**Hitching Mechanics of the Tractor Chassis**

**Adapted from Physical Science Applications in Agriculture**

**Buriak and Osborne**

**Table Top Laboratory Activity**

**Materials needed:**

* Objects to serve as a lever arm (i.e. 2”x2” or 1”x2” board length can vary between 3 and 4 ft)
* Object to serve as a fulcrum (i.e. cut a 2x4 to make a 45 corner. Lay hypothenuse parallel to the table top surface)
* Weights (i.e. washers, nuts, bolts, or pieces of metal)
* Scale for weighing materials
* Tape measure

**Formulas:**

Moment = Force applied x Distance of lever

Moment equilibrium formula: Fa x a = Fb x b

**Main Idea:** External forces acting on a tractor’s chassis may create instability resulting in a rear rollover

**Learning Objectives (S.W.B.A.T):**

Solve hitching and stability problems

Calculate a moment of force

Determine if tractor hitching is at equilibrium

**Concepts to discuss:**

Drawbar forces on tractors

Hitching procedures

Terminology associated with connecting implements

**Leading Questions**:

Is there a right way to connect implements to a tractor?

How do you connect implements to the tractor?

Have you ever wondered why we connect to the drawbar?

**Station One: Explore the concept of moment equilibrium**

At this station you will determine the magnitude of a moment (turning effect of a force). Magnitude of a moment is a product of force and the distance the force acts from the center of rotation. In our example the fulcrum will be the center of rotation. When moments are at equilibrium the should be no rotation of the lever.

**Materials:**

* Weights
* Lever (i.e. 1x2 board)
* Fulcrum
* Tape measure
* Scale

1.) Calculate the balancing force needed for equilibrium given the following formula and data. Show your work. (equilibrium formula: Fa x a = Fb x b)

a = 24 inches

Fa = 0.25 pounds

b = 12 inches

Fb = \_\_\_\_\_\_\_\_\_\_\_

2.) Using materials provided demonstrate moment equilibrium between force applied and your calculated balancing force. The diagram below provides an example of how to set up the lever.

(b)

Fb

Fa

Balancing Applied Force

Initial Applied Force

Mcc = Fa x a

(moment counter-clockwise)

Mc = Fb x b

(moment clockwise)

(a)

Fulcrum

**Station Two: Hitching Mechanics of the Tractor**

At this station you will determine effect of hitching height on tractor stability.

The picture below is labeled with the external forces acting on a tractor pulling an implement

The point at which the rear tires contact the ground serves as the fulcrum. Lever arm length (b) is the distance from the fulcrum to the center of gravity for the tractor. The center of gravity represents the weight of the tractor. Lever arm length (a) is the distance from the fulcrum to the hitching point. Force applied to lever arm (a) is a combination of the draft force (drawbar pull = Fx) and the tongue weight or (downward force = Fy).

For most tractors, Fy (dependent upon implement being pulled) and lever arm length (a) are fixed. However, Fx will change based on the drawbar height (y). The moment Fx is the product of drawbar pull and hitch height (Moment Fx = Fx x y).

(Fy) tongue weight or downward pull force

(Fx) draft force or drawbar pull force

a

weight of tractor (Wt)

b

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**Materials:**

Model tractor (1/32 scale)

Rubber bands

Paper Clips

Tape Measure

Small diameter wooden dowels

Sand paper (for tractor wheel traction)

Design an experiment to determine the effect of varying hitch heights on tractor rear rollover stability. Complete a test using the standard drawbar hitching height and a hitching point above the drawbar height. Use the paper clips to create connection points on the tractor. Attach the rubber band to the hitch point and pull to apply a draft load. For each hitching point, measure and compare the lengths that the rubber band stretches before the tractor frontend lifts. You may need to chock the rear wheels to keep the tractor fulcrum from sliding (note using sand paper may provide increase traction of rear wheels).

Drawbar Hitching Point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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rubber band

Raised Hitching Point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

rubber band

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You may consider adding weights to the front wheels of the tractor and determine the effect of counter weights on tractor stability.