WHY LARGER PELLETS WIN OUT AT LONGER RANGES

BY TIM WOODHOUSE

Unlike Trap and Skeet, sporting clays targets (particularly FITASC) vary in presentation (angle and distance), sometimes requiring the shooter to switch shot size (and velocity) to maximize his score. What works for a fast 40 yard crosser might not be the best choice for a long face on battue.

We have looked at pellet energy levels before and have established that an arbitrary minimum level of striking energy is required to ensure consistent target breaks. Face on standard targets are best struck with about 0.5 foot pounds of energy, whereas edge on standard targets require something in the order of about 0.75 foot pounds. As the range increases for any given target type, we must still deliver the same level of pellet striking energy to achieve consistent breaks.

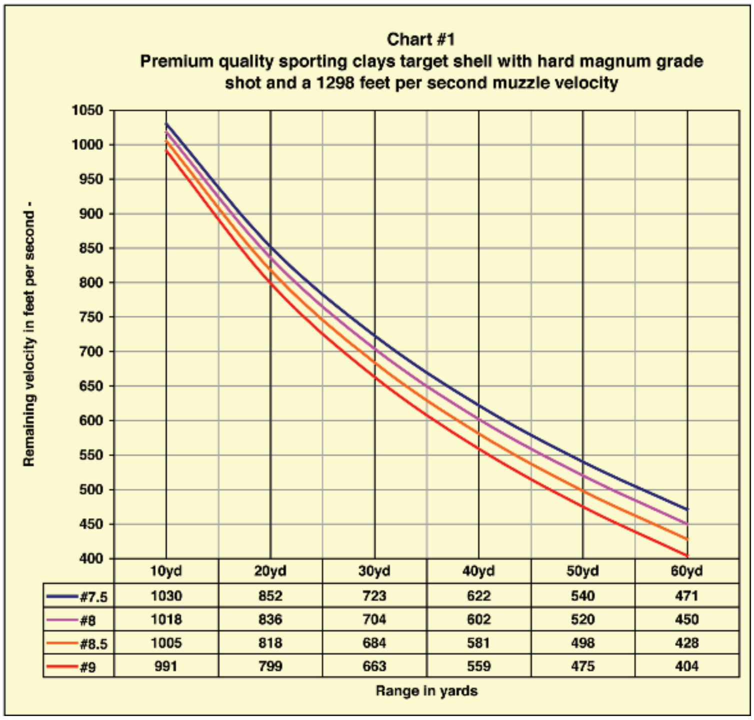
For longer distances, a typical approach is to go to a larger pellet size and a greater degree of choke constriction. The idea is to tighten up the overall spread and to ensure that there will be both sufficient pattern density and striking energy available to break the target. We know that larger pellets have greater hitting power at longer ranges, but do we really know why this is?

Downrange Velocity

It might be quite reasonable to assume that the larger pellets are heavier, so therefore they have more striking energy. This is undeniably true, but there are other factors to consider. Even a perfectly spherical ball (pellet) is a very poor shape from the ballistic viewpoint, being rapidly slowed by air resistance, but as the size of the 'ball' increases, its efficiency gradually improves.

If we take a regular sporting clays target shotshell loading containing #7.5 shot, with an actual muzzle velocity of 1298 feet per second (1230fps @ 3feet US rating with #7.5 shot) and compare the downrange pellet velocities, things start to get interesting.

If we know that the pellets of all sizes (from #9 through to #7.5) start out at 1298 feet per second when they leave the muzzle, then we can see that the smaller pellets' velocities drop off significantly more quickly as their range from the shooter increases.



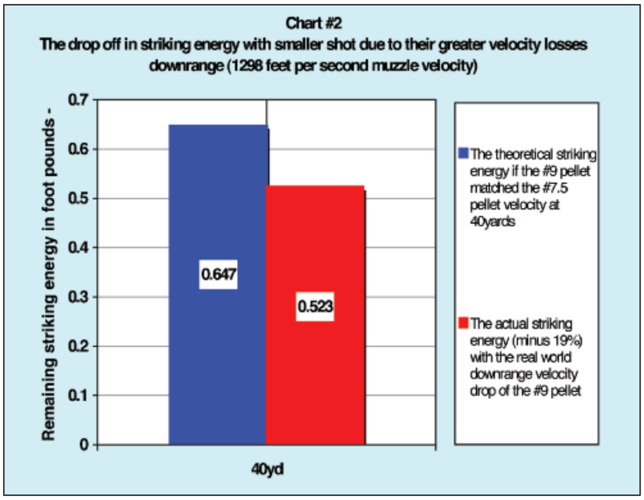
	10yd	20yd	30yd	40yd	50yd	60yd
#7.5	1030	852	723	622	540	471
#8	1018	836	704	602	520	450
#8.5	1005	818	684	581	498	428
#9	991	799	663	559	475	404

The velocity losses are most savage at the closer ranges, as the drag of the air resistance pulls down the smaller pellets in a more authoritative manner. As the velocity of all of the pellets drops, so does the ferocity of this drag imposed upon them. This can be demonstrated by the following figures. At 10 yards the #9s are already 39 feet per second slower than the #7.5s. This velocity retention advantage of the larger pellets is superior with increases in range, so that by 40 yards the downrange speed differential has grown to 63 feet per second.

It would be fair to argue that 40 yards is close to the maximum effective range for #9s for even face on targets, but the reduced effect of this velocity drop can be seen at 60yards where the #7.5 pellets' advantage has only grown to 67 feet per second (just 4 foot per second more). What we can gain from this information is that the worst of these velocity-reducing effects are mostly spent by 40 yards.

Striking Energy Losses

Because the smaller pellets have lost a greater proportion of their initial velocity, this also has an effect on their residual striking energy levels. Taking 40 yards as a convenient distance, if they were not slowed down more rapidly by the resistance of the air to their flight, the #9s could theoretically have the same velocity (622 feet per second) as the #7.5s. If the smaller #9s could achieve this higher velocity (622fps), then they would retain 0.647 foot-pounds of striking energy. However, in reality, at 40 yards range they have dropped down to 559 feet per second, which lowers their available striking energy to 0.523 foot pounds. This means that their actual retained velocity (559fps) is just over 10% slower than the faster #7.5s (622fps), but their striking energy potential has dropped by just over 19%. On a percentage basis, this loss of potential striking energy is very nearly double that of the velocity drop.

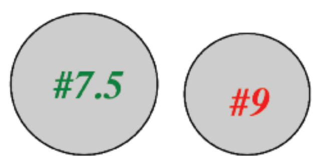


Velocity Disadvantage

As the magnum shot pellets shown in chart #1 are made of an identical lead alloy and therefore of the same density, there must be another factor at work that is slowing them down more quickly.

Pellet weight
- 1oz of #9s = 581 pellets, so each one weighs 0.753 grains (diameter 0.080 inch/2.032mm)
- 1oz of #7.5s = 347 pellets, so each one weighs 1.261 grains (diameter 0.095 inch/2.413mm).

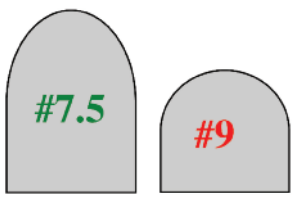
Figure #1



A SPHERE (BALL OR PELLET) IS A POOR SHAPE BALLISTICALLY, BUT A SMALLER SPHERE IS EVEN MORE SO. THE #7.5 PELLET IS VERY NEARLY 67.5% HEAVIER THAN THE #9, BUT IT ONLY HAS A 41% LARGER FRONTAL AREA (FLIGHT PATH AREA), BUT WITH A SIZEABLE WEIGHT ADVANTAGE.

The relatively small percentage increase in diameter when compared to the much larger percentage weight increase would appear to give the larger pellet (#7.5) a massive advantage. However, there is rather more to it than that. It is the actual area of the path of the pellet through the air (directly linked to its diameter) that is the most relevant factor in determining its ability to retain downrange velocity. The actual flight path area of the #7.5 pellet is 41% greater than that of the #9, but it also has a 67.5% weight advantage, so the #7.5 pellet is most definitely going to retain its velocity more efficiently. Taking these two figures we can see that the larger #7.5 pellet has an overall advantage of 26.5%. It is this larger weight advantage when compared to the smaller increase in its flight path frontal area that gives the larger #7.5 pellet its ranging power advantage and allows it to retain more of its velocity and hence its striking energy downrange. In the interests of clarity, we can demonstrate this advantage pictorially (in Figure #2 overleaf) with the two pellets represented as the same diameter but both being cylindrical in form like round nosed lead handgun bullets – the advantage of the #7.5 pellet is perhaps more obvious. The larger #7.5 pellet is superior to all of the smaller sizes (#8, #8.5 and #9) for downrange velocity retention on a roughly sliding scale, as is illustrated in Chart #1.

Figure #2
A schematic impression of the velocity retaining advantages of the larger pellets



THE #7.5 PELLET HAS THE ADVANTAGE OF GREATER MASS WHEN COMPARED TO ITS AREA.

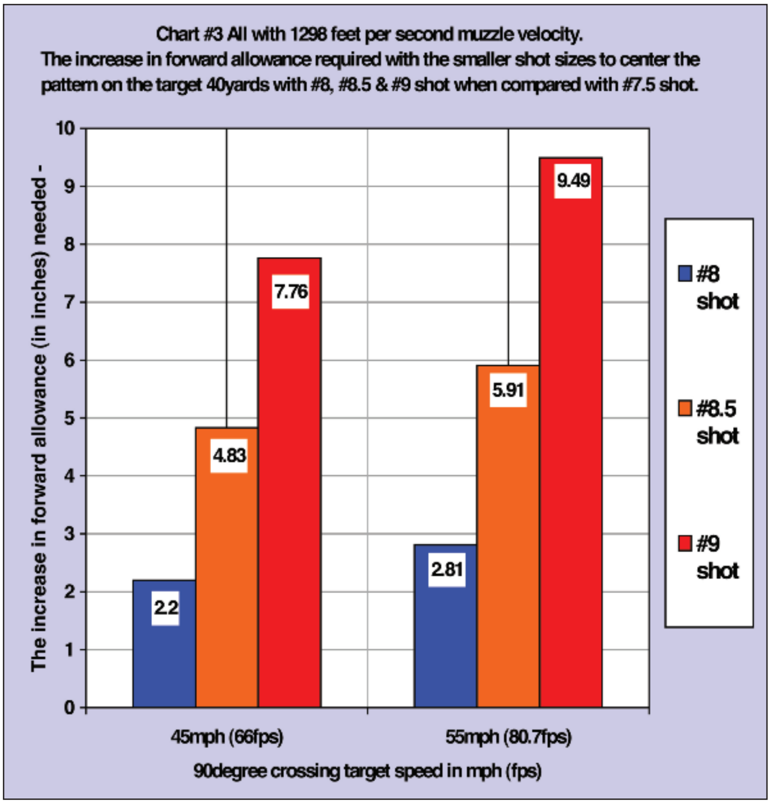
Flight Time

The larger pellets retain a greater percentage of their initial velocity downrange and are consequently flying faster than the smaller pellet sizes at any given range. Referring again to Chart #1, because the smaller pellets loose their initially identical velocity more quickly, they ultimately take a little longer to reach the target than the larger ones.

If we take a typical sporting clays target such as a crosser, passing directly 40 yards in front of the shooter's position, we can see that as the pellets get smaller than #7.5, they take longer to reach the same 40 yard distance and as a consequence changes the amount of lead required to hit the target. (#7.5 = 0.1415 seconds, #8 = 0.1443 seconds, #8.5 = 0.1476 seconds, #9 = 0.1513 seconds.)

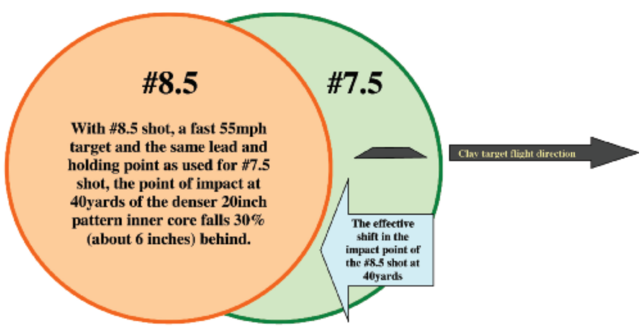
There is 0.0098 of a second differential between the fastest (#7.5) and the slowest (#9) pellets.

How much difference is this apparently tiny time difference actually really going to make to the required forward allowance on a crossing clay target? A typical crossing clay target speed is about 45mph, but in some cases with the traps wound up further, 55mph is possible. 45mph is 66 feet per second, which means that in 0.0098 seconds, the target travels a further 0.647 feet (7.8 inches) across the shooter's path. 55mph is 80.7 feet per second, so this translates into a further 0.79 feet (9.49 inches).



In Chart #3 we can see that there is more difference in the required leads than might have been previously thought. If we take the faster 55mph target and #8.5 shot at 40 yards, just under 6 inches (5.91 inches) of more lead is required. If the shooter is trying to center the 20 inch inner pattern ring on the target then this will shift the impact point of the pattern center by almost 30% (see Figure #3). With #9 shot this pattern shift has grown to an astonishing 47.5%!

Figure #3
20 inch pattern core circles. Both the #7.5 and #8.5 shot are launched at an identical 1298fps muzzle velocity. The smaller shot loses out more rapidly to the ravages of air resistance, so it takes longer to reach 40 yards.

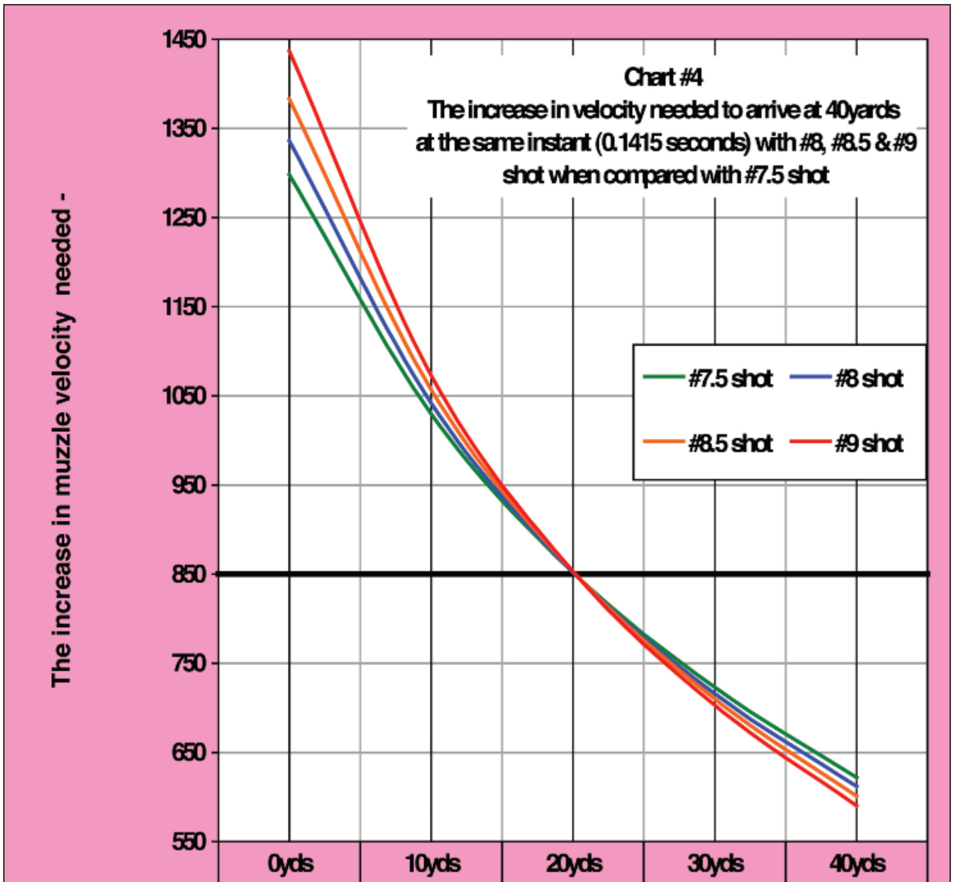


By the time that the impact center of the denser 20 inch inner core of the #8.5 shot pattern has reached 40 yards, the clay target has traveled another six inches. The impact of the shot has fallen behind by 30% (6 inches). This means that a clay target that would have been placed within the inner core using #7.5 shot (as shown), is now only partially caught within the outer 30 inch circle and its greatly reduced pellet density (not shown). The certainty of breaking the clay target has diminished.

High Velocity

Increased velocities when using smaller sized pellets in sporting clays loads is one way of countering the increased leads required at 40 yards. With reference to Chart #3, we can see that there is an increasing time lag between the instant of firing and the pellets reaching 40 yards as their size reduces. For the interests of clarity, a suitable pellet flight time interval of 0.1415 seconds to 40 yards has been chosen. This is the time taken for a charge of #7.5 pellets when fired with a 1298 feet per second muzzle velocity. So, what velocities are required for each of the smaller pellet sizes to reach 40 yards in 0.1415 seconds?

– A one-ounce International FITASC shell containing 581 #9 pellets fired with a muzzle velocity of 1437 feet per second has a US rated 1350 fps three foot velocity. On average these high-speed #9 pellets reach 40 yards in **0.1415 seconds**, with 0.58 foot-pounds of pellet striking energy.



	0yds	10yds	20yds	30yds	40yds
#7.5 shot	1298	1030	852	723	622
#8 shot	1336	1042	852	716	612
#8.5 shot	1383	1057	853	710	601
#9 shot	1437	1073	853	703	590

- With #8.5 shot (484 pellets) a muzzle velocity of 1383 feet per second gives a US rated 1303fps three-foot velocity and the pellets reach 40 yards in **0.1415 seconds**, with 0.73 foot pounds of pellet striking energy. The International FITASC 1oz loading carries 484 of these #8.5 pellets.
- With #8 shot and a 1336fps muzzle velocity (US rated 1263 three-foot velocity) the front pellets reach 40 yards in the same **0.1415 seconds**, with 0.89 ft/lbs of pellet striking energy.

Because all of the pellet sizes now reach 40 yards at the same instant, the leads required for a crossing target with all of these shells at 40 yards would be identical to the 1298fps #7.5 loading. Interestingly, #9s are still perfectly viable at this distance (now with 0.58 foot pounds of pellet striking energy) for the reliable breaking of a looper type 'face on' target, but an extra 139fps at the muzzle is needed, which also raises recoil with the same payload.

Chart #4 shows the relationship between the four pellet sizes and the increased velocities needed to reach 40 yards at the same time. What can also be gleaned from Chart #4 is that all of the pellets have identical velocities at 20 yards. This clearly demonstrates that the aggressive forces of air resistance work very much harder on the faster, smaller sized pellets in the first 20 yards or so of flight. This is also borne out by the further drop in the residual velocities of the four pellet sizes at 30 yards, there being but 20 feet per second between them, with #7.5 now being the fastest.

Pattern Density

- With a full choke 70% pattern, 1 1/8 oz of #7.5 (390 pellets) will have 273 pellets remaining within the 30 inch circle.
- With #8 shot (1 1/8 oz / 459 pellets) a Modified choke performance (60%) equates to 275 pellets within the 30 inch circle.
- #8.5 shot (1 1/8 oz / 545 pellets) can achieve a similar result of 273 pellets with an open Skeet type choking. With #9s, a true cylinder choke puts 262 pellets in the 30 inch circle.

However, the game plan is perhaps better served with increased pattern density, especially with trickier edge on target types. A good choice here would be the higher speed #8.5 pellets (US rated 1303fps @ 3 feet) using a Modified choke, which even with a 1oz International FITASC loading (484 pellets), puts 290 pellets into the 30 inch circle with 0.73 foot pounds of striking energy on a crossing target at 40 yards.

Conclusion

- #7.5 shot retains downrange velocity and energy the most efficiently. (Not counting International FITASC #7 pellets.)
- The smaller pellet sizes of #8, #8.5 and #9 do slow down more quickly than the larger #7.5 ones when fired at the same speed (Chart #1).
- Because the smaller pellets slow down more quickly, they need a greater amount of forward allowance for crossing and other types of target presentations, when using the same degree of choke constriction. The use of a progressively higher muzzle velocity as the pellet size decreases, can compensate for the differential in pellet arrival times at 40 yards and the need to increase leads (Chart #3 and Figure #3).
- When there is sufficient pellet striking energy available for the target in question, the higher speed smaller pellets can be beneficial, by allowing the shooter to use a more open choke while maintaining sufficient pattern density to break targets with certainty.
- This more open choke approach can also work when all pellets are fired at the same initial velocity (1298fps). This allows a greater spread and larger numbers of pellets in the front outer part of the 30 inch pattern circle. This can compensate for the need to increase leads and to ensure accurate placement of the central part of the pattern on the target. ■