03 Explanation on Nutrient Prices and Contents Calculation

Introduction

Welcome to the explanation video about the side calculation for pure nutrient prices and contents. This is a preparation that can be done back at the university or at home. The farmer does not need to be involved in this calculation process.

Fertilizer Calculation and Gross Margins

To calculate gross margins, we first need to work out the nutrient requirements of the crop and the pure nutrient costs. This procedure is explained in this separate video, so that the whole calculation can then be completed more easily. Of course, the calculation of the fertiliser side can also be done at the specific part of the gross margin.

Challenges in Gross Margin Calculation

There are some difficulties in calculating the gross margin in this sector, which need to be explained first. This calculation of fertilizer costs is made in kg of pure nutrients – nitrogen (N), phosphate (P_2O_5), and potassium (K_2O). This is easy to do when a farmer knows the cost and nutrient content of the fertilizer. Fertilizer labels give the percentage of nitrogen, phosphate, and potassium in the fertilizer. For example, the label for diammonium phosphate (DAP) is 18-46-0. This means there are 18 kg of N, 46 kg of phosphate, and 0 kg of potassium in 100 kg of DAP fertilizer. The amount of fertilizer taken into account in Gross Margins is the economic nutrient requirement, relevant for management-related analysis. It does not aim to calculate the fertilizer quantity to be spread on the field and does not serve as an agronomic fertilizer recommendation.

In simple terms, the calculation only counts the nutrient removal by the crop during this growing season. More fertilizer than necessary remains in the soil or is washed away by water. This has nothing to do with the production process. In the case of plant nutrition, some of the fertilizer comes from the soil and some from the applied fertilizer. No distinction is made. Only the required amount of nitrogen, phosphorus, or potassium is considered and multiplied by the pure nutrient cost.

Data Collection and Usage

The tricky part is finding out what the nutrient requirements are for each crop and region. This data is sometimes provided by national advisory bodies or verified by field trials and researchers. Also, an Excel data sheet for some crops growing in Germany is available. Additionally, a source containing information for different crops growing in other countries is given.

Example Calculation

In the example, the amount of fertilizer applied per hectare was calculated. If there is no data about nutrient removals by crop available, this data can be used. Further data collections about nutrient removals are presented and the usage will be explained.

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Understanding Fertilizer Composition

However, as mentioned above, the calculation is based on the amount of pure nutrients such as nitrogen, phosphorus, and potassium. It does not consider other components of the fertilizer that are added for structure or chemical types. Most commercial fertilizers have information on the percentage of each chemical component. The value of dung and manure can also be measured in laboratories.

In our example, the farmer used the KAS fertilizer, which has a total content of 27%. He also used Yara Mila, which contains 15% phosphorus in addition to 15% nitrogen. The farmer's own chicken manure was tested and contains 7% nitrogen and 7% phosphorus. It also contains 10% potassium. We can now calculate the pure nutrients used. To do this, we multiply the amount of fertilizer used per hectare by the percentage of the component in decimal figures. In the example of KAS, we multiply the 104 kilograms used by 0.27 because the percentage is 27%.

The kilograms of N, P, and K used could be added up and used as the quantity in the gross margin form. For the exact calculation, this approach would be wrong, so only if no other data can be found, this should be taken into account. Note that, where applicable, the pure nutrient requirements of a crop are usually used here. This method will be explained after the calculation of pure nutrient prices.

Calculating Nutrient Prices

Nitrogen Price

The next step is to calculate the prices of each individual nutrient. This is done on the basis of the complete fertilizer prices. The aim is to find out how many kg of pure nutrient we use and how much one kg of that nutrient costs. So we start with a fertilizer that has only one ingredient. In this case, it is KAS. The price per kg of KAS is 400, but we want to know how much one kg of pure nitrogen costs. So we divide the full price of KAS, which is 400, by the percentage of N, which is 27%. You can either divide by 27% or by the decimal number 0.27. If you only divide by 27, you will get a wrong result. The final result is a price of 1481.48 per kilogram of nitrogen. At first glance, this number might seem confusing. However, if you consider that 27% is roughly a quarter of a kilogram, to get 1 kilogram, you multiply by four. The same goes for the price, which is why it appears higher than the original price per kilogram of KAS.

Phosphorus Price

The next step is to determine the price for one kilogram of phosphorus. We have two fertilizers that contain phosphorus: Yara Mila and Chicken Manure. We'll start with Yara Mila because it only has two ingredients—15% nitrogen and 15% phosphorus. Since we already know the price of nitrogen from our earlier calculation, we subtract this cost from the total price of Yara Mila. The remaining cost is then divided by the 15% phosphorus content. Here's how it's done in practice: The price for one kilogram of Yara Mila is 450. From this, we subtract the cost of nitrogen, which is 1481.48, multiplied by the nitrogen content of 15%. The interim result is 227.78, which represents the remaining cost attributed to phosphorus. Given the phosphorus content is 15%, we divide the remaining price by 15% to determine the pure cost for 1 kilogram of phosphorus.

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Potassium Price

The same approach applies to the calculation of the pure nutrient price for potassium. Here we reduce the fertilizer price by the prices of nitrogen and phosphorus multiplied by their content. The result is divided by the content in percentage of potassium. In the example, we start with 250. From this, we subtract 1481.48 multiplied by 7%. The result is further reduced by 1518.52 times 7%. The costs for nitrogen and phosphorus are reduced now. We then divide these results by 10%, which is the potassium content. This calculation results in a price of 400 per kilogram of potassium.

Our three end result prices are 1481.48 per kilogram of nitrogen, 1518.52 per kilogram of phosphorus, and 400 per kilogram of potassium.

Calculating Nutrient Removal

Importance of Nutrient Removal Calculation

Now we move on to calculating the nutrient removal of our crop. This extra calculation is necessary because only the nutrients used by the plants can be attributed to the production process. Even if the farmer does not use any fertilizer at all, nutrient removal is still taken into account because the nitrogen, phosphorus, and potassium used by the plants are no longer available in the soil. Therefore, in general, we calculate the nutrient demand of the crop, which is equal to the nutrient removal by the crop, for the following reasons: Gross margins are based on a production process and, as mentioned above, only the nutrients used by the crop should be taken into account. Nutrients that remain in the soil, are washed away, or are taken up by other unused crops are not considered. Existing default values can be used to estimate nutrient removals, which will be explained in the following steps.

Sources for Nutrient Removal Data

First, the nutrient requirements of specific crops must be available. In this procedure, nutrient removal values are given from various available sources. In these examples, the data are based on German field trials and other sources. They can be used in a similar way, but local sources, if available, are preferable. For other crops that are not regularly grown in Germany, an additional PDF document is available where nutrient removals of more different crops and fruits can be estimated. In the long term, a dedicated regional or national database would be preferable. Universities, projects, or various data collection theses could aim to do this.

Example of Nutrient Removal Calculation

Using Potato as an Example

Due to the fact that potato is also a typical crop in Germany, we can use the available data from this source. A part of the given Excel table is shown here. At the beginning, it is structured by crop. Then the nutrients for one deciton of the harvested main crop are given. The unit is always deciton. One deciton is equal to 100 kilograms. The total nutrient requirement depends on the crop yield, so this must be calculated in the next step.

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Considerations for Side Crops

Next to the requirements for the main crop are those for the side crops. A side crop is not always harvested because in some cases, such as potatoes, the tops are useless and remain in the field. If the cereal side crop, i.e., straw, is harvested and removed from the field, this must also be taken into account.

Side Crop Yield Calculation

In addition, the ratio between the main crop and the side crop is given in the right-hand column. This can be used to calculate the yield of the side crop because if it is left on the field, the harvest is not normally measured or weighed. The full excel table contains way more different crop production processes, which can be used.

A separate Excel spreadsheet is provided as a guide to calculating the exact nutrient requirements. This is divided into the areas of nitrogen, phosphorus, and potassium. All the calculations are pre-defined, so all you need to do is enter the figures. However, you should be able to calculate these removals by hand. We see the nitrogen part divided into tubers and tops. This division can easily be made for other crops as main and co-products. The yellow cells are where the data should be entered.

Nitrogen Calculation

1. **Enter Nitrogen Requirement:**
    - First, enter the nitrogen requirement for one deciton of potatoes as given in the table.
    - Then add the requirement for one deciton of sidecrop, which in this case is tops.
    - Add the ratio of tubers to tops, which is 1 to 0.3. This is also shown in the table.
2. **Implement Harvested Yields:**
    - The farmer harvests a total of 14 tonnes per hectare, which is 140 decitons. This can be calculated by dividing 14,000 kilograms by 100 kilograms.
    - Apply the tuber to head ratio and multiply the yield of 140 decitons by 0.3. This gives a total of 42 decitons of by-products.
3. **Calculate Nutrient Removal:**
    - The Excel form will automatically multiply the two values and give a nutrient removal equal to the nutrient requirement.
    - Nutrients from tubers and tops can be added to give the total nutrient requirement.
    - As the by-products of the crop remain in the field, some nutrients are mineralized in the soil through chemical and biological processes. These mineralized nutrients can be reused by other plants and are then not used in the production process.

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- Our formula allows us to make adjustments to the percentage of these mineralized nutrients that can be used. For phosphorus and potassium, 100% can be taken into account, but nitrogen always requires special treatment. Because of special processes, some of the mineralized nitrogen is not stable and is not available for the next crop. It either escapes into the air or is washed away by rainwater. The nutrient return from nitrogen can therefore be taken into account at 40%. This can be adjusted slightly according to soil conditions.

4. **Adjustment for Mineralized Nutrients:**
   - In the calculation, the nutrient removal from the tops, which is 12.6 kg/ha, needs to be multiplied by 40%. The result is 5 kg/ha. These five kilograms are subtracted from the 65.8 kilograms calculated previously. If the tops are not removed from the field, the result of 60.8 kg can be used in our gross margin calculation.

Phosphorus Calculation

The same procedure is used for phosphorus. The figures for phosphorus are taken from the table. The yield for tubers and tops remains the same as previously calculated. Unlike nitrogen, the nutrient return from tops through mineralization can be counted as 100%. The final result is 22.4 kg of pure phosphorus needed to grow 14 tonnes of potatoes on one hectare of land.

Potassium Calculation

Potassium is also treated identically. We need 0.6 kg of potassium per deciton of tubers and an additional 0.42 kg per deciton of tops. The yield of tubers and tops is again identical, and the nutrient return from the tops can be taken into account at 100%. This results in a requirement of 84 kg of pure potassium for this specific production process.

Final Nutrient Requirements

The final nutrient requirements are now available. There are two different possibilities:

1. **Side Material Removal:**
   - The requirement is based on side material such as tubers and straw that is removed from the field and cannot then be mineralized. This is shown in green in this table.
2. **Mineralized Nutrients:**
   - The side material remains on the field, is mineralized, and the nutrients can be partially or fully reused by other plants. These values, as used in the example, are shown in red. The green values, when the tops are removed, are slightly higher than the red values. This shows that mineralization is taking place and the values in red are reduced by the amount of nutrients that are being recycled and reused.

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Summary of Data for Further Processing

1. **Pure Nutrient Costs:**
    - 1481.48 per kg nitrogen
    - 1518.52 per kg phosphorus
    - 400 per kg potassium
2. **Nutrient Requirements for Potato Production:**
    - 60.8 kg of nitrogen
    - 22.4 kg of phosphorus
    - 84 kg of potassium
3. **Comparison of Nutrient Usage:**
    - Sums of the pure nutrients used by the farmer in this example were calculated. These will not be used if other data is available, but they can be used for comparison. It is evident that the farmer in this example has used far more pure nutrients than the plants need to grow. This excess cannot be used by the plants and will remain in the soil or be washed into the groundwater, which is not good for the environment. The farmer can also save the cost of paying for too much fertilizer as no further yield is achieved.

Available Documents for Nutrient Requirements

At the end of the page, you will see the documents that can be used to find the nutrient requirements of crops. These Excel and PDF documents are available next to the videos. One is an Excel spreadsheet with the main crops grown in Germany. The other source is a PDF file with crops that are not typically grown in Germany. A better option for the future would be to establish own national or regional data sources to be used. This can be done through field trials, compiled from existing research, or the use of data from national extension services. In general, this topic is an opportunity for applied research, data collection, and field trials.

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ANNEX 1: Side calculation pure nutrition prices

Side calculation: Pure Nutrition Prices													
Applied amount of fertilizer			Price per kg	Price total	% N	% P2O5	% K2O	kg N	kg P2O5	kg K2O	Price/ kg N	Price/ kg P2O5	Price/ kg K2O
300	kg	NPK	290	87000	15%	15%	15%	45	45	45	586,96	336,59	336,59
150	kg	Urea	270	40500	46%			69	0	0	586,96		
							kg/ha	114,00	45,00	45,00			

ANNEX 2: Calculation of nutrient requirements

Calculation of balanced nutrient requirements for 1 ha of: Potatoes

	Contents kg/dt	×	Yield dt/ha	=	Removal kg/ha	=	Requir. kg/ha	
Tuber:Top - Ratio							1 : 0,3	
N Tubers	0,38	×	140,00	=	53,20	=	53,2	When tops are not removed from field, the balanced nutrient requirement is higher then requirements for tubers only, since there are losses to be considered for Nitrogen concerning both growing requirements and tops rotting: Requirement factor > 1 and Utilisation of N in tops < 100%
+ Tops*	0,30	×	42,00	=	12,60	=	12,6	
= Nutrient requirements (if tops are removed from field)						=	65,8	
– Nutrient return from tops					40,0%	–	5,0	
= Balanced nutrient requirements (if tops are not removed)						=	60,8	
P_2O_5 Tubers	0,16	×	140,00	=	22,40	=	22,40	When tops are not removed from field, the balanced nutrient requirement is equal to requirements for tubers only, since there are no losses to be considered for Phosphate concerning growing requirements and tops rotting: Requirement factor = 1 and Utilisation of P2O5 in tops = 100%
+ Tops*	0,06	×	42,00	=	2,52	=	2,52	
= Nutrient requirements (if tops are removed from field)						=	24,9	
– Nutrient return from tops					100%	–	2,5	
= Balanced nutrient requirements (if tops are not removed)						=	22,4	
K_2O Tubers	0,60	×	140,00	=	84,00	=	84,0	When tops are not removed from field, the balanced nutrient requirement is equal to requirements for tubers only, since there are no losses to be considered for Phosphate concerning growing requirements and tops rotting: Requirement factor = 1 and Utilisation of K2O in tops = 100%
+ Tops*	0,42	×	42,00	=	17,64	=	17,6	
= Nutrient requirements (if tops are removed from field)						=	101,6	
– Nutrient return from tops					100%	–	17,6	
= Balanced nutrient requirements (if tops are not removed)						=	84,0	

* Tops quantity : × Tubers yield

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