***Technical Appendix: Van Slyke Cheese Yield Formula***

This technical appendix details the derivation of the Van Slyke cheese yield formula and how it is used to define the Federal Milk Marketing Order (FMMO) protein price for Class III. The assumptions used here are implicit in the technical appendix detailing the derivation of opportunity cost pricing methods, *Technical Appendix: Opportunity Cost Pricing*.

The Van Slyke cheese yield formula currently used by FMMOs is:

 (1)

where is cheese yield per hundredweight of milk, is a farmgate milkfat test per hundredweight of milk, in lb/cwt, is a farmgate true protein test per hundredweight of milk, in lb/cwt; is a moisture percentage, denotes farm-to-plant milk losses, and captures farm-to-plant milkfat losses beyond . In particular, under the FMMO system, the milkfat test in standard milk, , is set to 3.5, and the true protein test, , is assumed to be 2.9915. Following the parametrization currently used by FMMO regulations, butterfat recovery in cheese, , is set at 0.90; casein percent of true protein, and is assumed to be 0.822. Casein loss to whey, , is 0.1. Yield factor, reflects the amount of salt, retained whey proteins, milk minerals, etc., and is assumed to be 1.09. A moisture level, , of 38% is likewise used based on current formulas and USDA’s Agricultural Marketing Service (AMS) Dairy Product Mandatory Reporting Program survey definitions. Farm-to-plant milk losses, , are 0.0025 lb/cwt, and milkfat losses, , are an additional 0.015 lb/cwt.

 Rewritten, the Van Slyke Cheese yield formula used by FMMOs is:

 (2)

The Van Slyke cheese yield formula and the FMMO assumptions, excluding farm-to-plant losses, result in a theoretical cheese yield of 9.6852 pounds of cheese. Adjusting for farm-to-plant milk and component losses, the theoretical yield is reduced to 9.6373 (USDA 2002). The yield formula can be rewritten as a sum of marginal contributions by butterfat and protein. By setting and to zero, we calculate the protein contribution to cheese yield to be 4.1369. Similarly, by setting and to zero, we calculate the butterfat contribution to cheese yield to be 5.5004. By dividing the butterfat contribution to cheese yield by the standard butterfat test, we obtain the marginal contribution to cheese yield per 1 lb of butterfat, 5.5004 / 3.5 = 1.572. Likewise, by dividing the protein contribution to cheese yield by the standard protein test, we obtain the marginal contribution to cheese yield per 1 lb of protein, 4.1369 / 2.9915 = 1.383. Table 1 provides the decomposition of the Van Slyke cheese yield formula into protein and butterfat yield contributions and the derivation of coefficients used in the current FMMO protein price formula.

Table 1: Van Slyke Cheese Yield Formula Factors and Yield Assumptions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Symbol | Description | Van SlykeFactors | ButterfatPortion | ProteinPortion |
|  | Butterfat recovery in cheese | 0.90 | 0.90 |  |
| *Ft* | Standard milkfat test  | 3.50 | 3.50 |  |
|  | Farm-to-plant (additional) milkfat losses | 0.015 | 0.015 |  |
|  | Casein percent of true protein | 0.822 |  | 0.822 |
|  | Casein loss to whey | 0.1 |  | 0.1 |
|  | Theoretical yield formula | 1.09 | 1.09 | 1.09 |
| *Pt* | True protein test \* | 2.9915 |  | 2.9915 |
|  | Moisture level | 38% | 38% | 38% |
| L | Farm-to-plant milk losses | 0.0025 | 0.0025 | 0.0025 |
|  | Cheese yield | 9.6373 | 5.5004 | 4.1369 |
|  | Cheese yield per 1 lb of component |  | 1.572 | 1.383 |

\* The 2.9915 factor reflects the assumption that standard skim milk tests 3.1 percent true protein. Not shown in this table is the assumption of the FMMO other solids price that standard skim milk tests 5.9 other solids. The sum of 3.1 plus 5.9 equals 9, the assumption of the Class IV nonfat solids price calculation..

Under the current FMMO pricing system, the Class III protein price is obtained by summing the protein value in cheese and the butterfat adjustment which captures the difference between the butterfat value in cheese versus the opportunity cost of using that butterfat in butter as shown in equation (3).

 (3)

Where, o is the Class III protein price, PCh is the cheese price, 0.2003 is the make allowance of cheese, 1.383 is the cheese yield per unit of protein, PBF is the FMMO price of butterfat, 0.9 is the butterfat retention factor, and 1.17 is the butterfat to protein ratio in standard milk.