### Interpretation of the Slope of the Regression Line

The slope of the regression line represents the change in the percentage of nitrogen removed per unit increase in the width of the grass buffer strip. Specifically, if the slope is positive, it indicates that for every additional foot in the width of the buffer strip, there is an expected increase in the percentage of nitrogen removed.

### Willingness to Use the Model for Prediction

I would be cautious about using this model to predict the amount of nitrogen removed for grass buffer strips with widths between 0 feet and 30 feet. Here's why:

- \*\*Extrapolation\*\*: The model is based on data from buffer strips of widths 6 and 13 feet. Extrapolating beyond this range, especially to 0 or 30 feet, could be unreliable due to potential non-linearities or other factors not captured within the observed range.

- \*\*Lack of Intermediate Data\*\*: Without data points between 6 and 13 feet or beyond 13 feet, the model's accuracy for intermediate or extreme values might be questionable.

### Sampling Distribution of the Sample Mean

For the observations on the amount of nitrogen removed by the four buffer strips with widths of 6 feet, the sampling distribution of the sample mean can be described as follows:

- \*\*Central Limit Theorem (CLT)\*\*: Assuming the individual observations are independent and identically distributed (i.i.d.), the sample mean will be approximately normally distributed for a sufficiently large sample size. With four observations, we can still apply the CLT, but with some caution.

- \*\*Mean and Variance\*\*: Let \(\mu\) be the true mean amount of nitrogen removed and \(\sigma^2\) be the variance of the individual observations. The sample mean \(\bar{X}\) will have:

- Mean: \(E(\bar{X}) = \mu\)

- Variance: \(Var(\bar{X}) = \frac{\sigma^2}{4}\)

### Constructing a 95% Confidence Interval

To construct an interval that has a probability of 0.95 of containing the sample mean of the observations from four buffer strips with widths of 6 feet:

1. \*\*Standard Error\*\*: The standard error of the mean (SEM) is \(\sqrt{\frac{\sigma^2}{4}} = \frac{\sigma}{2}\).

2. \*\*t-Distribution\*\*: Since the sample size is small (n=4), we use the t-distribution with \(n-1 = 3\) degrees of freedom.

Let \(\bar{x}\) be the observed sample mean and \(s\) be the sample standard deviation.

The 95% confidence interval for \(\mu\) is given by:

\[ \bar{x} \pm t\_{0.025, 3} \times \frac{s}{2} \]

where \(t\_{0.025, 3}\) is the critical value from the t-distribution for 3 degrees of freedom at the 95% confidence level.

### Determining the Better Study Plan for Estimating Slope

From the plots, the second study plan appears to provide a better estimator of the slope of the regression line. Here’s the reasoning:

- \*\*Variability\*\*: The second study plan shows less variability in the sample means (narrower confidence intervals) compared to the first study plan. This suggests that the second plan provides more precise estimates of the mean nitrogen removal at each width.

- \*\*Consistency\*\*: The regression line in the second study plan has a steeper slope with less uncertainty, indicating a clearer relationship between buffer strip width and nitrogen removal, which is desirable for estimating the slope accurately.

### Checking the Straight-Line Relationship

To check the assumption of a straight-line relationship, researchers could choose buffer strip widths in a way that allows for testing non-linearity:

- \*\*Non-Linear Design\*\*: Instead of just two widths (6 and 13 feet), choose a sequence of widths that spans the range of interest more evenly, such as 0, 3, 6, 9, 12, 15, 18, and 21 feet. This would provide data points across a broader range, allowing for visual inspection and statistical tests (e.g., polynomial regression or non-linear regression) to check for curvature or other non-linear patterns.

- \*\*Visual Inspection\*\*: Plotting these observations against width would help visually assess if the relationship is truly linear or if there are deviations suggesting a different model might be more appropriate.