when they are employed in a smaller mass, and on an uncovered surface. They are therefore mixed with other suitable materials which are cheaper, and which increase the mass and nutritiousness. Five or six schäffels (= 31 to 37 bushels) of human excrement, bone-dust, malt-dust, or ashes put on a morgen (= $\frac{5}{8}$ of an acre), under favorable circumstances, that is, in moist weather, produce lucrative results, but in unfavorable, dry weather, will have little effect. If with the quantity mentioned, also be added 8 or 10 schäffels (about 50 to 62 bushels) of peat-dust, or plant-mud, or leached ashes, the surface would be better covered, the moisture longer retained, and therefore, under all circumstances a greater effect produced.

"8. The effect of folding is in exact proportion to the degree of the moisture of the soil and climate. A part of the watered meadow of Hard, which had 3 years before a strong manuring in the fold, gave during a period, an increase of production of 66 cwt. of hay on a morgen, while the dry meadows at Schleisheim, produced only 26 cwt. of the same description, and with equally great manuring.

"9. Maltings, if employed with good effect, must be used on grounds sufficiently moist to decompose them, or before being used, must be dissolved or reduced to powder, in which state, compared with their cost, they are profitable.

"10. Peat-dust, in regions where easily obtained, is a very cheap and most efficacious means of manure, if suitably employed, protected against drying up, and joined with such other materials of manure as will continue it moist till decomposition, or if used for plants under the shadow of which it can remain moist long enough.

"11. That for manuring over a morgen, of all the materials of manure, gypsum required the least quantity, is evident, and gives occasion for the supposition, that its powder, especially in a moist atmosphere, lies among the young leaves and stalks, which produces, in proportion to the manure employed, the greatest effect. But because this is very dependent on foreign influences—and therefore this manure frequently remains without results—it is used within moderate limits, and only in the most needy quantity of 3, $3\frac{1}{2}$, and at the highest, 4 metzen (nearly as many bushels) on a morgen.

"12. The compost employed in No. 30, consisted of the chief materials there named, and of horse-dung, in the proportion of the latter to the former of 1:5, with fluid mixture, with brick-kiln ashes and refuse.

"13. Manuring in holes, directly on the seed, as was the case with the potatoes, exceeds in efficacy all other kinds of manuring. A cubic foot of the manure, according to the size of the seed and the efficacy of the manure, should be used for 100, 150, and at the highest, 200 holes; and therefore, in 10,000 holes or plants for a morgen (= 0,842 acre), there must be used at the above rate of 100 holes, 11 schäffels (= 68 $\frac{6\,7\,3}{1\,0\,0\,0}$ bushels), at the rate of 150, 7.4 schäffels (= 46 bushels), and at the rate of 200 holes, 5.5 schäffels (= 34 bushels). Should now all the results of the observations and experiments made concerning the effect of manure as its value be collected together, we shall be convinced that the amount of this value depends on a great variety of partly accidental, unavoidable circumstances, partly on the correct knowledge of the cheapest means of manuring, and mode of preparation and employment of the same, and also on the character of the farmer. The *positive* value of manure, therefore, we vainly seek to ascertain, because the factors are not fixed quantities, and in raising them, it depends on the will of the person."

In speaking of the duties of the Director of the Farm, Vol. III. p. 260, Veit also uses, with reference to this subject, language which applies well to our own country. "There is scarcely in general any circumstance of Land-Husbandry more out of suitable proportion than the great need of manure, owing to the little care used for its preparation and increase. This disproportion is the more striking, as everywhere there are opportunities for increasing the amount, and the whole blame lies in a want of sufficient attention to this subject. As Schwertz remarks, that it is incredible how the Belgians with so little manure can manure so much land, so it is incredible how little land is manured with us with a proportionably greater quantity of cattle and materials for the production of manure. From Schwertz, too, we further learn with what uncommon carefulness the Belgians collect all kinds of materials for the production of manure, in what estimation they hold manure, and how closely and accurately they know how to proportion and classify the manuring-power of different kinds of manure. Such facts ought to make us ashamed and wake us up to a zealous imitation.

"The most admirable talent of the Director (farmer) consists in this, to collect all the materials of manure, and to cause them to be prepared partly alone and partly by the suitable mixture into a manure which shall be most suitable to be employed in the various kinds of culture, and thus to increase the quantity of manure. A director who has a proper sense of the importance of these things, will not leave disregarded whatever will better or increase the manure, and will so direct and employ his workmen as to seek out and use whatever materials he can obtain. And thus he will leave no day to pass over in which he will not give a thought to the question, by what means a higher value can be imparted to it, and whether the materials for its manufacture are employed to the greatest advantage."—Tr.]

3. HOW GREAT MUST BE THE NUMBER OF CATTLE ON A FARM TO AID IN THE PRODUCTION OF MANURE?

1. In every farm-husbandry (Acker-wirthschaft) beasts are necessary for labor; and because the manure which these yield, is not sufficient to supply the necessity of the field, we have also so many other beasts—cattle kept for manure, &c. (Nutsvieh)—in order thus to supply the deficiency of manure.

2. How much manure each head of working-cattle will yield, must, therefore, first be sought, before we can proceed to the answer of the second question: How much one head of cattle, kept for manure, will give, and how many of such cattle must be kept?

3. But because cattle, kept for labor and various other uses, are large or small, well or ill-fed, either constantly foddered in the stall or pastured, sometimes a greater, sometimes a smaller part of the year; and because sometimes they are littered profusely, and sometimes only sparingly, and the manure is suffered more or less to rot before it is brought into the field; therefore the weight of manure, which one head of cattle of the same kind yields in the farm, varies according to the difference of these circumstances.

To the different circumstances above mentioned must it be ascribed, that the beasts yield sometimes more, sometimes less manure, and that even in the same farm, of the same number of beasts, not always an equal weight of manure is obtained. MAYER, in his Estimates for Farms, reckons that one cow,—which weighs live-weight 350 lbs., and is pastured 6 months, during which time she is only every night brought to the stall, and for 6 months in the winter is fed and littered daily with $10\frac{1}{2}$ lbs. of straw and $5\frac{1}{4}$ lbs. of hay,—will yield $5\frac{3}{4}$ 4-spanned (or 2 yoked) cartloads, at 1746 lbs., or 10.039 lbs. of manure. If the cow weighs 525 lbs. live-weight, and is supplied in the winter with $10\frac{1}{2}$ lbs. of straw and $13\frac{1}{5}$ lbs. of hay, she will give 7.39 cartloads, or 13,002 lbs. of manure; and if she weighs 700 lbs. live-weight, and for winter-fodder has 14.8 lbs. of straw and $13\frac{1}{5}$ lbs. of hay, she will yield 8.8 cartloads = 15,364 lbs. of manure.

Working-oxen give, in the same circumstances, less manure, as, on account of labor in the field, they are absent from the stall.

Sheep usually pasture the greatest part of the year; they are often scarcely more than 3—4 months in the stall. According to this time, according to their size, fodder, and litter, we reckon sometimes more, sometimes less manure. HUBE found that one sheep in 150 days of winter, gave $12\frac{1}{2}$ Rhenish cubic feet (about the same English) of manure. MAYER reckons for one sheep daily, $3\frac{1}{2}$ lbs. of manure; according to him one sheep produces in 135 days of winter fodder, 472.5 lbs. of manure.

With swine, the quantity of manure is given as variously; sometimes it is thought that one single yoked cartload, sometimes two, may be obtained from one animal.

I had on my farm, 3 horses, 12—15 cows, 3—5 heifers, 3 sows, with their progeny. If I reckon a horse equal to a cow, as respects the production of manure, the young cattle, according to the need of fodder, and 5 one-year swine, equal to one cow, I have thus given the proportion of the animals. One cow on an average weighs 700 to 800 lbs. live weight. They were always foddered in the stalls, and only go on the meadows and clover-fields to feed on the after-crop of grass, from the 15th of September to the end of October, at which time also they are every morning, noon, and evening brought a while to the stalls. They were well but only moderately littered. Of these beasts I had in the course of years by no means an equal yearly amount of manure from a head; because they were not always equally littered, and because the people, one year when there was a surplus of clover, foddered them very abundantly, and in dry years practised more economy. I had of one cow, or of cattle reduced thus, in the lowest case 12, in the best 14 two-yoked cartloads of half-rotted manure; each cartload reckoned at 12 cwt., therefore from 144 to 188 cwt. a year.

4. Because the amount of the weight of manure which one head of cattle yields, varies according to the difference of these circumstances; so in

general it can in no wise be determined how great the number of head of cattle to be kept for manure, &c, (Nutsthiere), must be, by which the manure required may be produced.

5. Should a head of cattle yield a certain mass of manure in the stall, so there must be voided a certain quantity of excrement which is mixed with a certain quantity of litter. But as the weight of the excrements stands in an equal proportion with the weight of the given fodder; so will a person obtain only as much manure as he employs fodder and litter in the stalls, and while the beasts remain in the same. If the beasts are pastured, then their production of manure is to be reckoned according to the proportion of time in which they are brought up into the stalls.

[Veit quotes Vol. I. p. 287. from an average of estimates of his own, and of Block, the following result, as exhibiting the production of manure from different kinds of fodder, and with different animals.

Of one lb. of	Horse.	Cattle.	Sheep.
1. Usual meadow hay,	1.50	2.00	1.25
2. Straw-fodder	1.40	1.90	1.20
3. Grass and clover in a green state.	0.40	0.60	0.37
4. Roots and knob-vegetables, { Potatoes,	0.50	0.70	0.25
{ Turnips	0.40	0.50	0.37
5. Grain,	1.50	2.00	1.00
6. Straw litter,	1.70	2.20	1.37

But should the materials for fodder be reduced to hay-value, they would give, in manure on one lb. of hay-value,

	When 100 lbs. of hay are equal to	Horses.	Cattle.	Sheep.
1. Usual meadow hay,	100	1.50	2.00	1.25
2. Straw fodder,	200	2.80	3.80	2.00
3. Grass and clover in a green state,	450	1.80	2.70	1.50
4. Roots and knob vegetables: { Potatoes,	200	1.00	1.40	0.74
{ Turnips,	300	1.05	1.50	0.75
5. Of grain,	50	0.75	0.90	0.60

By which it appears that of 1 lb. of hay, one head of cattle yields 2 lbs, one horse 1.4 lbs. and one sheep 1.2 lbs. of manure. If, therefore, the articles of food be reduced to hay-value, as they may be by the tables heretofore given, the multiplier may be easily used, as respects either the horse or a head of cattle or a sheep."—Tr.]

6. In order to compute accurately beforehand the mass of manure, therefore, we must know how much a working animal, or one kept for manure, &c., consumes in a day; how much litter is given out; how the weight of the fodder eaten is proportioned to the weight of dung; and how great the loss of weight in dung and litter may be by putrefaction.

7. But because only that manure is at the free disposal of the farmer which is obtained in the stalls, so regard must be had to the time in which the beasts are brought into the stalls, and we must deduct for those beasts for labor, which are foddered in the stalls, that time which they spend out of them on account of being employed in labor, as well as for those which are pastured, and so fed out of the stalls, that time of the increase of manure must be counted in which, in the summer, they are kept in the stalls.

How much fodder beasts need in proportion to their size and use, is given in the Special Rearing of cattle. The consumption of litter must be governed by the quantity and kind of fodder, and partly by the surplus which one has of these materials, and the space which each particular beast occupies; it is sometimes 3, sometimes 6 lbs. of straw.

[On the subjects embraced in some of the immediately preceding paragraphs, I will also introduce some other computations of Veit which may farther aid in the labor

of estimating the cost of manure, and the methods of its economical production. In Vol. III. p. 1147, he observes:

"It is known that the dry fodder and the juicy, estimated according to hay-value, with litter employed for the cattle, for manure in general, will give double the weight in moderately decomposed manure. For the production of 19,800 cwt. of manure, there are therefore necessary, of materials for the manufacture of manure, 9900 cwt., which may be obtained from the following weight of products:

	No. of morgen. (a morgen =5-6 acre.	Material employed for making manure. Hay.	Hay value of juicy fod'r.	Grain.	Straw and stalks.	Total.
		cwt.	cwt.	cwt.	cwt.	cwt.
Potatoes, for fodder,			138			138
Potatoes, hay val. slops,			671			671
Potatoes, stalks, dry,	50				400	400
Winter rape,	20				400	400
Winter wheat,	20				400	400
Winter rye,	20				400	400
Summer rye,	40			67.2	720	787
Barley,	20				260	260
Oats,	20			136	300	436
Peas,	20				340	340
Beets,	10		617		80	697
After grain,				18.2		18.2
Red clover,	20	800				800
" "	20	400				400
Luzerne,	10	450				450
Meadow thrice mowed,	60	2160				2160
" twice "	117	2340				2340
" once "	70		200			
The hay value of fodder for swine, of sour milk slops, then the weight of the oil cake, bran and barley scum, may be reckoned at,	557	6630	1626	222	3300	11777
						370
						12147

Multiply 12,147 by 2 = 24.294, and there remains, after deducting the loss of dung on the meadows, at least 22,000 cwt. therefore more than was required.

The following table of the consumption of fodder and straw or materials for the production of manure for 10 working-horses, may also be useful in its relation to this general subject:

1. Oats, 70 schäffel (= 435½ bushels), at 180 lbs. = 12,600 lbs.
2. Rye, 5 " (= 31 ") " 280 " = 1,400 "
3. Hay, 12 lbs. per head a day . . . 45,800 "
4. Häcksel of hay per day, 12 lbs. . . . 36,500 "
   " " " 5 " . . . 18,250 "
5. Straw-litter, at 3 lbs. per head a day 10,950 "

125,500

On this allow 115 days of rest . . . 38,910 × 2=77,820 lbs. manure.
250 " of labor . . 84,590
2

169,180 "

After deducting ⅓ of loss while at labor . 56,393 "
There remains in manure . . . 112,787 " "

Total, 190,607 " "

Veit has also furnished us with estimates on this subject, relating to cattle of various breeds, ages and sizes. One of them only will here be given. It will be observed that in this as in the former example the consumption of fodder is multiplied by two to give the weight of manure, which is according to his previous remarks as to the proportion between them.

Need of Fodder and Litter for 12 *Working-Cattle, of a large kind.*

1. For the Winter period, from 1st of October to the end of May, 8 months—or 245 days.

Häcksel, hay 12 lbs. =	35,000 lbs.
" straw 9 " =	26,244 "
Hay at 6 lbs. per head daily	17,496 "

Refuse of potatoes from potato-distillery at 36 maas = 104,976 maas = 1,450 gallons = 163 cwt. of hay-value.

2. For the Summer-period, for 122 days.
   Green fodder 90 lbs. per head daily = 20 lbs. of hay value = 29,280 lbs.
   Hay 6 lbs. = 8,784 lbs.
3. Through the whole year.
   After-grain 3 schäffels = 18½ bushels at 260 lbs. = 780 lbs.
   Summer-rye 3 " = " " " 280 " = 840 "
   Straw-litter at 3½ lbs. per head a day 15,324

	Totals.
Grain	16.20 cwt.
Hay	905.60 "
Hay-value of juicy fodder	163.00 "
Straw-fodder	262.44 "
Straw-litter	153.24 "
	1500.48 "

On this allow 135 days of rest 527 cwt. X 2 = 1,054 cwt. manure.
" 230 days of labor 973 "
2
1.946

After deducting ⅓ loss while employed in labor 649 cwt.

There remains of manure	1,297 cwt. manure.
Add to this of horses	1,907 "
Total .	4,258 "

By means of cattle kept for manure, therefore, to hold its own must be produced . . . . . 15,542 "

in order to gain the above-shown need of manure of 19,800 "

Need of fodder and litter for 800 *Sheep, i. e.* 758 *grown, and lambs equal to* 42.

1. For the Winter period from 1st November to middle of April, through 165 days.

Hay	2,000	cwt.
Beets 1400 cwt. in hay-value . . .	466	"
Straw-fodder	300	"
After-grain 2 schäffels = 12½ bushels at 260 lbs.	5.2	"
Oats 6 schäffels = 37 bushels at 180 lbs. .	10.8	"
Straw-litter at 0.3 lbs. per head daily	396	"

3,178X2=6,356 cwt. of manure.

For the Summer period, from the middle of April to the end of October, therefore for 200 days, the sheep must be kept on hired pasture.

For 10 *fattening-Oxen, to be fed according to the example of the working-oxen above given, to* 1*st of November.*

From 1st of November to the end of April, through 6 months of fattening.

Häcksel, of 20 lbs. of hay per head daily on an average	360 cwt.
" 6 " straw . . .	108 "
Rye 16 schäffels = nearly 100 bushels, at 280 lbs.	48 8 "
Steamed potatoes 42 schäffels=261½ bushels in hay value	63 "
Beet-roots 450 cwt. in hay value . . .	151 "
" leaves 400 " " . . .	80 "
Distill. slops 72,000 maas in hay-value at 6.42 maas	112 "
Straw-litter at 5 lbs. per day for a head . .	90 "
	1009 "
	2
	2018 " manure.

For 40 *Milch Kine,*

For the Winter period, from 1st of October to the end of May—for 245 days.

Häcksel 12 lbs. of hay per head daily . .	1,176 cwt.
" 6 " straw " " . .	588 "
Slops, 24 maas per day " 235,200 maas	
" in hay value at 6.42 maas . . .	566 "
Oil-cake	3.5 "

For the Summer period, from June 1st to the end of September—120 days.

Green clover in hay-value 18 lbs. per head daily	864 cwt.
Straw-litter at 5 lbs. per head, therefore in the whole through the year	438 "
Total	3435.5 "
	2
	6871.0 " manure.

For 17 *Swine,*

For the Winter period, from middle of October to the end of April, through 180 days.

Distillery slops at 6½ maas per head daily = 19,825 maas, in hay value at 6.42 maas	30.8 cwt.
Sour-milk at 5½ maas per head = 16,830 maas at hay value	16.8 "
Steamed potatoes at 4.9 lbs. per head daily = 150 cwt. in	" 75 "
Bran of 30 schäffels of rye and 20 schäffels of wheat .	18.8 "
Beer-maltings of 5 schäffels of malt = 1250 lbs. in hay-value	4.16 "
Barley-scum 1 schäffel at 180 lbs.	1.80 "

For the Summer period, from the middle of April to the middle of October, for 185 days.

Sour-milk at 5½ maas per head = 17,297 maas in hay-value	172 cwt.
Pasture in hay-value per day for a head 4 lbs. .	126 "
Milk for the pigs 5348 maas	33.4 "
After-grain, 2 schäffels at 260 lbs.	5.2 "
Straw-litter through the year	1037 "
Total	739 "
	2
	1478 "
Of this ⅓ of manure to be deducted for time of pasturing .	198
	1280 " manure.

SUMMARY.

	10 horses.	12 working oxen.	800 sheep.	10 fattening oxen.	40 milch kine.	17 swine	Total.
Hay and green fodder, in hay-value,	cwt. 803	cwt. 905.6	cwt. 2000	cwt. 360	cwt. 2040	cwt.	cwt. 6108
Straw,	292	415.6	696	198	1026	103.7	2731
Oats,	126		10.8				136.8
Rye,	14	8.4		44.8			67.2
After-grain,		7.8	5.2			5.2	18.2
Potatoes, in hay-value,				63		75	138
Beet-roots, " "			466	151			617
Do. leaves, " "				80			80
Bran,						18.8	18.8
Slops, in hay-value,		163		112	366	30.8	671.8
Milk, in " "						374	374
Maltings, " "						4.16	4.16
Barley-scum,						1.8	1.8
Oil-cake,					3.5		3.5
Pasture-fodder in hay-value,						126	126
Total,	1235	1500.4	3178	1009	3435.5	739	11097
Hence of manure multiplied by two,	2470	3000	6356	2018	6871	1477	22194
After deducting $\frac{1}{3}$ of manure during time of labor and pasture,	563	649				198	1410
There remains of manure,	1907	2351	6356	2018	6871	1280	20784

The quantity of *drink* and of *litter*, by the different animals, are given by VEIT in the Tables that follow:

The quantity of water needed in proportion to the dry food.

	Living weight of the beast.	Quantity consumed in a day.			Proportion of water to 1 lb. of dry fodder in	
		Hay.	Water in			
			Winter.	Summer.	Winter.	Summer.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs
Working horse,	1050	26	35	50	1.34	1.92
Working ox,	1000	24	55	70	2.29	2.91
Cow,	700	17	42	60	2.47	3.52
With some salt in the water,	—	—	55	—	3.25	—
Sheep,	70	1.8	2.5	3	1.38	2.0
In a day when salt was given,	—	—	3.0	—.6	1.66	—
Swine,	140	4 in hay-value	16	20	4	5

The quantity of litter differs according to the different species of cattle, of the fodder, drink, and the longer or shorter time the beasts are kept up in the stall. For the most part, the proportion is according to the need of fodder, and as follows:

For a	At a daily need of fodder in hay-value of	On 100 lbs. hay-value there is a need of straw-litter.	Therefore daily,	
			In stall-feeding.	In pasture or at work.
	lbs.	lbs.	lbs.	lbs.
Working horse,	30	10 —20	3 —6	3 —4
Working ox,	24	14.5—29	3.5—7	3.5 —4
Fattening ox,	30	16.6—30	5 —9	
Milch cow,	20	15 —20	3 —6	2 —3
Sheep,	2	10 —20	0.2—0.5	0.15—0.25
Swine,	8	30 —40	2 —2	

TR.]

4. WHAT PROPORTION DOES THE FODDER CONSUMED, TOGETHER WITH THE LITTER, BEAR TO THE WEIGHT OF THE MANURE?

1. All nourishment which the beasts take in a fluid or solid form suffers in the process of digestion a loss of weight, which is owing to the fact that a portion of the same is taken into the animal substance, and another portion is dissipated during these processes; then the weight of the animal excrements and the litter used is diminished by the putrefaction which the manure undergoes before it is carried into the field. On the other hand, the excrements obtain an increase by the animal liquids employed in their decomposition.

2. If one knew accurately the weight of the waste and increase, he would then know also the weight of fresh manure which will be produced by a given quantity of fodder and litter.

3. But because one can know as little of the mass which is taken up into the animal organization in solid substance, which may be dissolved in water, as of those parts which are dissipated during their passage through the organs of digestion, and by the later putrefaction on the dunghill; therefore we must be contented with the conclusions which are indeed drawn from experience, but which, on account of their defectiveness, must only be considered an approximation to the truth.

[THAER says, "Beasts are to be viewed only as machines which, in proportion to their size, but especially to the mode of feeding, convert part of the fodder into their own animal substance, and the far greater part into manure, i. e., not only the dung, but also the urine, and the trodden litter, and what passes off by evaporation. This manure is not merely from the offals of the fodder, but from the excretions of the animal body. Whether the solid mass of the fodder consumed, even in a dry state, becomes more or less in the excrements, is not known. Probably less, as the increase of the body, growth of wool, and production of milk requires a part of the same. Yet this is only small, and it is not yet decided whether the water drank, and the substances filled with gases are so dispersed through the body as to form solid matter. The weight of manure from dry fodder by the moisture added to the excrements is certainly increased one half, viewing it in the state of moisture we use it."—TR.]

4. The weight of the moist manure yet existing in the state of warm fermentation, is double the weight of the dry substance consumed, and of the litter employed in a proportionate quantity.

The dry nutritious substance, or that which is reckoned by its dry weight, suffers in the bodies of beasts a considerable diminution by the loss of that which the absorbing vessels appropriate to themselves from it, and which with the excrements secretory of nutritious substances are so easily decomposed by the process of putrid fermentation, that in a short time its substance as well as its weight is very considerably diminished. If we therefore say that 100 lbs. of dry substance of consumed fodder with a proportionate quantity of litter gives 200 lbs. of manure, this must be understood of stall-manure, where the greatest amount of urine is mixed in part with solid excrements, or if they should be dissipated on the dunghill, would be replaced again by rain.

The more raw—more recent—stall-manure is; the more the beasts drink; the more they take of juicy food; the greater is the proportion of the weight of stall manure, compared with the weight of the fodder eaten; wherefore there is more manure from horned cattle than from horses, and the least from sheep.

The following experiments may serve as confirmations of these statements. Gericke undertook, with 3 cows, seven experiments to ascertain how much of different nutritious matter such beasts ate, and also the water drank, how much milk they gave from it, and how great was the weight of their solid and liquid excrements. Every experiment lasted 7 days, with the exception of Nos. 4 and 5, and was tried with great accuracy. In the following table these experiments are collected without being reduced to Vienna weight, because it is only the proportions which are of value in any weight.

No. of Experiments	Time.	Fodder and Drink.														
		Dry Fodder.			Juicy Fodder.					Milk produced.	Litter used.	Weight of the dung with the litter.	Loss by evaporation	Proportion of the dung weight of the litter to the weight of the dry fodder consumed.
		Kind of Fodder.	Weight.		Kind of Fodder.	Weight.								
			Fodd'r	Water.		In soft state.	In a dry state. *)	Water.						
			lbs.	lbs.		lbs.	lbs.	lbs.		qts.	lbs.	lbs.	lbs.	
1.	22—29 March,	Hacksel at ⅓ hay, ⅓ peas, ⅓ oat-str'w, mixed with ⅔ ground barley	580	2054						123⅞	105	1785.5	0.284	260 : 100
2.	29 March—5 April,	Hacksel at ⅔ hay, ⅓ barley straw, with ⅔ ground barley	628.5	2315						128⅛	105	1822	0.329	248 : 100
3.	5—12 April,	Hay, mixed with ⅓ ground barley,	627.2	2359						135⅝	105	1902	0.308	259 : 100
4.	7—14 June,				Grass for 8 days,	2687.5	4)671.8	561	156⅝	144	1579	0.461	190 : 100	
5.	15—20 "				Clover for 6 days,	2223.5	5)444.7	441	123¼	108	1255	0.490	227 : 100	
6.	14—20 Nov.				Beets,	1893	5)378.6	222	140¼	126	1366	0.328	270 : 100	
7.	21—27 "				Swedish turnips,	1861	5)372.1	28	162¾	126	985	0.373	197 : 100	
8.	28 Nov.—Dec. 4,				Potatoes,	1832	4)458	168	144	126	1398	0 210	239 : 100	

*) The numbers 4, 5, standing before the bracket, denotes the divisor thus : 2687 by 5 = 671.8.

Laborious, and in many respects instructive as are these experiments, yet they are also in many particulars defective.

We can employ only the first five in conclusions; since chaff-mixture (Häcksel or Häckerling), hay, grass, and clover must be considered as the natural kinds of fodder. With beets, Swedish turnips, and potatoes, one cannot exclusively fodder beasts without making them sick, which happened with beets, and would happen with other roots certainly if they were longer used.

The proportional greater weight of stall-mixture,—since one ought not to call by name of manure this raw mass consisting of excrement and straw 8 days old,—from the dry fodder, compared with the grass, must be ascribed to the greater quantity of water which the beasts drank while eating chaff-mixture and hay, and the less evaporation in March, compared with the stronger in June. Why they ate less of clover reduced to its dry weight, than of hay, and even of the chaff-mixture, most probably was owing to the clover being in full bloom, in which state the beasts eat it not so freely. Why, finally, the proportion of the dung, together with the litter, in the fod-

dering of grass, if this is reduced to hay, is so small, whilst 2687 lbs. of grass, 561 lbs. of water, and 144 lbs. of litter, together 3392 lbs., produced only 1579 lbs. of manure; but 627 lbs. of hay, 2359 lbs. of water, with 105 lbs. of litter, together 3091 lbs., produced 1902 lbs. of manure, owing to the difference of the dissimilar evaporation during the use of both means of foddering. At Schleisheim, in Bavaria, many experiments were made on a farm there, in order to ascertain the proportion between the fodder and the litter, and the manure. It is a disadvantage that the experiment made with milch-kine is so far useless as we know not determinately how much of the particular kinds of articles of fodder were given to the beasts; since if the object is to find out the proportion of weight between the fodder which is given to the beasts, and their excrements, must one know the absolute weight of the former, because its relative worth compared with hay, if it were even ascertained with certainty, which is nowhere the case, is of no use, as we have already shown. The casually-tried experiment with horses, speaks always of hay and its substitutes, i. e. nourishing substances, which are reduced to hay according to their relative value; only with sheep no such mention is made of the reduction.

With horned cattle, 760 lbs. of hay, straw fodder, and substitutes for hay, gave 2300 of fresh dung (proportion 100 : 230), which after 50 days lost $\frac{1}{3}$ in weight; according to which 100 lbs. of fodder and litter gave 188 lbs. of fermented manure.

With horses in the month of March, 620 lbs. of hay, straw fodder, and substitutes for hay, with 380 lbs. of straw litter, gave 1400 lbs. of fresh dung (proportion 100 : 140), which after 34 days lost in weight 0.48, according to which 100 lbs. of fodder and litter gave only 75 lbs. of fermented manure.

With sheep from 19th of February to 25th of April, 710 lbs. of fodder and 290 lbs. of litter gave, on the 27th of May, 800 lbs. of manure (proportion 100 to 80).

The above mentioned differences between the weight of fodder and litter, and of the fermented manure, are explained by the different proportion of the straw litter mingled with the dung. With horned cattle the proportion of litter to hay, is as 5 to 15; with horses, as 11 to 18; with sheep, as 5 to 11. With horses and sheep the proportion of the litter to the fodder was clearly too great, on which account the manure thus produced weighed less than the materials employed in preparing it; since a part of the same which was dissipated by the putrefaction, was not replaced by the small quantity of the liquid excrements; with the horned cattle the proportion between the litter and fodder was more correct, and therefore the results agreed more with those before quoted.

Mayer, who deserves the highest praise on account of his estimates of the proportions of husbandry, in his work concerning the division of a community (P. III. 69) first gave importance to the method of reckoning the gain of manure from the weight of the fodder and litter employed. He proposed to multiply the consumed fodder and straw litter by 2.7, but the hay, of which the body is more assimilated, by 1.8. Consequently on these rules, from 70 lbs. of straw, and 30 lbs. of hay, we should have $189+54=243$ lbs. of manure, but from 30 lbs. of straw and 70 lbs. of hay, only $81+126=207$ lbs., and therefore $\frac{1}{5}$ less, which appears beforehand in the highest degree improbable, and by experiment is proved incorrect. The divisors for root-vegetables, are with him from 2.1 to 2.8, but with potatoes, 1.3. 100 lbs. of potatoes which contain somewhat more than 28 lbs. of dry substance would therefore give 77 lbs. of manure, while, according to our statements, they yield only 56 lbs. The grains finally he would multiply by 3—3.7.

Thaer has frequently quoted this subject in his Annals, and in the first Volume of his Rationellen Landwirthschaft, p. 258, as well as in his History of the husbandry of Mögelin, p. 166. He there maintains that we must multiply the hay foddered out and the amount of straw-litter by 2.3, if we would know the weight of manure gained. The juicy plants for fodder he would first reduce to their hay-value; according to which, 100 lbs. of hay are equal to 200 lbs. of potatoes, 460 of beets, 350 of cabbage-turnips, 525 of water-turnips, 266 of carrots, 600 of white cabbage, 90 of young clover-hay, 90 of vetch-hay, 90 of luzerne and sainfoin, and then would give the manure in this proportion, i. e. 200 lbs. of potatoes, or 256 lbs. of turnips, or 100 lbs. of hay, would give an equal quantity of manure. Mayer is inconsistent with himself when he advises us to multiply hay by 1.8, and grain by 3, in order to ascertain the amount of manure; since if the physical system of beasts absorb more from hay than from straw, and hay yields less manure according to its weight than straw, therefore, this must be much more true as respects the grains which are so much more nutritive than hay. Thaer is of the same opinion with Mayer, and believes that a horse in a great measure fed on grain would yield not fully but nearly as much ma-

nure as if he was fed on hay only, and sets it at double the weight. According to him, it is the same whether we give a horse 25 lbs. of hay, or 10 lbs. of oats and 5 lbs. of hay; and 25 lbs. of hay or 15 lbs. of dry nutritious substance give the same weight in excrements. But if 10 lbs. of oats will give a beast as much nutritious substance in 24 hours as 20 lbs. of hay, then must there be not only in an absolute but also in a relative respect a much less weight of excrement than from 20 lbs. of hay. That the excrements of a beast fed with grain are of greater efficacy as manure, we have already shown; but since here the only object is to ascertain the quantity of manure from the quantity of fodder and litter, therefore we cannot now have regard to that point. Count D'ANGEVILLE (Mögl. Annual, Vol. I.) says that with a very small littering 100 lbs. of hay give 216 lbs. of fresh manure, which is nearly the same I have supposed. But because the object is to know the weight of manure which has lain in heaps for 3 or 4 months compared with the consumed materials of fodder and litter; therefore it will not be too small to reckon 100 parts of fodder and litter against 200 parts of half-rotten manure.

Finally, I must here observe, that, in the first edition of this work, I have multiplied the materials of fodder and litter by 2.17, in order to compute the weight of manure; and that in the following editions I have thrown away the fractional part of the multiplier, and taken the double weight of manure for the single in fodder and litter, which has been retained in the present edition, while I am always more convinced that we do best in this *approximation of computing the manure, to reckon all the fodder, be it of what description it may be, according to its dry weight, to add to it the litter and then multiply by two the collective sum.*

[THAER's views have been alluded to above, by our Author. He has given a great variety of tables and deductions, which are found in his first volume, and afterwards modified in the Introduction to the second volume of his work heretofore quoted. It may be well to subjoin a few extracts from these, as they contain valuable information in reference to the production of manure from the various crops produced. It is not supposed indeed that the products will exactly correspond to those in our own country, though the principles of computation may answer.

Vol. I., p. 177, he thus speaks of the proportions of grain, straw, and manure: "As the result of many experiments, it is found that the proportion of grain to the straw varies—

In	Rye,	from 38—42	: 100
	Wheat,	" 48—52	: 100
	Barley,	" 62—64	: 100
	Oats,	" 60—62	: 100

"With peas, it is more undetermined, and the addition of the pods, as is well known, is in very different proportions to the stalk. Count PODEWILL found it to be as 5 to 21. I believe that on the whole it should be given as 35 to 100, as peas are usually planted; but it would be the surer way to reckon the straw of one yoke (= 1.422 acre) of peas at 4130 lbs. (= 3844 to an acre), while the product of straw in this fruit is usually much larger than of the grain. It is the same with respect to vetches. If therefore 1 metzen (= 1.69 bushels) of good rye, somewhat heaped, weight 88$\frac{3}{4}$ lbs. (= 1 bushel at 52 lbs.), and the grain on an average is as 40 : 100; then one yoke (= 1.422 acre) of rye will give,

At	3	metzen (= 5 bushels),	product	665	lbs.	of straw, and so	1529	lbs. of manure.
	4	" 6$\frac{3}{4}$	" "	887	"	"	2039	"
	5	" 8$\frac{1}{2}$	"nearly"	1108	"	"	2549	"
	6	" 10	" "	1330	"	"	3059	"
	7	" 11$\frac{3}{4}$	" "	1552	"	"	3569	"
	8	" 13$\frac{1}{2}$	" "	1773	"	"	4078	"
	9	" 15$\frac{1}{4}$	" "	1995	"	"	4588	"
	10	" 17	" "	2217	"	"	5098	"
	11	" 18$\frac{1}{2}$	" "	2348	"	"	5608	"
	12	" 20$\frac{1}{4}$	" "	2660	"	"	6117	"

This, corresponding to the first computation of one yoke at 3 metzen, is for 1 acre at 3$\frac{3}{4}$ bushels, a product of straw of 467 lbs., and of manure of 1066 lbs. Consequently, every added bushel on the acre will give about 125 lbs. of straw, and about 300 lbs. of manure.

"If one metzen (= 1.69 bushels) of wheat weighs 94$\frac{5}{6}$ lbs. (= 56 lbs. the bushel) and the grain is to the straw as 50 to 100, then 1 yoke (= 1.422 acre) gives,

At	3 metzen (see last table for bushels)	569	product in straw, and so	1309	lbs. manure.
	4 "	759	" "	2181	"
	5 "	948	" "	2181	"
	6 "	1138	" "	2617	"
	7 "	1328	" "	3054	"
	8 "	1517	" "	3490	"
	9 "	1707	" "	3926	"
	10 "	1897	" "	4362	"
	11 "	2086	" "	4799	"
	12 "	2276	" "	5236	"

This, corresponding to the 3 metzen per yoke, is for 1 acre at $3\frac{3}{4}$ bushels, a product of straw of about 298 lbs., and of manure about 700 lbs. Consequently, every added bushel per acre gives about 80 lbs. of straw, and not quite 190 lbs. of manure.

"If 1 metzen (= 1.69 bushels) of barley weighs 70 lbs. (nearly 42 lbs. the bushel), and the grain is to the straw as 60 : 100, then 1 yoke (= 1.422 acre) of barley gives

At	3 metzen (see 1st table for bushels)	350	lbs. of straw, and so	805	lbs. of manure.
	4 "	466	" "	1072	"
	5 "	583	" "	1340	"
	6 "	699	" "	1607	"
	7 "	815	" "	1875	"
	8 "	932	" "	2143	"
	9 "	1049	" "	2412	"
	10 "	1165	" "	2679	"
	11 "	1281	" "	2946	"
	12 "	1398	" "	3214	"

This, corresponding to the 3 metzen per yoke, is for the acre at $3\frac{3}{4}$ bushels, a product of straw equal to about 162 lbs., and of manure about 382 lbs. Consequently, every added bushel gives for an acre about 44 lbs. of straw, and about 106 lbs. of manure.

"If 1 metzen (= 1.69 bushels) of oats weighs $53\frac{3}{5}$ lbs. (= 33 lbs. to the bushel nearly), and the grain is to the straw as 60 : 100; then 1 yoke (1.422 acres) of oats gives

At	3 metzen (see 1st table for bushels)	266	lbs. of straw, and so	611	lbs. of manure.
	4 "	355	" "	816	"
	5 "	443	" "	1020	"
	6 "	532	" "	1223	"
	7 "	621	" "	1427	"
	8 "	719	" "	1631	"
	9 "	798	" "	1835	"
	10 "	887	" "	2029	"
	11 "	975	" "	2242	"
	12 "	1064	" "	2447	"

This, corresponding to the 3 metzen per yoke, is, for the acre at $3\frac{3}{4}$ bushels, a product of straw equal to about 139 lbs., and of manure of about 321 lbs, consequently every bushel added gives of straw about 37 lbs., of manure about 86 lbs.

"To determine the manure which the food in the pasture gives, it has been weighed, and for a well-fed milch cow, in a *rich* pasture, has been found to be, in 24 hours, 34 lbs. on an average, or in 5 months, or 153 pasture days, 5200 lbs. The manure by day, and that by night, has been separately weighed, and found to be, in the former case, 19 to 21 lbs., in the latter $13\frac{1}{2}$ to 14 lbs."

"We have therefore the following for the different kinds of cattle:

	Winter Straw.	Summer Straw.	Hay
For a great ox,	3530 lbs.	1646 lbs.	1717 lbs.
" middle-sized "	2940	1370	1348
" small " "	2350	1100	1078
" large cow,	1760	1235	1293
" middle-sized "	1470	1030	1078
" small " "	1116	823	862
" horse foddered in the stable,	4700		2587

Therefore, according to the proportions adopted,

	Of straw and fodder.	Manure.	Will manure at 22,000 lbs. per yoke.
For a large ox,	6793 lbs.	15,624 lbs.	0.71 yoke
" middle-sized "	5658	13,013	0.59
" small " "	4528	10,400	0.47
" large " cow	4288	9,862	0.44
" middle " "	3518	8,091	0.36
" small " "	2861	6,580	0.30
" stabled horse,	7287	11,222	0.51

Average per head, 0.48 yoke = $\frac{7}{10}$ of an acre.

"In my edition of BERGEN'S Guide for raising cattle, I have given a table of the fodder which some cows of mine consumed in a year. It amounted per head to,

		Reduced to hay value.
White cabbage,	4,790 lbs.	798 lbs.
Potatoes,	3,820	1,910
Turnips,	1,790	335
Carrots,	1,210	453
Green clover,	13,800	3,066
Hay,		1.630
Straw-fodder,		2,266
Straw-litter,		3,577

from which was produced 32,280 lbs. of manure.

"See also on this point, the table quoted from VEIT, Vol. I. p. 287, already given on pages 103—106 of this work.—TR.]

5. WHAT PROPORTION MUST THE PRODUCTION OF PLANTS FOR SALE BEAR TO THE PRODUCTION OF THOSE FOR FODDER?

1. The object of Agriculture is the highest gain; which is obtained from the sale of those vegetable and animal products that are not required for the management of the farm.

2. But since beasts are necessary for the nourishment of plants, and the degree of the growth of plants depends on the quality of manure which the fields receive; hence is clear the necessity of producing so much manure in every farm as is needed to keep the field in a state of uniform power, or if this is too small, to increase it.

3. In a farm which has for its object simply the rearing of cattle, or the domestic use of them, we need only suit the number of cattle to the produce of the land, because all the land, be it plough-land or meadow or pasture, produces only plants for fodder; and in the same proportions as the produce of the land in plants is raised by the manure employed, the number of cattle, or the product of any particular part which before was less, may be increased.

4. But in a farm which derives a great part of its receipts from the sale of vegetable produce, must a part of the land be employed for the food of the beasts required for carrying on the operations of the farm, and another portion for the production of plants, &c., for sale.

5. The proportion between the lands which must be allotted to the production of manure, and that which yields products, which are not so employed, is found from the produce of the first in fodder and litter, and the need in manure of the latter.

6. There must, therefore, always be so much land employed for the production of fodder and litter, that the manure produced will maintain

the entire extent of the field under culture, in the highest capacity of production suited to the circumstances.

7. But fodder and litter either grows spontaneously on meadows, pastures, in woods and bogs, or is purposely produced on cultivated grounds.

8. When the manure, which proceeds from the employment of the natural fields of fodder and litter, is sufficient for the quantity of production of the plough-land, then can this be wholly employed for plants for sale; if a part only fails, then this may be replaced by the production of as much straw from the cultivation of grain as is needed; but, should there be little or a very disproportionately small portion existing of such natural fields of fodder or litter, then must the whole, or the greatest part of the manure, be obtained from the production of the cultivated land, and one must then employ according to the proportion of the circumstances which, more or less agree with the growth of plants for fodder, in favorable circumstances, one quarter, often one half, and yet more of the plough-land for the production of fodder, in order to be able, on the other, to produce grain and other plants for the purposes of trade.

Where all land consists only in that which is tilled, and neither meadows, pastures, nor woods, are found, and all the fodder and litter must be produced on the plough-land, we can only, in the most favorable situation, be satisfied with a fourth part to be used for fodder, and ought to raise on the other three parts, no herbaceous plants, which yield no straw. Take as an example this rotation: 1, Maize; 2, Barley; 3, Clover; 4, Wheat.

The produce on 100 yokes (142.2 acres,) of plough land:

Of Maize, 25 yokes (nearly $35\frac{1}{4}$ acres), at 30 metzen (50.7 bushels), is 1,750 metzen ($2{,}957\frac{1}{2}$ bushels), at 80 lbs. = 60,000 lbs.

Barley, 25 yokes (nearly $35\frac{1}{4}$ acres), at 20 metzen (33.8 bushels), is 500 metzen (845 bushels), at 66 lbs. is 33,300 lbs.

Clover, 25 yokes (nearly $35\frac{1}{4}$ acres), at 6,000 lbs. is 150,000 lbs.

Wheat, 25 yokes (nearly $35\frac{1}{4}$ acres), at 16 metzen (= 27 bushels), 450 metzen (760 bushels), at 82 lbs. is 32,000 lbs.

The manure will be produced from 1,500 cwt. of clover, and also from

25 yokes of	Maize-stalks at 35 cwt.	= 875	"
" "	Barley-straw at 20 "	500	"
" "	Wheat-straw at 30 "	750	"
		3625	"

As all the straw, with the clover, will be restored to the field in manure, so ought the weight of the grain raised on it, and not employed for the production of manure, be restored by an equal weight of other vegetables, or by the surplus of the gain in assimilating inorganic matter, which the clover makes.

The weight of the grain-harvest yields:

Of Maize, ...	600 cwt.
Of Barley, ...	330 "
Of Wheat, ...	328 "
	1258 "

and since half of the product of the clover yields, as the surplus of the gain in assimilating inorganic matter, 750 cwt; therefore, there are only wanting 508 cwt. of hay and straw in order to make up the given production of the cultivated field, but which deficiency will be fully covered by the roots of clover.

If little clover is raised, then 31 yokes (= 44 acres,) of meadow requiring no manure, and which will give each 40 cwt. of hay, is needed to produce so much fodder as, joined with the straw of the cultivated field, may furnish the necessary manure to yield the above-mentioned product of grain. Here then are $\frac{2}{5}$ of the field for fodder, against $\frac{3}{5}$ of cultivated land.

Is the situation less favorable for clover or luzerne, and must vetches in part take

their place, one needs then $\frac{3}{8}$ of the field for fodder, in order to plant $\frac{5}{8}$ with grain: For example, 100 yokes (= 142.2 acres), of plough land, lie in the following rotation: 1, Maize, manured; 2, Barley; 3, Clover; 4, Wheat; 5, Vetches, manured; 6, Oats; 7, Vetches; 8, Oats.

Acres.					Bushels.				
12.5 yokes	($17\frac{1}{2}$)	of	Maize,	give of grain, at	30 metzen	($50\frac{7}{10}$)	per	yoke,	: 300 cwt.
"	"	"	Barley,	" "	20 "	($33\frac{8}{10}$)	"	"	: 165 "
"	"	"	Wheat,	" "	16 "	(27)	"	"	: 164 "
"	"	"	Oats,	" "	24 to 50 lbs	($40\frac{1}{2}$)	"	"	: 155 "
"	"	"	Oats,	" "	20 "	($33\frac{3}{8}$)	"	"	: 120 "
									904 "

These 904 cwt. must be replaced by that which the clover and the vetches have appropriated to themselves from the inorganic matter.

12.5 yokes	($17\frac{1}{2}$ acres,)	of	clover,	give here, per yoke,	50	cwt.	625	cwt.
"	"	"	of manured vetches	" "	30	"	375	"
"	"	"	unmanured	" "	25	"	312	"
							1312	"
				Half of this is			656	"
				There is wanting, therefore,			248	"

which must be replaced by fodder or litter, but in the present case may be replaced by the clover roots, if the rest could only gain 80 cwt., on the extent of a yoke.

In the first example we have produced, on 100 yokes of plough land, 1,258 cwt. of grain; here only 904 cwt., because so large a part must be employed for fodder, while the clover gave a smaller product, and in the sixth and eighth year the land could only be cultivated for oats.

Since, in the first volume of this work, I charged the peas-straw wholly to the manure, I will therefore repeat the computation of the productions quoted on page 181 of that volume, (for which also see pp. 80—85 of this work) and examine how the quantity of the field for fodder is proportioned to that which bears grain. We produce, in this mode of husbandry, in six years, in grain, on 100 yokes of plough land,

Acres.					Bushels.		Metzen.		
$16\frac{2}{3}$	yoke	($23\frac{1}{2}$)	in	Maize, at	40 metzen	($67\frac{6}{10}$)	at 80 lbs.	: $650\frac{2}{3}$	: 520 cwt.
"	"	"		Barley,	24 "	($40\frac{1}{2}$)	at 66 lbs.	: $394\frac{2}{3}$	: 260 "
"	"	"		Winter Rye,	18 "	($30\frac{2}{10}$)	at 80 lbs.	: 300	: 240 "
"	"	"		Peas,	12 "	($20\frac{2}{10}$)	at 94 lbs.	: 200	: 188 "
"	"	"		Oats,	18 "	($18\frac{4}{10}$)	at 50 lbs.	: 300	: 150 "
									1358 "

Of clover, we produce for one yoke 60 cwt.; consequently, of $16\frac{2}{3}$ yokes, 1000 cwt., of this half belongs as a supply for 500 cwt.

Of peas-straw, is produced, per yoke, 30 cwt.; consequently, of $16\frac{2}{3}$ yokes, 500 cwt., of this half belongs here 250 "

750 "

There is wanting, therefore, 608 cwt. addition for grain, which must be either wholly or, in a great part, replaced by the clover roots. If, on the extent of one yoke, only 80 cwt. of fresh roots are found, on $16\frac{2}{3}$ yokes there would be 1,332 cwt.; therefore 333 cwt. of grain replaced, and there is wanting only 275 cwt. more of hay to be supplied; but, if we reckon 140 cwt. of roots per yoke, the amount supplied would be 583 cwt.

Should the clover be left out of this rotation, we should then need, for the supply of 1358 cwt. of grain, as much hay; and if the meadows gave not more than 25 cwt. per yoke, then there would be needed 54 yoke.

Great harvests can only be produced by great auxiliaries, as this computation very clearly shows. When, formerly, I produced on my farm, at Wolfsberg, 67 metzen (= $113\frac{1}{4}$ bushels) of maize; 40 metzen (= 67 6.10 bushels) of barley; 20 metzen

(= 33 8.10 bushels) of wheat: and 34 metzen (= 40½ bushels) of rye, per yoke, I had the following rotation:

1st year, { maize, potatoes, beans; } 2d year, { barley, winter wheat;

3d, clover; 4th, winter wheat;

5th, winter rye; and as an after-crop, turnips in the stubble.

Near by I had an equal number of yokes of dry, not very productive meadow, as plough-land, and obtained in leaves of the fruit-trees as much as half the product in straw.

[SCHWERTZ, in Vol. III. p. 150, gives also some estimates as to the production of manure, according to different modes of culture. "The first was where the field was allowed every 2d year to lie fallow, and the other years were cultivated with grain. The product in straw and manure was the following. The weight is in kilograms, of which one kilogram = about 2¼ lbs.

	Straw.	Manure.
1. Naked fallow, manured,	0 kilograms.	0 kilograms.
2. Rye,	3,500	7,000
3. Naked fallow,	0	0
4. Rye,	2,625	5,250
5. Naked fallow,	0	0
6. Oats,	2,250	3,957
	8,375	16,207

equal to 18 cartloads of manure. Therefore the product is equal to the need.

"On the system of a fallow, manured every 3d year with grain,

	Straw.	Manure.
1. Naked fallow, manured,	0 kilogr.	0 kilogr.
2. Rye,	3,500	7,000
3. Oats,	3,000	5,250
4. Naked fallow, manured,	0	0
5. Wheat,	3,300	6,600
6. Barley,	2,200	3,850
	12,000	22,700

equal to 25.22 cartloads of manure. The farm needs 36 cartloads, for each fallow year 18, therefore it falls short 1078. A similar farm of 100 hectares = 250 acres, suffers, therefore, a loss of 179⅔, to cover which, an addition of 33 hectares of meadow are required.

"The same mode of husbandry, with fallow every 3d year, but with clover, gives the following results:

	Straw and fodder.	Manure.
1 year, naked fallow, manured,	0 kilogr.	0 kilogr.
2 " rye,	3.500	7,000
3 " barley,	2,200	3,850
4 " clover, manured,	4,998	8,270
5 " Wheat,	3,300	6,600
6 " Oats,	3,000	5,250
Total,	16,998	30,970

which is 34½ cartloads. There was needed in manure for the fallow, 18 cartloads.

" " clover, 24

42

The product in manure, 34½

Deficiency, 7½

being 125 cartloads to 100 hectares, to cover which, there must be 23 hectares of unmanured meadows.

"In resorting to the production of roots, the following is the result in the case of potatoes, &c.

		Materials of manure.	Manure.
1 year,	half potatoes,	3,780 kilog.	6,615 kilog.
	half naked fallow,	0	0
2 "	half wheat,	1,650	3,300
	half rye,	170	3,500
3 "	half oats,	1,500	2,625
	half barley,	1,100	1,925
4 "	clover, dry,	5,000	8,270
5 "	wheat,	3,300	6,600
6 "	oats,	3,000	5,250
	Total,	21,080 kilogr.	38,085 kilogr.

The manure is 42½ cartloads.

The need of manure is, for half a hectare of fallow, 9 cartloads.
" " " " potatoes, 15
For 1 hectare of clover, 24
48

"There is a deficiency, therefore, of 5⅔ cartloads of manure. The amount on 100 hectares is 94½ cartloads, for which 17½ hectares of meadow are required. On comparison of the above three examples of the culture of grain, it appears that without the culture of fodder, but with a 3d part naked fallows, on 100 morgen of plough-land, 33 hectares of good meadow, which require no manure, are needed; that with the culture of clover, with the use of the 6th part as naked fallow, 23 morgen; and finally with clover and potatoes, using ⅙ of naked fallow, 17½ morgen of meadow are required. Therefore we save, on 100 morgen of plough-land, by clover, 10 morgen of grass growth, and by the culture of potatoes, 5½ morgen. We might therefore expect that clover and potatoes, where both are resorted to, would gain ¼ part of the cultivated soil for the plough. If we compare the above examples, it follows that only by a frequent return of the naked fallow, as well in the system of grain crops as in the rotation of fruits, can an addition of meadows be avoided."—Tr.]

9. Should the cattle feed themselves in the summer on the pastures, and we compare the quantity of the pasture-land with the quantity of the plough-land, we must, according to the proportion of the goodness of the pasture, have at least as much field for fodder, in order to keep an equal amount of plough-land in a fruitful state. If the meadows are poor, and one has only little meadow, and practises fallow, then the extent of the grain-bearing land to the pasture, meadow, and fallow, is often as 100 to 200 and upwards.

The farm of Mr. Bloomfield, in Norfolk, described in the 1st Vol. of the Möglin Annals, had 800 acres of plough-land, of which one-half was sown with turnips, clover, and vetches, together with 100 acres of artificial, 900 acres of natural pasture. 400+100+900 = 1400 acres of land for fodder, against 400 acres of grain-bearing land. That he could easily raise on this 36 metzen (= 68 3/10 bushels) of barley, and 26 metzen (= 44 bushels) of wheat per yoke, we may well believe, if we consider only the extent of the pasture on the strand, on account of its exposure to the flood.

The estates of Gusow and Platkow have on the high grounds:

In wheat, barley, and oat-land,	1477	morgen, at ⅚ of an acre.
In three year rye-land,	300	"
In wheat,	90	"
	1867	

If we set off from the first land ⅓ for fallow = 492, and from the 2d ⅔ as pasture = 200, there remains 985 morgen of grain-bearing land, but of which again 70 morgen must be subtracted for clover and potatoes; therefore 915 morgen against 952 morgen of pasture, and some meadow.

In fallow these estates have in wheat, rye, barley, and oatland, 1735 morgen,
In meadow, 602 "
2337

If we set off of the first $\frac{1}{3}$ for fallow, with 578 morgen, 80 morgen more for clover and potatoes, there remain 1077 morgen of grain-bearing land against 1260 morgen of pasture, meadow, and plants for fodder. But that this proportion of land for fodder to the grain-bearing land is not sufficient, and that too little winter-fodder would thus be produced, the small harvests which I have mentioned in many places in the Special Culture of plants proves.

Möglin had in 7 divisions 619 morgen of plough-land. The rotation was, 1, hoed-fruits, the greater part of which were foddered out; 2, barley; 3, clover; 4, winter-fruit; 6, husk-fruit; 7, winter-fruit. There were $\frac{3}{7}$ of the plough-land cultivated with plants for fodder. The inclosed divisions contained 350 morgen, and were used two years one after another, for grain, and then three years for pasture. The farm of Koenigshoff produced on an average 777 cwt. of hay yearly, and probably half as much in straw = 1165 cwt., which might well enough be the case on 100 morgen of land.

There was, therefore,

In Möglin, of . .	619	morgen,	set apart for fodder	258	morgen.
In the inclosed divisions of	350	"	" pasture	210	"
Total,	969	"	" Total,	468	"
On the farm of Koenigshoff, hay and litter was obtained on				100	"
			Total,	568	

Without regarding the addition of Koenigshoff, the proportion in Möglin between land for grain and for fodder, was as 969—468 = 501 to 468, that is, as 100 to 93. With Koenigshoff as 501 to 568, i. e. 100 to 111. With the Koppel, or Egarten-wirthschaft (see 6, 7,) there is always more land necessary for fodder than ought to be employed for the production of grain. The Koppel-wirthschaft which THAER mentions in the 1st Vol. of his Rationellen Landwirthsch, p. 159, consisted of 1200 morgen of plough-land, but of which only $\frac{3}{5}$ was sown with grain, 450 morgen; the other $\frac{2}{5}$ = 650 morgen, are 150 morgen fallow, 150 morgen, of clover, and 450 morgen of pasture. This farm required further 150 morgen of meadow, and 100 yokes of out-pasture: 650 + 150 + 100 = 900 morgen of land for fodder against 450 morgen of land for grain.

If we examine our mountain-farms with their fallows, heath-pastures, meadow and woods, which produce little in abundance, we should find frequently 30 and 40 yoke of land for fodder and litter, against 10 yoke of grain-land.

6. HOW MUST THE DIFFERENT PLANTS CULTIVATED FOLLOW EACH OTHER, SO THAT THE NECESSARY WANTS OF FODDER AND LITTER MAY BE MET AND SUITED TO THE GREATEST POSSIBLE PRODUCTION OF PLANTS FOR GRAIN AND FOR TRADE, WITHOUT THE FIELD BEING TOO MUCH EXHAUSTED OR RENDERED BARREN, OR NEEDING ANY EXTRAORDINARY CULTURE?

1. The order in which the crops should follow one another on a field is called the *Succession of Fruit* (Frucht-folge, Frucht-wechsel)or the Turnus.

2. Such plants only ought to be adopted in the Succession of Crops in a given country, which are suited to the nature of the climate, of the soil, and the circumstances of local situation.

In a dry and loose soil, to cultivate wheat will bring the greatest disadvantage, while rye and buckwheat will yield the best profit. Beans in a moist, cold climate bring more profit than maize, and *vice versa;* and where there are only a few men for labor, all those vegetables which require much hand-labor, as millet, flax, carrots, &c., yield little or no profit.

3. Plants which we cultivate in any farm standing by itself, are either designed as food for the beasts required for their cultivation, plants for fodder, or to yield products—which only in part, or scarcely not at all, are applied to the nourishment of beasts, or the production of manure—and plants for grain or for trade.

4. Where sufficient pastures and meadows exist, there the whole field can be employed for wheat and plants for trade.

5. The mode of husbandry, where the land under cultivation is employed only for the production of grain and plants for trade, and not for vegetables for fodder, is called *Field-farming* (Felder-wirthschaft.)

6. Where pasture and meadows are wanting, or not existing in sufficient extent and goodness, the fodder must be wholly or in part produced upon the field, and plants for fodder and grain, must be interchanged on the cultivated land.

7. When the field is left over for two or more years to a *wild natural growth of grass*, and in this time is used as a meadow or pasture, this mode of husbandry is called the Egarten, or Koppel-wirthschaft; but if the field is sown alternately with grain and plants for fodder, and this last cultivated proportionally, this kind of husbandry is called the *Rotation of Crops* (Frucht-wechsel-wirthschaft).

8. The *Field-farming* (Felder-wirthschaft) may be adopted wherever pastures and meadows, required for the amount of cultivated land, and its comparatively highest use, exist in sufficient extent, and are not capable of a higher use.

9. The *Natural Grass-growth*, (Koppel-wirthschaft) is only profitable where the climate so much favors the natural growth of grass, that the field left to itself will become a meadow, if it is not ploughed, without the necessity of sowing it with plants for fodder.

10. The *Rotation of Crops* (Frucht-wechsel-wirthschaft) must be employed where the existing field of plants for fodder, pastures, and meadows, do not produce the fodder required to meet the demand, and the climate too little favors the natural growth of grass; so that either all the fodder or a part of the same must be produced on the cultivated fields; or where the soil from the number of population has so high a value, that a person must be contented with a small use of the same for a pasture, or of a small, more productive meadow.

11. Only in rare cases will one of these kinds of husbandry be used by itself; for the most part one is more or less joined with others, and a person cultivates with the *Field-husbandry* (Felder-wirthschaft) also some fodder on the tilled land, or with the Koppel-wirthschaft makes use also of *natural meadows and pastures.*

12. If a person has adopted a selection of grain-plants for fodder and for trade, suited to the nature of the climate, soil, and local situation of the farm, and has fixed on the proportion in which the plants producing fodder and straw, should stand to those which are not applied to the production of manure, the *order* then must be given in which these plants should follow one another on the field.

13. The plants cultivated on the field must be so cultivated successively, following each other on the field, that those which will bear the most manure without suffering injury from it should come on the field in the first year of the manuring, and later afterwards those which need more humus, and later still those which are in a state to appropriate to themselves more of the inorganic matter. Besides this, they must be so arranged, that the

condition of the field in which it is left by the culture of the preceding fruit shall be most suited to the succeeding fruit, and most profitable for itself.

14. Those plants bear the most manure which form a thick and stiff stalk, or grow low in the field, moreover all root-vegetables. To these belong maize, beans, head-cabbage, hemp, potatoes, turnips, &c., &c.

Culmiferous grain (i. e. having a haulm or hollow-jointed stalk,) easily suffers injury from fresh manure, as it shoots up too tender and too high, easily lodges, and has feeble ears, or becomes rusty and blighted; whilst maize, and beans, head-cabbage, and the root-vegetables, yield in the same proportion a greater product according as one employs the more manure for these fruits.

15. The usual culmiferous and pod-bearing plants need less manure, and buckwheat the least.

16. But above all, the amount of the product of all the plants is in exact proportion to the amount of those before-existing in the soil in a dissolved state, assimilating to themselves a quantity of organic nutriment of plants; and we shall obtain a harvest so much the richer, the more we take care that the field shall always contain that quantity of manure which is most suited to the nature of the plants.

Many are of the opinion that one kind of grain needs more, another less manure, not so much in an absolute as in a relative point of view, in order to produce a definite weight of straw and grain; others suppose that plants assimilate to themselves different parts of the humus, and that we must ascribe it to this last circumstance, that we suffer first wheat and then oats to follow one another in the field; and others still, that a course of fruits with a proportionate succession, with a given manuring will produce more organic matter than with a disproportionate one. But I hold on this subject, that the product of all fruits is greater in the same mass, as they find in the soil more humus in a state easy to be dissolved, which they suck in, and out of which they form the different particular parts of plants. On this account only, we cause wheat to come in the field earlier after the manuring than oats, because the increased product of the wheat-plants in a strong field, has a greater cash-value than that which the oat-plant produces, though this generally produces a greater volume, and is earlier in a rich soil and later in a poorer soil. Plants, like beasts, first take the nourishment appointed for them to themselves, and then secrete in their interior parts, by assimilation, those substances which they need for the formation of the organic material; and as from hay, with the cow, is formed milk, with the fattening-ox, tallow, and with the sheep, wool, by the process of life of the beasts; so from the same humus dissolved in water, according as a plant sucks it in, a vegetable product contains sometimes more, sometimes less gluten, farina, sugar, slime, oil, &c. But this product is always in that proportion of quantity which corresponds to the amount of dissolved humus in the soil.

[Liebig pronounces the theory respecting the rotation of crops, the only one which rests on a firm basis. Decandolle supposed that the roots of plants, in extracting soluble matter of various kinds from the soil, absorbed a variety of substances which were not fitted for their own nutriment, and that therefore these were ejected, and returned back to the soil. Of course, the soil thus filled with this ejected matter would be unfit for another crop of the same plant. But these very substances might be a suitable nutriment to other plants of a different species, and by being absorbed from the soil it might again be rendered proper for the plants before raised on it. He cites as confirmatory of this theory also the experiments of Macaire Princep. This theory of Decandolle, and also the one to which our Author alludes above, which merely considers the innutritious matter as not at all extracted from the soil, but left in it, Leibig thinks do not explain how a field is improved by lying fallow, and this according as it is improved, nor how a soil gives carbonaceous matter by the cultivation of luzerne and sainfoin. He says that the advantage of the alternation of crops proceeds from two causes: "A fertile soil ought to afford to a plant all the inorganic bodies indispensable for its existence in sufficient quantity and in such a condition as allows their absorption."

"All plants require alkalies, &c.; where those are in combination with silicic acid, the ashes obtained from the incineration of the plant contain no carbonic acid, &c." See LEIBIG's Organic Chemistry, Cambridge edition, pp. 214, and onward. The whole of this valuable work deserves the reflecting study of all our intelligent farmers; for in it they will find explained many of those questions of deep practical interest which force themselves upon their minds while carrying on the operations of their Agriculture; and they may derive from it, too, many important rules for the regulation of their usual husbandry. More here might be quoted on some of the preceding propositions of our Author, from VEIT, THAER, and others, but it seems unnecessary, as many of the topics which appear to need farther illustration have already been casually embraced in the various extracts heretofore made from those authors.—TR.]

17. Whoever manures his field, can cultivate the same fruit continuously with equal results, if between the harvest and the sowing-time a sufficient period be given to prepare the soil suitably, and if he also takes care that the field shall be cleared of weeds.

Summer-fruits may always be cultivated on the same field, if one only takes care to manure it; but with winter-fruits, especially wheat, it does not always succeed, because between the harvest and the time of sowing, the period is often too short to clear the field, by repeated ploughing of the weeds, and reduce the hardened soil. That one can always cultivate head-cabbage, hemp, maize, potatoes, in the same field with equally good results, no one scarcely doubts; and whoever does doubt it, can easily convince himself at any time of the correctness of this fact. But may not that which succeeds with maize and hemp, also do so with barley, oats, and summer-wheat? If one supplies the quantity and quality of manure proper for these plants, it is undoubtedly true. I know the field of a butcher which he has sowed for 20 years with barley, and every year scattered on it some sheep-dung, and which has produced him continually the richest harvests. Surely we can always cultivate oats and barley on the same field with equal results if we think it profitable. But because summer culmiferous fruit, manured with fresh stall-manure in moist weather, more easily lodges and becomes rusty than if it were sown in the second and third year after manuring, so we had always much rather take such summer-fruits for fresh manuring, which the manure will injure in no weather. Winter-wheat we cannot sow after winter-wheat in Northern Europe for many reasons; because the period of time from the harvest in August till the sowing-time at the end of September, is too short, and usually too moist, to clear and pulverize the clayey soil by repeated ploughing; because the soil, by too frequent ploughings following one another too rapidly, causes too much work in too short a time; because it may easily become too loose, whereby the plants are winter-killed, and because the crude stall-manure, and the late sowing of the seed occasion rust and blight. But in the South of Europe, one may sow with good success frequently winter-wheat many times in succession, in the same field. In the South of France, ARTHUR YOUNG saw the fields of luzerne broken up three times in succession, sowed with wheat without any damage being occasioned, and in the newly broken up rich marshy fields in the South of Hungary, they cultivate wheat many years in succession. But winter-rye one may raise with us as well as in Western Germany continuously in the same field, since this fruit is here cleared from the field at the end of June, and therefore allows us time to plough repeatedly till the end of September. Rye also can be raised on a loose soil, and it suffers not from the strong loosening; it is also scarcely liable to blight, and very rarely to rust, and the fresh manure frequently does it less injury than it does wheat.

18. But because on account of the division of labor and the danger of the failure of the crop, we cultivate many plants for fodder and grain, and because the usual manure which we carry into the field is only gradually dissolved in the course of many years, therefore we must cause the plants fixed on for our fields, so to follow one another that the quantity of manure may not be injurious to the plants, and the remainder of it which is still left in the field after the harvest of the preceding fruit, may also correspond to the need of the after-fruit.

If we cultivate only a small variety of the fruits of cultivated land, then we are lia-

ble to loss from accidental failures of the same. If we cultivate many, then the loss which we suffer from the failure of one fruit may be made up by the success of another. Further, we must take care to keep our beasts and people appointed for the work in constant useful activity, and this will only be possible when we cultivate a large variety of plants: and because, finally, the stall-manure mixed with litter dissolves itself only gradually; thus can we, according to the proportion of the quantity and quality of the same, draw benefit from it for several years; only we must not expect every year equally great harvests of plants which are of similar proportion as to their need of humus. But because some plants possess in a higher degree than others the power to assimilate to themselves inorganic matter, therefore we may obtain by their culture valuable harvests; provided, indeed, the mass of the humus in the soil is only smaller, and not at variance with that crop which requires more, to which belong, for example, vetches, peas, lentils, and buckwheat.

19. But the greatest regard must be had to leave the plants so to follow one another, that the condition in which the soil is left by the preceding fruit may be suited to the after-fruits; so that on the one side the plants may seize on that state of the division of the soil which is adapted to their nature under the given circumstances of climate, and on the other hand may avoid any extraordinary effort for its purification.

20. If we cultivate in a suitable alternation on the same field such plants as are raised to their usual development at wide intervals, and must be frequently hoed and well hilled, with culmiferous fruit and other plants, which by their thick state and the shadowing of the soil hinder the springing up of the weeds and the hardening of the soil, we shall then reach the object perfectly.

Potatoes, beets, Swedish-turnips, maize, beans, peas, tobacco, teazles, &c., must be planted wide apart, and during their growth must be hoed, and up to the two last be also hilled. Thus the field will be put into a loose and very clean state, and if it is ploughed once after the harvest, it is sufficiently prepared for the following fruit: Clover, luzerne, vetches, and lentils, grow so thick in a well-prepared soil that weeds do not come up among them, and by hemp the field is kept in the cleanest state. It is only by the culture of the culmiferous grains—which during the growth are not hoed, and which, by their trembling state and their thin, early dried-up leaves, oppose little hinderance to the coming up of the weeds, and which allow the sun too great an influence on the soil—that the field begins to waste; and herein alone, and in nothing else, lies the cause why we must watch, and not allow two culmiferous fruits to follow one another, unless we immediately leave it fallow again, or raise a hoed fruit, or suffer the field to lie for a pasture, or to a natural growth of grass.

21. If there is at hand no suitable rotation-crop, then the clayey soil so easily hardens and runs to waste in unfavorable weather, or in a cold and moist climate, that it can only be restored by lying fallow.

He who always sows culmiferous grain, and finds not time nor power to loosen and clear the soil properly, in the interval from the harvest of the preceding fruit to the sowing of the after-fruit, nothing remains for him in such circumstances, than to give up the product of a year, and employ the whole summer in cleaning and pulverizing the soil run to waste.

22. The fallow, therefore, is never absolutely necessary, because the object of the same can be obtained perfectly by hoed fruits; it is only accidentally necessary if we are hindered by the weather from imparting to the clay soil that degree of loosening and cleaning which the culture of plants demands.

23. It is only then when the cultivation of the field must be carried on with very small means of aid, or when the burden of the pasturage rests on the fields, that one need resort to fallows.

He who uses no fallows, must have more or stronger teams of cattle than he who employs them; because he must prepare his field suitably from the harvest of one

fruit to the sowing-time of another often in quite a limited space of time, whilst with the fallow he might employ the space of a whole summer to prepare the third part of the field for sowing the winter-crop; and the ploughing and carrying out the manure may be attended to at a time when the labor of a crop presses. That one needs less manure when he practices on the fallow system is very natural, because only $\frac{2}{3}$ of the field bears fruit; for a like production therefore he needs $\frac{1}{3}$ less manure. But afterwards one harvests so much the less for it, since the greater product of the winter-fruit gathered makes not up the deficiency of a third part of the field, which gives at the best but a sparse pasture.

We have already treated of this subject in the first volume, p. 242, and here refer to what we there said. Great farms usually need fallows because they have neither teams nor manure sufficient for the extent of the field; and where the farms are managed on the soccage-principle (Fröhne) there the fallow is indispensable, if the climate favors not the mode of farming by the system of the natural grass-pastures (Egarten-wirthschaft). We see, therefore, in all the North of Germany, in a great part of England, and of Hungary, &c., fallow practised. But where the farms are small and the burden of the pasturage rests not on the fields, there fallows are almost wholly unknown, or they gradually disappear; as for example, in the Netherlands, in Switzerland, in Alsace, in Tyrol, Steirmark, Carinthia, and in Italy. A clear proof that great estates are hinderances to the welfare of a nation in two ways; because they produce less and hinder a great part of the population from becoming proprietors and lessees.

Thaer, in the first volume of his Rationellen Landwirthsch, has stated very well the reasons for and against fallows; in the first No. also, of the Transactions of the Agricultural Society of Vienna, may be found admirable remarks on this subject.

The advocates of fallows are acquainted usually with only the land-husbandry of their own country and the circumstances there; and because there fallow is practised, and after fallow fine winter-grain is harvested, and those who plant their fallow in part with summer-fruits have poor winter-grain, and this and that person who have solely employed their fallows for cultivation must return again to the fallow system, they therefore conclude that one can hardly raise grain to advantage without fallows. But they overlook the fact that, on the other side of the mountains they have no fallows, and yet raise as fine and more grain than here at home: that those who have planted their fallows in part with summer-fruits, without taking care to use more manure, must necessarily only weaken the field; and that it is from imprudence and laying up too small means of aid, that this and that person must give up again a mode of farming which they do not understand, and in which they were in no wise brought up.

[The remarks to which our Author refers as found in Vol. I. p. 242, &c., respecting fallows, are these: "When a person ploughs and harrows a field in the course of the year many times, 3 to 6 times, merely for the purpose of preparing it for the sowing in autumn, this is called to *fallow* the field, the field itself is the *fallow*.

"As the fallow is the most costly preparation of the soil, which is used while it is ploughed, from 3 to 6 times, and besides, the interest of two years and the loss of a harvest, as well as the useless dissipation of the manure during this time, which is very much aided by frequent turning of the soil, must be counted as a charge; hence it is clear that only in the most pressing circumstances should one resort to this mode of preparing his field.

"In easy and mellow soil one always has time enough, between the harvest of the preceding and the sowing of the after-fruit, to pulverize and clean the soil sufficiently, by the plough, harrow, and extirpator; the culture of the hoed fruit affords also an effectual means of aid to reach this object; but in a tight, hard, clayey soil, one is often hindered from ploughing the field in the usual time of the year, and if not to be sown in the most uncleared state, yet nothing else remains than to plough it again later, whereby many times the period of the summer sowing is lost.

"From this it is clear that the fallow is only accidental, not necessary in itself for the preparation of the soil.

"Although it is certain that the real ground on account of which men have adopted fallows, lies only in the nature of a light soil not reduced except by much work; yet it appears in the lapse of time to have been forgotten, and because the fallow was every where introduced into Europe from many causes, therefore the chief ground became a secondary ground, and other grounds were relied on to prove the necessity and use of the same.

"The fallow would, by a rest of an entire year, gain in power and by the oft-re

peated turning over of the soil, become enriched with atmospheric substances. As to what concerns the first reason, it would be superfluous to deny it, as we are now more accurately instructed than they formerly were, as to the effect of the soil on vegetation; and as respects the second, the advantage is always double—one that, by the frequent turning of the soil, the humus is brought into a more soluble state, and then, that by frequent ploughing under, the weeds always springing up again, increase the mass of the humus itself. But we ought not here to overlook the fact, that in the period that the soil is exposed to the air and brought into activity, no plants occupy the field which can take it up, and that by the evaporation of the old humus the advantage of its easier dissolution, and probably its increase itself, is lost. The real advantage of this treatment always confines itself only to the clearing of a soil greatly overrun with weeds, which is more rarely, or of a firm, cohesive, tight, and hardened soil, which is most usually the case.

How it happens that it is believed necessary to repeat the fallow for three years on the same field, in other words, why the Triennial or Threefield system of husbandry is every where the most usual on hard and lazy soil, must be sought for in the disproportionate size of the farms, or what is the same, in the too small means of aid to manage them, in the breaking up of pasture-land, in the want of fodder, in the prevalence of soccage, in the right of pasturage, and in the senseless imitation of doing that which a father or a neighbor has done. It is nowhere absolutely necessary, since it is in no case supposable that one cannot sufficiently prepare a clayey soil, if also it is run to waste, by means of one deep ploughing in the autumn, and the repeated employment of the cutting and shovel plough in favorable weather in the spring, so as to obtain at least one summer-fruit. From the Danube at Vienna to the Po fallows are unknown, and who will maintain that these extensive lands produce less than those which lie between the Danube and the Baltic sea. The climate in Steirmark, Salzburg, Tyrol, Carinthia, and Carniola, is as different as the soil of those different lands, and one finds there as many variations as in those lands which practice fallow. The ground of the necessity of the fallow lies therefore not in the climate, and not in the soil. But when we compare the circumstances of the farms of countries which have no fallows, with those where the Threefield system of husbandry is the most common, then the true ground and the correctness of our above-mentioned opinion is evident. The inclosed and proportionately small farms, the great stock of cattle, the extended culture of plants for fodder, and the great extent of meadow, make it possible there in fields unbroken either to raise grain or plants for fodder, while as one must carry on large farms with small means of aid, the fallow, as also in mellow, sandy soil is indispensably necessary.

How the soil must be ploughed in the fallow year, depends on the proportion of each ploughing to its object, and on the weather, which more or less favors the cleansing and pulverizing it. The object must be obtained, and the smaller the cost is with which one reaches it, the greater the profit. If one starts up the fallow at its full depth in autumn, he may in the following spring and summer very perfectly pulverize the strongest clayey soil with two ploughings, and as frequent harrowing, and following this with the extirpator or scarifier. Besides, one reckons, according to the rule, that the soil must be ploughed up in Autumn, in Spring, in June, August, and September, if the fallow is to be fully prepared. The manure should be brought on the field, and buried under the ground in May and June, again in August, and again buried in September; there is, therefore, time enough for it to evaporate itself uselessly, as respects the field, during the lapse of nearly a whole year; and of all the objections which are made to fallows, this waste of manure is one of the most important, although the least considered. The summer deposit is frequently made in cross lines with the hoe, which is certainly very suitable. But if one leave the fallow field, as is much more commonly done, unbroken till June, in order to use it as a pasture, and then first break up the soil, then in dry summers he would not always obtain his object in the fallow, even not to mention that now the greater part of the work on the field must be done in the time of the harvest. We generally notice that a person wishes with a fallow to attain two contrary objects; he practises fallow to purify the soil from weeds, and render it as finely divided as possible, and he does so also to have pasture for his cattle. In most cases he has no other field for fodder; his cattle, especially sheep, feed on it till the cutting of the winter grain. Not to leave his beasts to suffer, one ploughs up his fallow late, leaves it between each ploughing to grow green and harden again, and if he is not always in a state to attain the object of the most perfect cleaning, loosening, and pulverizing the soil, yet he believes himself recompensed by the enriching of the soil; then in such a case the

fallow must be regarded as a species of green-manuring, and the most enigmatical opinion, that in many regions grain is always produced on the fields without manuring them, and without that one employs in them any particular heaping up of the old humus, must be partly explained by the green-manuring, by means of the three year-returning fallows. The most convenient time to turn the soil, is when it is in that state of moisture with which it exerts the least degree of cohesion. If it is necessary to give the soil by a repeated ploughing a proper degree of cleanness and looseness, yet it is not so, nor even profitable, to turn up the soil in the frequent ploughings to the same depth."—TR.]

24. Where the fields are divided into three parts, and one part is left fallow, one part is sown with winter, and one part with summer grain; this mode of farming is called the *Three-field* or *Three-shift* system. (Dreifeld-wirthschaft.)

25. What method of husbandry will bring the greatest profit in the given situation can only be determined after a close survey of the nature of the soil, the climate, the political and commercial relations.

26. In general we may assume, that in cold, moist regions with a clayey soil, where the population and the capital employed for carrying on the farm are small, the Koppel-wirthschaft will yield the greatest profit, because the climate and the soil favors the grass-growth, and because this mode of husbandry demands the least expense of power and manure; but in warmer and dryer regions, and where moreover the value of the soil, with a large population, stands not too low, the system of Rotation of Crops (Frucht-wechsel-wirthschaft) brings the most profit.

27. The Koppel-wirthschaft brings under the plough all the field which is not watered meadow, or dry and remote pasture-land, and cultivates on it grain, for 2 to 5 years, whereupon it is used as long, or even twice as long, for meadow and pasture.

28. The object in the employment of the Koppel-wirthschaft is either the rearing of cattle or the cultivation of grain. In the first case, one must draw out the power of the field by ploughing and the raising of grain as little as possible, and employ manure more for the grass than for the grain; in the second case, one seeks to obtain by his employed manure an increase of grain. In the first case, the fallow becomes a meadow, but in the second case, only a pasture.

In the mountains of Southern Germany and Switzerland, the Egarten-wirthschaft has prevailed from time immemorial. In what rotations the fields are employed, the following examples may show.

In Salzburg at Mittersill, 1, winter-rye, manured; 2, summer-wheat, manured; 3 and 4, grazing-pasture.

We cannot, in highly situated, cold, and moist lands, bring the winter-fruit into the second year, but must sow it in the fresh, unploughed, grazing-fallow; then the summer-wheat is removed from the field too late for us even to venture to sow rye.

If both kinds of grain should be manured, which there is very possible where a small cultivation of the field is joined to great mountainous and Alpine meadows, as well as aided with bog-litter, then is the product in grain and straw very great, and the grazing-meadows appear like the most luxuriant well-watered meadows.

In Upper Steirmark at Murau, 1, summer-wheat, without manure; 2, oats, without manure; 3, winter-rye, manured; 4, 5, and 6, grazing, or natural grass-growth (Egarten).

The climate is milder than at Mittersill, wherefore one can sow winter-rye after oats; but because it is manured only once in six years, though with the grain fruit, therefore the product of the grass-growth (Egarten) is less, indeed scarcely any thing, in a third year, than a good pasture.

In Carinthia, I. 1, Winter-rye, manured; 2, Oats; 3, Summer-rye, manured; 4, 5, and 6, Egarten.

II. 1, Oats, manured; 2, Summer-rye, manured; 3, Winter-rye, manured; 4, 5, and 6, Egarten.

III. 1, Summer-wheat, manured; 2, Oats; 3, Winter-rye, manured, 4, 5, and 6, Egarten.

IV. 1, Oats, without manure; 2, Winter-rye, unmanured; 3, Summer-rye, manured; 4, 5, and 6, Egarten.

The rotation of crops on these lands is always determined by the climate and the quantity of manure which one obtains by mountain-meadows, pastures, and wood-litter. For each fruit the soil is only once ploughed before sowing, partly because there is not time to plough oftener, and partly because it is not desired to uproot, but only to keep under the weeds existing in the soil; manure is always employed for the last fruit, so as not to weaken the power for grass growth.

In the level country of Northern Germany, the Koppel-wirthschaft has been recently introduced; they became more intimately acquainted with it by the intercourse with Denmark and England, where this mode of farming, has been common from time immemorial. We must make a distinction between this system of husbandry, as practised in Holstein, and in Mecklenburgh. The first has, as is the case with our grazing-system, the rearing of cattle more for an object, than the cultivation of grain, and has no fallows; but varies in this, that they have more divisions, i. e., they harvest grain for a longer course of years, and then leave the field to revert to a pasture as long, often, indeed, twice as long. But especially these two modes of farming are distinguished in this, that with us the grass-growth is treated and used as a meadow, whilst in Holstein, it is only a pasture; then most of the manure brought on the field is taken back again in the grain, whilst we manure the last year, and then leave the field to lie.

The Mecklenburg kind of Koppel-wirthschaft unites fallows with pasture husbandry. Their principal object is the cultivation of grain, and not the raising of cattle; therefore they seek by fallows to destroy the weeds, and to bring the manure into greater activity, that it may benefit the grain-fruits. But therefore their pastures are poorer and less valuable, and they leave not their land to lie so long as pasture.

EXAMPLES OF THE HOLSTEIN KOPPEL-WIRTHSCHAFT.

I. 1. Oats unmanured. 2. Winter-rye manured. 3. Barley. 4. Rye. 5. Oats. 6, 7, 8, 9, 10 and 11, Pasture.

II. 1. Buckwheat. 2. Winter-rye, manured. 3. Oats. 4. Oats. 5, 6, 7, 8, 9, 10, and 11, Pasture.

Examples of the Mecklenburgh Koppel-wirthschaft:

I. 1. Fallow, manured. 2. Winter-rye. 3. Barley. 4. Oats. 5, 6 and 7, Pasture.

II. 1. Fallow, manured. 2. Wheat. 3. Barley. 4. Rye. 5. Oats. 6, 7, 8, and 9, Pasture.

29. In the system of the Rotation of Crops (Frucht-wechsel-wirthschaft), the grain-fruit and the plants for trade only interchange together if sufficient meadows and pasture exist; or the plants for fodder must be cultivated in common with these if there are hardly any natural fields for fodder or not in sufficient measure.

30. The plants which one adopts in a rotation of crops must correspond to the nature of the climate and of the soil and to the circumstances of the farm, and be so arranged one after another according to the degree of manure in which the field is, that the culture of the preceding fruit may leave the soil in such a state, that the cultivation of the after-fruit may require no extraordinary labor and care upon it.

EXAMPLES OF THE ROTATION OF CROPS WITHOUT PLANTS FOR FODDER.

In a cold climate, and heavy soil.

I. 1. Beans, manured, hoed. 2. Wheat. 3. Barley.

II. 1. Beans, manured, hoed. 2. Wheat. 3. Peas. 4. Barley.

In both these cases there are first, hoed-fruits; to this follows wheat, with which the

strong and clean state of the soil especially agrees, and with which we use in a higher degree the manure existing in the soil, than with the later fruits. Between the harvest of wheat and the sowing of barley, in the first example, there is time enough to plough up the field twice, and extirpate the weeds; but we sow peas; thus these cover the field by their thick state, and protect it from drying up; they may also be drilled and hoed, and because they draw less out of the soil than the culmiferous fruits, therefore we may expect from the barley, in the fourth year, yet a very excellent harvest.

b. In a warm climate, and a heavy soil.

I. 1. Maize, tobacco, hemp, manured, and the first hoed. 2. Wheat. 3. Barley, Summer-wheat, or Oats.

c. In a cold climate, and an easy soil.

I. 1. Potatoes, manured, hoed. 2. Oats. 3. Winter-rye.
II. 1. Winter-rye, half-manured. 2. Buckwheat. 3. Oats, half-manured. 4. Winter-rye.

d. In a warm climate, and an easy soil.

I. 1. Maize, manured, hoed. 2. Winter-rye. 3. Oats.
II. 1 and 2, as before. 3. Peas. 4. Oats.

EXAMPLES OF THE ROTATION OF CROPS, WITH PLANTS FOR FODDER.

a. In a cold climate, and a heavy soil.

I. 1. Beans, head-cabbage, manured and hoed. 2. Barley. 3. Clover. 4. Wheat.
II. 1, 2, and 3, as before. 4. Peas. 5. Wheat, half-manured. 6. Oats.

b. In a warm climate, and a heavy soil.

I. 1. Maize, hemp, Swedish turnips, beets, manured and hoed. 2. Barley. 3. Clover. 4. Wheat.
II. 1, 2, 3, and 4, as before. 5. Vetches manured. 6. Wheat.

c. In a cold climate, and an easy soil.

I. 1. Potatoes, Swedish turnips, manured and hoed. 2. Summer-rye, barley, and oats. 3. Clover. 4. Winter-rye.
The Rotation in Norfolk is:
II. 1. Turnips manured, and hoed. 2. Barley. 3. Clover. 4. Winter-wheat.

d. In a warm climate, and an easy soil.

I. 1. Maize, potatoes, manured and hoed. 2. Barley and oats. 3. Clover. 4. Winter-rye, and as an after-fruit, water turnips.
II. 1. Maize. 2. Barley. 3, 4, 5, 6, and 7, Luzerne. 8. Wheat. 9. Oats.

THAER, Vol. II. p. xvii., furnishes the following estimates of the exhaustion or addition of power by different crops and modes of tillage.

No. 1.

PURE THREE-SHIFT, OR TRIENNIAL SYSTEM.

	Increase of power.	Loss of power.
1. Fallow,	10 degrees.	— degrees.
13½ loads of manure,	60	—
2. Rye, 12 metzen (20½ bushels),	—	30
3. Barley, " " (" ")	—	21
4. Fallow,	10	—
5. Rye, 7 metzen (11.82 bushels),	—	17.5
6. Oats, 8 " (13½ "),	—	10
7. Fallow, light folded,	28	—
8. Rye, 8 metzen (13¼ bushels),	—	20
9. Barley, 6 " (10 "),	—	10.5
	108	109

Loss in 9 years, 1 degree.

No. 2.

IMPROVED THREE-SHIFT OR TRIENNIAL SYSTEM.

	Increase of power.	Loss of power.
1. 13½ loads of manure,	60 degrees.	— degrees.
Peas,	—	10
2. Rye, 10 metzen, (17 bushels, nearly),	—	25
3. Barley, " " (" " "),	—	17.5
4. Fallow,	10	—
18 loads of manure, including folding,	80	—
5. Rye, 14 metzen (23.66 bushels),	—	35
6. Barley, " " (" "),	—	24.5
7. Clover,	12	—
8. Rye, 12 metzen (20½ bushels),	—	30
9. Barley,	—	17.5
	162	159.5

Gain of power, 2½ degrees.

No. 3.

SEVEN-DIVISION KOPPEL-WIRTHSCHAFT.

	Gain of power.	Loss of power.
1. Fallow,	12 degrees.	— degrees.
13 loads of manure,	58	—
2. Rye, 15 metzen (25.35 bushels),	—	37.5
3. Barley, " " (" "),	—	26.25
4. Oats, 14 " (23.66 "),	—	17.5
5. Mown clover,	10	—
6, 7. Pasture,	20	—
	100	81¾

Gain in 7 years, 18¼ degrees.

No. 4.

EIGHT-DIVISION ROTATION OF CROPS, WITH PASTURE.

	Gain of power.	Loss of power.
1. 20¼ loads of manure,	90 degrees.	— degrees.
Potatoes,	10	30
2. Barley, 18 metzen (30.42 bushels),	—	31.5
3. Peas,	—	10
6¾ loads of manure,	30	—
4. Rye, 16 metzen (27 bushels),	—	40
5. Mown clover,	12	—
6, 7. Pasture.	20	—
8. Oats, 22 metzen, (37.18 bushels,)	—	27.5
	162	139

Gain in 8 years, 23 degrees.

No. 5.

EIGHT-DIVISION ROTATION OF CROPS, WITH STALL-FODDERING.

	Gain of power.	Loss of power.
1. 20¼ loads of manure,	90 degrees.	— degrees.
Potatoes, 160 metzen (270 bushels),	10	30
2. Barley, 18 " (30½ " nearly),	—	31.5
3. Clover,	15	—
4. Oats. 26 metzen, (34 bushels, nearly),	—	32.5
5. 9 loads of manure,	40	—
Peas,	—	10
6. Rye, 18 metzen, (30½ bushels, nearly,	—	45
7. Green vetches,	10	—
6¾ loads of manure,	30	—
8. Rye, 16 metzen (27 bushels),	—	40
	195	189

Gain in 8 years, 6 degrees. TR.]

SECTION IV.

OF THE INNER DOMESTIC ECONOMY.

1. The *Inner Household* (Hausehalt), or the doctrine of the *organization of the interior-husbandry*, teaches the distribution of occupations among many members of the farming establishment, the reciprocal duties of the same, and the manner how one may obtain a clear insight and a perfect conviction as to the profit or loss which proceeds from the various branches of the farm.

2. This doctrine divides itself, therefore, into three parts, of which the first shows *the distribution of occupations ;* the next, the *duties of employers and the laborers ;* and the third, *the mode of keeping the accounts of husbandry.*

A.—OF THE DISTRIBUTION OF OCCUPATIONS.

1. The distribution of occupations in land-husbandry, is ordered on the same general principles as in other business which employs many and various laborers.

2. When several large farms belong to the same proprietor, he or his representative is fully occupied, if he plans the organization of the estates, directs the mode of husbandry, watches that his directions are followed, and reviews the Farm Accounts.

3. The execution of the mode of husbandry adopted in general, belongs to the Administrator, or head of the particular farm, from whom the Overseer receives the directions which the laborers carry out under his guidance and inspection.

4. In small farms the proprietor usually acts as Administrator, and in the farms of the peasantry, puts his own hand also to the work.

5. Every laborer must have a specific work assigned to him, which may keep him sufficiently busy, and for which he is accountable.

Thus one has the care of the horses, another of the oxen, the sheep, or the swine. The maids must attend to the cows, the swine, the poultry, to the kitchen, &c. It is well to commit to each hostler or herdsman, not only the cattle which he drives, as his exclusive care, but also the tools he requires, as he will be more careful of the cattle and tools if he is personally answerable for them.

6. The occupations of the next day must be arranged on the evening before, so that every man may be kept busy from early in the morning till night, with the business assigned him.

7. One must often satisfy himself whether the laborers begin and end their work at the appointed time, and whether they properly perform it.

B.—OF THE DUTIES OF EMPLOYERS AND LABORERS.

1. The mutual duties of employers and laborers, in the most limited sense, consists in this, that the employer pays the laborer the wages agreed on for his labor, and that the laborer fills up the time agreed on, in those labors which he has bound himself to perform.

2. But this relation only has place with respect to day-laborers, and those who work by the job, of whose service we stand in need but for a short time, and for a definite work.

3. Between the employer and the domestics (Dienstboten) there is a

more social relation, that holds them closer together, and draws the latter nearer to the former ; for as the employer must commit his whole employed property to the domestics, so his profit requires him to cultivate their good will, that they may be more diligent and upright, and concern themselves to protect their employer from every loss.

The domestics will take the most lively interest in the welfare of their employer, if he is in every respect friendly, cares for them, and makes them feel as little as possible the difference between himself and them. They hate him if they see themselves little regarded and badly treated; then they labor only so far as compelled and answerable, and injure and provoke him when they can.

4. It is therefore not enough, that the employer fulfil his contract, i.e., give the domestic (Dienstboten) the promised wages and the board agreed on ; he must also treat him kindly, and take care of him if he is sick, or he will be unfit for further labor in his service.

5. The *amount of wages* will be governed by the value of money, the number of those seeking work, and the kind of labor to be performed.

In any country where money is plenty, there it is of less value, and the wages are greater, as, for example, in England and Switzerland, the Netherlands, where they give an hostler from 50 to 160 florins ($25 to $80), while with us he receives only 12 to 20 ($6 to $10). Where there are many domestics (Dienstboten) to be hired, the work is proportionately cheaper than where there are few. During war, the wages of a servant were with us about half as much again, and often even double those at present. In peace there is a surplus of laborers. Such work as demands more skill and art, as is just, is counted dearer than where mere bodily powers are required ; wherefore, laborers that plough and sow are paid more than those who are employed merely to fodder the cattle ; cheese-makers higher than the simple cow-herd, and the cook more than the kitchen-maid.

6. Every domestic must receive every year the wages suited to his condition, according to the customs of the country, so to appear decently clad, and with economy to lay by something for time of need, without being forced to give up all the enjoyments of life.

7. Because the domestic must not be looked on as a stranger, but as a member of the family ; therefore we must care not only for his support, but also for his moral education.

8. If order, morality, and a decided religious system be observed and practised in the household, we shall have orderly, contented, and happy domestics and laborers.

In all countries where the land is much divided and cultivated by free proprietors, assisted by domestics (Dienstboten) who live under the eye of their employer, and are provided for by him, we find greater morality among the laboring class, than where the Deputat or allowance-system is practised, or the day-laborer is left to take care of himself.

9. The complaint made of domestics, that they are lazy, coarse, unskilful and unfaithful, proceeds in a great measure from the everywhere neglected education of this class, and may be traced in part to the employers themselves, who are frequently coarse, immoral, ignorant, and niggardly, and in no case a fit example for their servants, or justified in reproaching them for things which may be recriminated on themselves.

It is aside from the object of this work to speak of the different modes of leasing landed property, and of the advantages or disadvantages connected with these leased farms, since we only propose a manual of land husbandry, in which he who manages a farm of his own, or under the direction of his employer, may find the

necessary instructions which may serve to guide him in his proceedings. He who leases his landed property, passes from the rank of husbandman to that of the man who lives on his rents (Rentier), and while he receives for his ground capital, a definite income in money, or natural products, or a fixed proportion of the rough amount of all, or of particular products of the farm, as in Italy and France, troubles himself no more with the management of the farm.

[Many of the preceding remarks apply more particularly to European life than to that of this country, and therefore need to be partially modified to serve as directions for our farmers and laborers; though the principles on which they are based, as well as the excellent spirit they exhibit, will commend them to the candor and good sense of every reader. TR.]

C—OF THE FARM ACCOUNTS.

1. Whether a man reaps profit or suffers loss from farming, and in what proportion one or another branch of husbandry has to be employed for this purpose, can be seen only by the accounts. Without an account one has only conjectures; by keeping an account he has clear ideas on the subject.

2. The *chief object* of a *Farm-Account* is to show how large an interest is paid by the capital vested in the farm.

3. The Capital of the farm is of three kinds, viz.: that which consists in the ground and soil, as well as in those buildings required for the business of the farm, called the *Ground-Capital*, the interest of which is the *Ground-Rent*; that which consists in the movables, living as well as dead, necessary for the management of the farm—cattle, tools, provisions for men and beasts from one harvest to another, called the *Inventory;* and the third, which consists either in money, or in part in the surplus and saleable products of the farm, wherewith the current expenses for labor, taxes, and necessary purchases, may be defrayed, and which is called the *Stock-Capital*, or business fund.

4. The *income* of the *ground-capital* is obtained by the sale or lease of the estate.

He who has bought his estate for 10.000 florins (= to $4.800) must bring yearly into the account the interest of this sum, at 3, 4, 5, or 6 per cent., according to the rate of interest in the different countries. He who has leased his estate brings the amount of the lease into the reckoning.

5. The interest, or *income* of the *inventory*, must be reckoned double that of the ground-capital, because its value lessens by age and use, is exposed to more hazard, and frequently is lost before the time.

6. The interest, or *income* of the *stock-capital*, is found by reckoning up the interest of the ground and inventorial-capital, as well as all the other expenses paid for the farm; then all the receipts, and the difference of the inventorial-capital of the last year from the present.

An example may make this plainer:

The value of the estate is supposed at . . .	10,000	florins.
" inventory, "	5,000	"
EXPENDITURES.		
Interest on the ground capital-at 5 per cent. . .	500	"
" inventory " 10 " . . .	500	"
Taxes, days'-wages, purchases, &c., which are called the outlay of the stock-capital, ...	4,000	"
Sum of Expenditures, . .	5,000	"

RECEIPTS.

From cattle and grain	4,600 florins.
The inventory of the present year is greater than the former	800 "
Sum of Receipts . . .	5,400 "

Deducting expenditures, there remains 400 florins as the income of the stock-capital of 4,000 florins, and this shows us that the ground-capital has been at a rate of interest of 5 per cent., the inventory at 10 per cent., and the stock capital at 10 per cent.; yet not the whole of the stock-capital has been repaid in cash, but a part, namely 800 florins, is contained in the inventory.

7. The next object of Farm Accounts is to know the profits or losses which one experiences from the different branches of farming.

8. To attain this object, it is not sufficient merely to keep an account of the expenditures and receipts in cash; we must also distinguish all the work, and every expenditure of money and products of the farm, and for what they have been laid out.

9. If a charge is made to any product of the soil of what it comes to in the ground-rent, and in the interest of the inventory, as well as in taxes of all kinds, of what has been expended for the same in money, products of the farm, and in labor; and if that which it has produced is credited; then the difference of these two sums shows the profit or loss of the same.

10. The sum of the ground-rents on all parts of the ground and soil belonging to the farm must be divided, according to the proportion of the objective and subjective values of the same.

11. The interest of the property invested, with the exception of the cattle, as well as taxes, must be divided, according to the same proportion as in the case of the ground-rents, over the soil.

12. To the different fields or fruits cultivated on the same, as well the plants for fodder and for trade, must also be reckoned the labor performed by one's own or other cattle, and men, and the manure carried out on the field.

We have already shown how the cash-value of a day's-work of cattle and men may be ascertained, and also before explained our view of the value of manure, and therefore merely refer to them.—See § I. A. a. 8. and b. 24, and III. B. 2.

13. But, because the manure brought on the field is only gradually consumed, according to the quality of the same, the fruits which are cultivated, the mode of culture, the climate and the soil; therefore to the fruits, which vary on the same cultivated land, must be charged a part of the cost of manure, corresponding to these circumstances.—See § III. B. 2.

We carry out, for example, on one yoke of plough-land, 300 cwt. of manure, worth 24 metzen of rye. On this field we cultivate maize, barley, clover, and wheat; we must, therefore, charge to maize—as it yields the greatest product and consumes the whole animal part of the stall-manure, and a great portion also of the vegetable —$\frac{1}{2}$ of the manure; and the more so because, by hoeing and hilling, much is also dissipated. To the barley must be charged $\frac{1}{4}$; to the clover $\frac{1}{8}$; and to the wheat $\frac{1}{16}$; therefore, the manure is charged:

1st	year,	the value	of 12	metzen of rye.
2nd	"	"	6	"
3rd	"	"	3	"
4th	"	"	$1\frac{1}{2}$	"

Did only $\frac{1}{16}$ of the manure remain after the clover, then would the wheat yield a very scanty harvest; but, as the clover furnishes an increase of manure by it, roots, which in the foregoing case equal 0.20 of the original quantity of manure, therefore the wheat has nutriment enough in the soil. But, for this reason, the manure-account stands differently, since to clover only $\frac{1}{2}$ of the portion of manure consumed by it as above ought to be charged, but to the wheat crop that follows

must be charged, not only the portion already given for it, but also the newly-produced increase of substance furnished by the clover roots.

he manure account, therefore stands as follows:

1st year,	to	Maize, the value of		12	metzen of rye.
2nd "		Barley, " . .		6	"
3rd "		Clover, instead of 3 . .		1.5	"
4th Wheat		the portion before given,	1.5	6.3	
		increase by clover-roots	4 8		
				25.8	
But because the value of stall-manure is . .				24	"
" " clover-roots . .				4	"
		Total . .		28	"

Therefore there remains in the soil, of power 2.2 metzen of rye.

If we wish to keep the clover account exact, we must credit its roots, in value 4.8 metzen of rye, here charged to wheat. But if we cultivate wheat after maize, then barley and oats, the value of the manure of 24 metzen of grain must be divided, according to the above given proportion of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{10}$, $\frac{1}{10}$, among these four fruits.

14. As the beasts are nourished by the products of the field, which have been already reckoned for ground-rent; so they cannot in this respect be charged with any thing but the interest of their own value and the cost of fodder and keeping.

We must, indeed, consider the cattle as well as the field as a profit-bringing body. Should any one charge the interest of the cattle to the field, then the use of the cattle must be disproportionally raised above the cost of the cultivation of the field.

15. Therefore we must credit to it not only the labor, but also all that it yields in animal products, and what it gains in the numbers and increased value of particular portions.

How the cash value of the manure is reckoned see § III. B. 2.

16. Should an account be adopted, setting in the clearest light every particular branch of farming, then must every labor and outlay be credited to that which it produces, and charged to that which receives it.

17. Every branch of husbandry, and all the powers and means of aid belonging to the management of the farm must, for this purpose, be considered as so many persons, with whom the debt and credit-account is kept.

This mode of keeping accounts is called the Double-entry Book-keeping, because every receipt or expenditure is twice exhibited, i. e., it is credited to him who performs the labor, and charged to him who receives it.

18. But, because this mode of keeping accounts is much more extended than usual, it only repays the trouble, &c., when the farm is large and widely connected, and where, without it, one retains one of his own men for the Farm-accounts; in small or very simple farms, it is sufficient if the chief object of the Farm-account is attained.

In Farm Accounts there should be the following books: one for *Cash*-receipts and expenditures, the Cash Journal; one for receipts and expenditures in *vegetable* products, the Granary and Barn Journal; one for *animal* products, the Cattle Journal; and one for the *labor* of men and beasts, the Labor Journal. By these the Single-entry Farm-accounts may be formed by the opposite entries of Expenditures and Receipts; but in the Double-entry Book-keeping we form from these books—first, the different Special-accounts, pro or contra, the Accounts of the different parts of the husbandry, from which is seen their gain or loss; and by bringing together these accounts the balance shows the profit or loss on the whole farm. On this subject see THAER'S Annals of Agriculture, Vol. IV. p. 477, also his Annals of Improvements, Vol. III. p. 50, and Vol. I. of his Rationallen Land-wirthschaft.

THE END

TABLES OF MEASURES AND WEIGHTS,

USED BY DIFFERENT AUTHORS QUOTED IN THIS WORK.

BURGER and THAER use the Austrian measures. VEIT uses the Bavarian measures, and SCHWERTZ the French. In the reductions, in the following sections, fractions have sometimes been disregarded

AUSTRIAN.

LONG MEASURE.

1 foot = 12 inches = 12 lines each, and = 1.037 English feet
1 klafter is about 6 feet.
1 mile is about 4½ miles, English.

SQUARE MEASURE.

1 yoke [Joch] = 1600 square klafters, = 1.422 English acres.
1 square klafter is about 5 square yards.

DRY MEASURE.

1 metzen = 16 mæssl, = 0.211 of an English Quarter of 8 bushels, or 1.69 of an English bushel, or about 54 quarts.
1 mæssl = about 3 quarts.
The metzen is also sometimes divided into 8ths, or 2 mæssl.

LIQUID MEASURE.

1 wine eimer = 40 maas: equal to about 12½ English gallons.
1 beer " = 42½ " " " 13 " "
1 maas = 0.311 gallons, =2½ pints.

WEIGHT.

1 centner; or 100 lbs., = 123.4 lbs. English.
1 lb. contains 32 loths, about ½ an oz. each.

BAVARIAN

LONG MEASURE.

1 foot = 12 inches of 12 lines each, = 0.957 English feet.
1 mile, about 4½ miles English.

SQUARE MEASURE.

1 morgen = 400 quadrat ruthen, or square rods, or 40,000 square feet, = 0.842, or about 5-6 of an English acre.

DRY MEASURE.

1 schæffel = 6 metzen = 4 quarters = 4 mæssl = 6.223 English bushels.
1 metzen = 1.037 English bushels.
1 quarter = about 8 quarts, or a peck, English.
1 mæssl = about 2 quarts, English.

LIQUID MEASURE.

1 eimer = 60 or 64 maas = about 14 or 15 gallons, English
1 maas = 0.235 gallon, or nearly 2 pints, English.

WEIGHT.

1 centner, or 100 lbs. = 123.4 lbs. English.
1 lb. = 32 loths.
1 loth = about ½ oz. English.

MONEY.

The German florin = 60 kreutzers, is reckoned at about 48 cents. 1 kreutzer, about ¼ of a cent 1 groschen, about 2 cents.

FRENCH.

SQUARE MEASURE.

1 hectare = 2.471, thus nearly 2½ English acres.

DRY MEASURE.

1 hectolitre = 100 litres = 0.344 English quarters, or somewhat over 2¾ bushels.
1 litre = about 1¾ English pints.

WEIGHT.

1 kilogram = 2.204, nearly 2¼ lbs. English.

The following tables of the Austrian yoke and Bavarian morgen, into English, is added, as these measures are of the most usual occurrence.

Yokes.		Acres.	Morgen.		Acres.
1	=	1.422	1	=	0.842
2	"	2.844	2	"	1.684
3	"	4.266	3	"	2.526
4	"	5.688	4	"	3.368
5	"	7.110	5	"	4.210
6	"	8.532	6	"	5.052
7	"	9.954	7	"	5.894
8	"	11.376	8	"	6.736
9	"	22.798	9	"	7.578
10	"	14.220	10	"	8.420
20	"	28.440	20	"	16.840
30	"	42.660	30	"	25.260
40	"	56.880	40	"	33.680
50	"	71.100	50	"	42.100
60	"	85.320	60	"	50.520
70	"	99.540	70	"	58.940
80	"	113.760	80	"	67.360
90	"	127.980	90	"	75.780
100	"	142 200	100	"	84.200
1-2	"	0.711 nearly 3-4	1-2	"	0.421 over 2-5
1-3	"	0.474 " 1-2	1-3	"	0.280 " 1-4
1-4	"	0.355 over 1-3	1-4	"	0.205 " 1-5
1-5	"	0.244 nearly 1-4	1-5	"	0.168 " 1-6
1-6	"	0 237 " 1-4	1-6	"	0.140 " 1-7
1-7	"	0.203 over 1-5	1-7	"	0.120 " 1-8
1-8	"	0.177 " 1-6	1-8	"	0.105 " 1-10
1-9	"	0.158 " 1-7	1-9	"	0.093 " 1-11
1-10	"	0.142 " 1-8	1-10	"	0.084 " 1 12

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